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DEPARTMENTS

- 10 Feedback
- 11 Who's Where
- 12-13 The World
- 14 Up Front
- 15 Commander's Intent
- 16 Inside Business Aviation
- 17 Airline Intel
- 18 In Orbit
- 19 Washington Outlook
- 55 Classified
- 56 Contact Us
- 57 Aerospace Calendar

THE WORLD

- 12 **AgustaWestland** begins flying the first fully configured AW101 CSAR helo destined for the Italian AF
- 12 **Karem Aircraft** confirmed as one of four vying for the preliminary design of Darpa's VTOL X-Plane
- 12 **India tops** world's importers of military hardware, says report from Swedish research institute

MH370

- 20 **Hunt for MH370** throws a harsh light on internal and cross-border relationships in Southeast Asia
- 22 **Recovery of MH370** wreckage will be next challenge as investigators develop possible crash scenarios
- 23 **U.S. Navy's P-8** pushed into the limelight to join the search for Malaysian Airlines Flight 370

DEFENSE

- 24 **Some defense** industry officials see F-35 budget dominance as jeopardizing EW capabilities
- 25 **USAF KC-135** crash in Kyrgyzstan in 2013 prompts significant changes to flight and emergency training
- 27 **U.S. remains** world leader in defense exports—up 11% in last five years—but Russia is gaining market share

SPACE

- 28 **Pentagon guards** Russian Atlas V engine options as discord with Moscow deepens over Crimea
- 29 **Satellite-servicing** firm developing life-extension vehicles for commercial sats in geostationary orbit

AIR TRANSPORT

- 32 **Market dynamics** may safeguard huge Airbus and Boeing order backlogs against usual cyclic blows

- 33 **Airbus may be** ambivalent about a reengined A330, but a growing market sector is voicing support
- 34 **Looming shortage** of skilled airline operations personnel may lead Indonesia to limit aircraft imports
- 54 **Emirates' growth** this year promises to be more muted due to infrastructure work at its main hub

SAFETY SYSTEMS

- 36 **Preliminary airline** accident statistics from ICAO for 2013 are cause for optimism
- 37 **Airlines and** pilot-training providers reprogram upset prevention and recovery training
- 40 **Airline industry** taking a proactive stance on safety upgrades triggered by new flight-training rules


44

Aerospace and aviation luminaries from around the globe gathered March 6 at the historic National Building Museum in Washington for Aviation Week's 57th annual Laureate Awards.



ON THE COVER

36 Runway excursions, such as this Singapore Airlines Boeing 777-300ER veer-off in Munich in 2011, continue to dominate non-fatal accident statistics, while loss-of-control-in-flight remains the deadliest type of accident. A special report starting on [page 36](#) examines new, proactive interventions by regulators and the airline industry to reduce the impact of both. Photo courtesy of German Federal Bureau of Aircraft Accident Investigation (BFU). Also highlighted on the cover are photos and highlights from Aviation Week's 57th Laureate Awards ([page 44](#)).



53 **Finmeccanica** pursuing a plan to focus solely on its core aerospace, defense and space businesses, and shed other areas.



28 Reliability of U.S. access to the Russian-made RD-180 engine used to power national security payloads to space now in question.



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Find Aviation Week





40 Airline working group closing in on ways to minimize the most common contributor to airline accidents

42 Boeing and Embraer safety effort launched in 2012 yielding first fruits to help with runway excursions

LAUREATES 2014

44 Aviation Week editors recognize individuals and teams for contributions built on boldness and innovation

45 X-47B team clinches Laureate for proving a stealthy, unmanned aircraft can operate on a carrier deck

45 RTCA 'Skunk Works' takes Laureate as the makers, users and regulators of advanced vision systems

46 Bradley Mottier receives Laureate for guiding GE into small engines, using his passion for aviation

46 IAG's Willie Walsh wins Laureate for airline successes that show his fights for what he believes is crucial

47 Team from Dassault and DGA honored for flying Europe's first stealthy unmanned combat air vehicle

47 Space Laureate goes to Jean-Yves Le Gall, new president of CNES and ex-chairman of Arianespace

48 Photos show Aviation Week's Laureate Awards dinner, which drew 350 executives and officials

50 Canadian helo crew wins Heroism Award for wilderness rescue that tested courage, resourcefulness

51 Laurent Beaudoin honored with Lifetime Achievement Award, remains guiding force in Bombardier's plan

51 Harold Rosen, father of the communications satellite, wins a Lifetime Achievement Award

52 Members of the four U.S. service academies honored for excellence and interest in aerospace careers

BUSINESS

53 Finmeccanica changing shape as it works to overcome spiraling debt, effects of government spending cuts

VIEWPOINT

58 We need to improve both stall prevention and recovery training, so stalls do not catch pilots off guard

On the Web

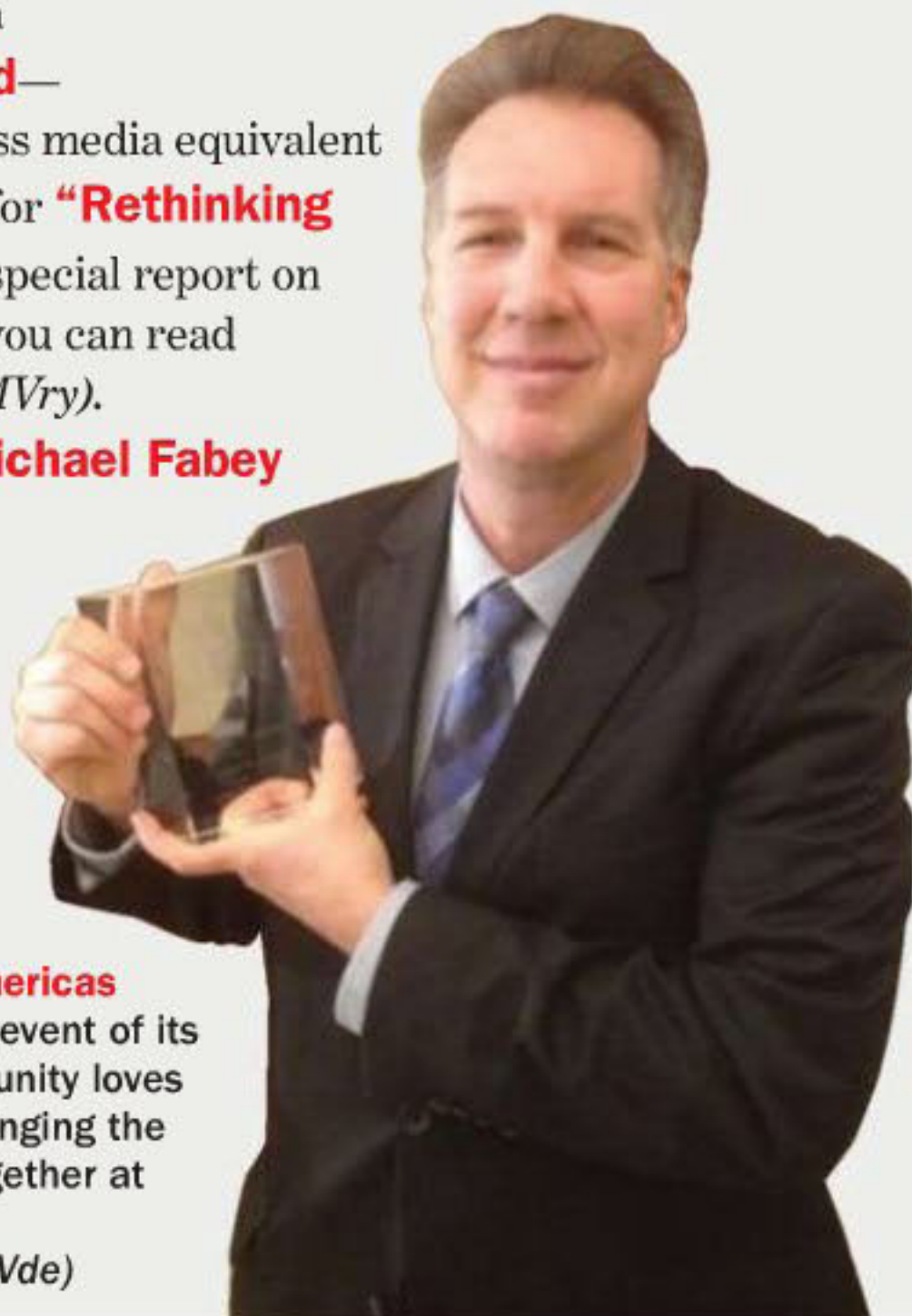
A round-up of what you're reading on AviationWeek.com

In our latest **Check 6** podcast, Aviation Week's editors discuss the role of military and civil radars in the search for Malaysia Airlines Flight 370. **Download** this and past editions from the iTunes store: (ow.ly/uMUWe) and read this week's coverage beginning on [page 20](#).

Aviation Week won a **Jesse H. Neal Award**—the business-to-business media equivalent of the Pulitzer Prize—for **"Rethinking the Unthinkable"** a special report on nuclear weapons that you can read in its entirety (ow.ly/uMVry). And, **Naval Editor Michael Fabey** won the prestigious Timothy White Award for Editorial Integrity for his reporting on the U.S. Navy's Littoral Combat Ship.



MRO Americas is the largest networking event of its kind and the MRO community loves to tweet, so we're now bringing the **#MROAM** community together at the first **MRO TweetUp**. Plan to attend! (ow.ly/uMVde)



STEALTH-BUSTER

Saab says state-of-the-art infrared search-and-track systems can detect and track stealthy aircraft at the kind of distances associated with beyond-visual-range engagements, even if they are not using afterburner. Read about this development on our Ares blog (ow.ly/uNOKQ). **AviationWeek.com/Ares**

READER COMMENT

On one of our articles about **Malaysia Airlines Flight 370**, 'Guimar' writes, "If the scenario on MH370 is a deliberate attempt to shut off systems on the aircraft, any onboard solution would not solve the problem, if the crew can shut the system off. Not being able to shut off systems presents a fire hazard." (ow.ly/uNOWD)



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WEIGHT TRUMPS LENGTH

There has been a lot of talk from the "experts" on TV regarding the number of 5,000-ft.-long airports that could accommodate a Boeing 777. A TV-station-generated analysis that states there are 634 such airports is being bandied about recklessly.

This flawed analysis ignores the fact that a runway must be strong enough to accommodate a 777. Since the empty-fuel-max-operating weight of the aircraft is 190,600 lb., I doubt there is a 5,000-ft.-long runway in existence strong enough to withstand that amount of weight.

USAF Col. (ret.) Gene Cirillo
GOLD RIVER, CALIF.

INVESTIGATION IMPEDIMENTS

It is disappointing that the media, including Aviation Week, elected to engage in a public debate on the aviation capabilities of the crew onboard the fatal UPS Flight 1354 that crashed short of Birmingham, Ala., on Aug. 13, 2013.

The author did caveat within the second paragraph of "Unfamiliar Ground" (AW&ST March 3, p. 46) that the NTSB investigation is still months from "completion," but he then focused on the captain's and first officer's abilities to operate into Birmingham-Shuttlesworth International Airport, and in particular on their conducting a non-precision approach.



This form of public discussion does not do justice to the process of investigating and determining the most likely cause of this tragic accident. The media owe it to this crew as well as all the other Part 121 cargo carrier pilots to allow the process to come to its conclusion without influencing the public's

perception of any pilot's reputation and capabilities.

Leave this form of journalism to the political arena. Safety demands that we follow tried and true processes in investigative events, void of sensationalism based, in part, on assumptions.

Capt. Sean P. McDonald
Air Line Pilots Association, Int'l.
WASHINGTON, D.C.

DISMAYED WITH DELTA

In "Back Again" (AW&ST March 17, p. 36), Delta Air Lines CEO Richard Anderson makes some remarks about his future fleet strategy efforts for the airline that seem to align with the rag-tag strategy the carrier has held practically throughout its history.

Along with myriad mergers and acquisitions, the airline has kept older inefficient aircraft that would not be competitive in a marginally profitable environment. Present profits are gleaned from low fuel prices and employee contracts held hostage to the specter of bankruptcy.

His remark that Boeing did not have an answer to the 767 is surprising considering the 787 is at least 40% more efficient and has improved maintenance and reliability. As to the A350 being "pretty much down the road," the aircraft has not even entered service to those typical shakeout periods of airline operations. Plus, the reengined A330 would be an experiment, needing extensive flight testing and modifications.

Delta Air Lines Capt. (ret.) Tom Carey
FREELAND, WASH.

OEMS' OVER-THE-TOP DEMANDS

In the "Warning Sign for the Supply Chain" (AW&ST Mar. 17, p. 66), Tom Captain forecasts that when original equipment manufacturers (OEM) pressure sub-tier suppliers to reduce prices, bad things might happen in our industry.

He is right, except for the timing. It is already happening. One OEM is asking for cost reductions that would total 15% over five years—and this is for legacy parts, where margins are already razor thin.

OEMs forget that moving high-tech machining out of their facilities resulted in immediate savings. Following this trend, I guess we should soon prepare to pay OEMs to take our products.

Glenn W.E. Ford, President
B&E Precision Aircraft Components
SOUTHWICK, MASS.

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, 1200 G St., Suite 922, Washington, D.C. 20005. 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.

THE POWER OF GROUND FORCES

I must take issue with Bill Sweetman's "A Shrinking Army" (AW&ST March 10, p. 16). It is not good that we are reducing the size of our Army, nor should we reduce the size of any of our other military services, especially at a time of heightened world tensions.

We do not maintain ground forces out of fear of invasion. Fortune bestowed the security of peaceful neighbors and two large oceans on our frontiers. But we need ground forces because they are capable of effecting direct control where the essential social, economic and political activity of mankind takes place—on land.

Ground forces often take more casualties than do their air and naval brethren. But they have the flexibility to go from fighting to administering aid to providing security, often within the course of a single mission—a level of direct contact with other humans that air and naval forces rarely have.

In the end, military conflicts involve people. I have never known of a missile that could discriminate between a combatant and noncombatant at the last second, but I have known quite a few soldiers and marines who could, and did—often putting themselves in harm's way.

This in no way diminishes the boundless contributions of air and naval power. But in the end, it was the soldier or marine, equipped with a rifle and unyielding of the real estate upon which he or she stood who decided the final outcome of the conflict. That may seem like an antiquated statement on the pages of a journal dedicated to technologies that can reach the stars, but it is a truth nonetheless. Even after two atomic bomb attacks—delivered by U.S. airpower—it was still necessary to occupy Imperial Japan in order to demilitarize and democratize that nation. There are countless other examples. I hope our political leaders reflect on them before acting rashly.

Joseph Davis
PEORIA, ARIZ.

Who's Where



Don J. Chavez



David W. Miller

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.

Paul H. Jona has been appointed senior vice president of U.K.-based *Cobham Satcom*. He succeeds **Walther Thygesen**, who plans to retire in June. Jona was chairman/CEO of CoActive Technologies in the Netherlands and had been senior vice president of the Cable Systems Group at the Amphenol Corp.

Don J. Chavez (see photo) has been named vice president/associate general counsel/sector counsel for the Falls Church, Va.-based *Northrop Grumman Corp.*'s Technical Services. He has been counsel in the Electronics Systems sector's Navigation and Maritime Systems.

John C. McNellis has become president of New York-based *L-3 Communications'* Aerospace Systems, which is part of a realignment of the company's divisions. **John S. Mega** has been named president of Communication Systems. Continuing as presidents of their divisions are: **Steve Kantor**, Electronic Systems; and **Les A. Rose**,

National Security Solutions.

Michael Hotze has been appointed vice president-customer support and training for *Agusta Westland's* Philadelphia facility. He succeeds **Giovanni Cecchelli**, who has been promoted to vice president-capability development and governance, customer support and training. Hotze was director field operations and director customer support for Bell Helicopter.

David W. Miller (see photo) has been named NASA's chief technologist. He has been a professor of aeronautics and astronautics at the Massachusetts Institute of Technology in Cambridge and director of its Space Systems Laboratory. He succeeds **Mason Peck**, who has returned to his teaching position at Cornell University. Miller also has been principal investigator for NASA for the Regolith X-ray Imaging Spectrometer for the Osiris-REx asteroid sample return mission.

HONORS AND ELECTIONS

Robert A. Hoover, former air show pilot and USAF

test pilot, has been named to receive the fifth annual Outstanding Aviator Award of the New York-based *Wings Club* and the *International Aviation Women's Association*. The award recognizes contributions to aviation and/or security and aviators who serve as role models. Hoover is considered one of the founders of modern aerobatics, having performed his flying maneuvers over millions of people during the past five decades. Additionally, he has flown more than 300 types of aircraft and flight-tested or piloted nearly every kind of fighter aircraft. ☛



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SPACE

Sofia Faces Budget Ax

As part of the U.S.-German Stratospheric Observatory for Infrared Astronomy (Sofia) program—a 2.5-meter telescope designed to fly on a modified Boeing 747-SP—Berlin is seeking a reprieve. NASA, which has grown weary of paying the bulk of annual maintenance costs for the \$3 billion observatory, has proposed shelving the project in its 2015 budget request to Congress, citing costs of around \$85 million per year as being second only to those for the Hubble Space Telescope. Berlin, which pays more than 20% of those costs, argues NASA should uphold its commitment to Sofia through at least 2016, by

India Leads Military Imports

India imports nearly three times as many arms as China and Pakistan, a Swedish-based research institute says, firming the country's position as the world's leading buyer of military weapons: 65% of its hardware.

India increased its arms imports by 111% over the past five years, compared with 2004-08, and now accounts for 14% of the world's weapons imports, the Stockholm International Peace Research Institute (Sipri) says in a new report last week. The second-highest importers, China and Pakistan, each account for 5% of international defense imports.

During 2009-13, India procured 90 of the 222 Sukhoi Su-30MKI combat aircraft ordered from Russia, and 27 of 45 MiG-29Ks bought for use on aircraft carriers, Sipri says. India also has ordered 62 MiG-29SMT and 49 French Mirage 2000-5 combat aircraft (see page 27).

India replaced China as the world's leading importer of weapons in 2010 and has retained the spot ever since. The former spends nearly \$30 billion a year on defense, while China spends three times as much, according to the International Institute for Strategic Studies.

Yet, despite India's emergence as the world's largest arms importer, it has failed to build a robust defense-industrial base, unlike China. Experts say the inability of India's domestic defense industry to manufacture high-tech arms makes the country susceptible to blocked supply lines during emergencies.

At the same time, India's armed forces continue to grapple with shortages of fighter jets, helicopters, submarines and night-fighting capabilities as its defense equipment modernization takes place in an arbitrary manner.



RICHARD PITTMAN

which time a third partner—possibly a member of the 20-nation European Space Agency—could materialize with additional funding for the program. In the meantime, the issue is particularly dire for Germany, which is planning heavy maintenance work on the Boeing jet this summer in order to keep Sofia operational. “If we cannot continue to use it, should we do that maintenance?” asks Johann-Dietrich Woerner, head of the German Aerospace Center DLR. “If not, that means a problem for the plane,” he said, adding that without the overhaul, Sofia would be removed from service at year-end. Nearly two decades in the making, Sofia is only now on the verge of full operational capability, with nearly 20 years of operational life ahead of it. In 2010, NASA said it had spent about \$614 million on Sofia, versus the \$265 million planned when the program started in 1995. But Woerner argues that scrapping the program now is a waste of money.

Solar Orbiter on Atlas V

NASA will pay \$172.7 million to United

Launch Services, the contracting arm of United Launch Alliance, for preparation and launch of the U.S.-European Solar Orbiter Collaboration mission in 2017 on an Atlas V. The company will handle spacecraft processing, payload integration, launch and related launch services for the mission, which is expected to study the Sun and its outer atmosphere with high-resolution imagery and in-situ measurements from solar orbit. It will use an Atlas V 411 flying from Launch Complex 41 at Cape Canaveral. Launch is set for July 2017.

First Orion Flight Slips More

First spaceflight of NASA's Orion crew capsule, with an instrumented prototype riding atop a Delta IV Heavy, may not come until December. At first scheduled for September, the Experimental Test Flight-1 (EFT-1) mission originally was bumped until October by range-scheduling issues at Cape Canaveral (AW&ST March 10, p. 12). Now the launch has moved back to Dec. 4, according to Orion prime contractor Lockheed Martin, with a

Karem Reveals Its Tiltrotor Design for Darpa's VTOL X-Plane

Karem Aircraft has been confirmed as one of four competitors selected for the preliminary design phase of the Defense Advanced Research Projects Agency's (Darpa) Vertical Takeoff and Landing (VTOL) X-Plane program. The program aims to demonstrate a vertical-lift aircraft that can cruise at 300-400 kt., with a 75% hover efficiency, cruise lift-to-drag ratio (L/D) of at least 10 and a useful load of at least 40% of the vehicle's gross weight. Conventional helicopters have a maximum speed of around 170 kt., hover efficiency of 60% and L/D of 4-5.

Karem is offering a variant of its optimum-speed tiltrotor concept. This has variable-speed proprotors with light, stiff blades rigidly attached to the hub, which in turn is rigidly attached to the driveshaft. All four VTOL X-Plane designs are for unmanned aircraft, but Darpa says the technologies are intended to apply equally to manned aircraft.

Boeing is designing the Phantom Swift, which has two ducted rotors embedded in the fuselage and two tilting ducted fans on the wingtips. Sikorsky, teamed with Lockheed Martin Skunk Works, is designing the Unmanned Rotor Blown Wing. This is a tailsitter that takes off and lands in a vertical attitude and tips over into a horizontal attitude for forward flight. Aurora Flight Sciences has not revealed the configuration of its Lightning Strike design, but points to its experience with ducted-fan and hybrid-propulsion aircraft. The four competitors plan to submit preliminary designs in late 2015, after which Darpa will decide whether to select one to build a 10,000-12,000-lb.-gross-weight technology demonstrator to fly in 2017-18.

Italian Combat Search-and-Rescue HH-101 Emerges

AgustaWestland has begun flying the first fully configured HH-101 Caesar combat search-and-rescue (CSAR) helicopter destined for the Italian air force (AMI).

The first AMI HH-101 flew in a green configuration in February and underwent a short test flight at Yeovil, England, on March 17 (see photo). AMI has 12 of the helicopters on order. Company officials say the aircraft are the most advanced versions of the AW101 flying.

The aircraft are being fitted with defensive aids and an electro-optical sensor under the nose. They will eventually be configured for mid-air refuelings from AMI's fleet of KC-130J Hercules. First deliveries are expected this year. The aircraft are due to replace the aging Agusta-built Sikorsky HH-3F Pelicans that fly in the CSAR role and the peacetime SAR mission.

"protect date" in October in case the logjam clears. EFT-1 will be a two-orbit Earth loop-around designed to validate the capsule's big heat shield by bringing it back into the atmosphere at 80% of the velocity it would see on a return from the Moon. The company says it will still deliver the flight hardware this summer, which means it could maintain its original September launch date, according to a company spokeswoman.

DEFENSE

Top-Tier Scrutiny

The Pentagon is increasingly looking at first-tier subcontractors and their deals with prime providers of major weapons and systems, and all of them are being judged on what they do to lower costs for the Defense Department, according to Shay Assad, director of defense pricing and acquisition policy. "We're looking at them as closely as we're looking at the prime in any major business deal," he says of so-called Tier 1 subs, which regularly involve companies that could be primes on other contracts. For

instance, in the F-35 Joint Strike Fighter program, the Defense Department is just as interested in BAE Systems' and Northrop Grumman's deals with prime Lockheed Martin as it is with Lockheed itself, Assad says. "We are distinguishing between the companies that are focused on lowering their costs, and the ones that aren't," he told Aviation Week's Defense Technologies and Requirements conference this month. "We want to reward the companies that are focused on giving us a better deal."

First M-346 for Israel

AleniaAermacchi has rolled out the first of 30 M-346 jet trainers destined for the Israeli air force (IAF). The aircraft, which made its first flight on March 15, was presented in IAF colors at the company's facility in Venegono, Italy, on March 20. AleniaAermacchi will deliver nine M-346Is to Israel this year, with the first pair due on July 10. Another 18 will be delivered in 2015, with the remainder in 2016. The M-346s are destined to replace Israel's aging TA-4 Skyhawks.

India To Buy Pilatus Trainers

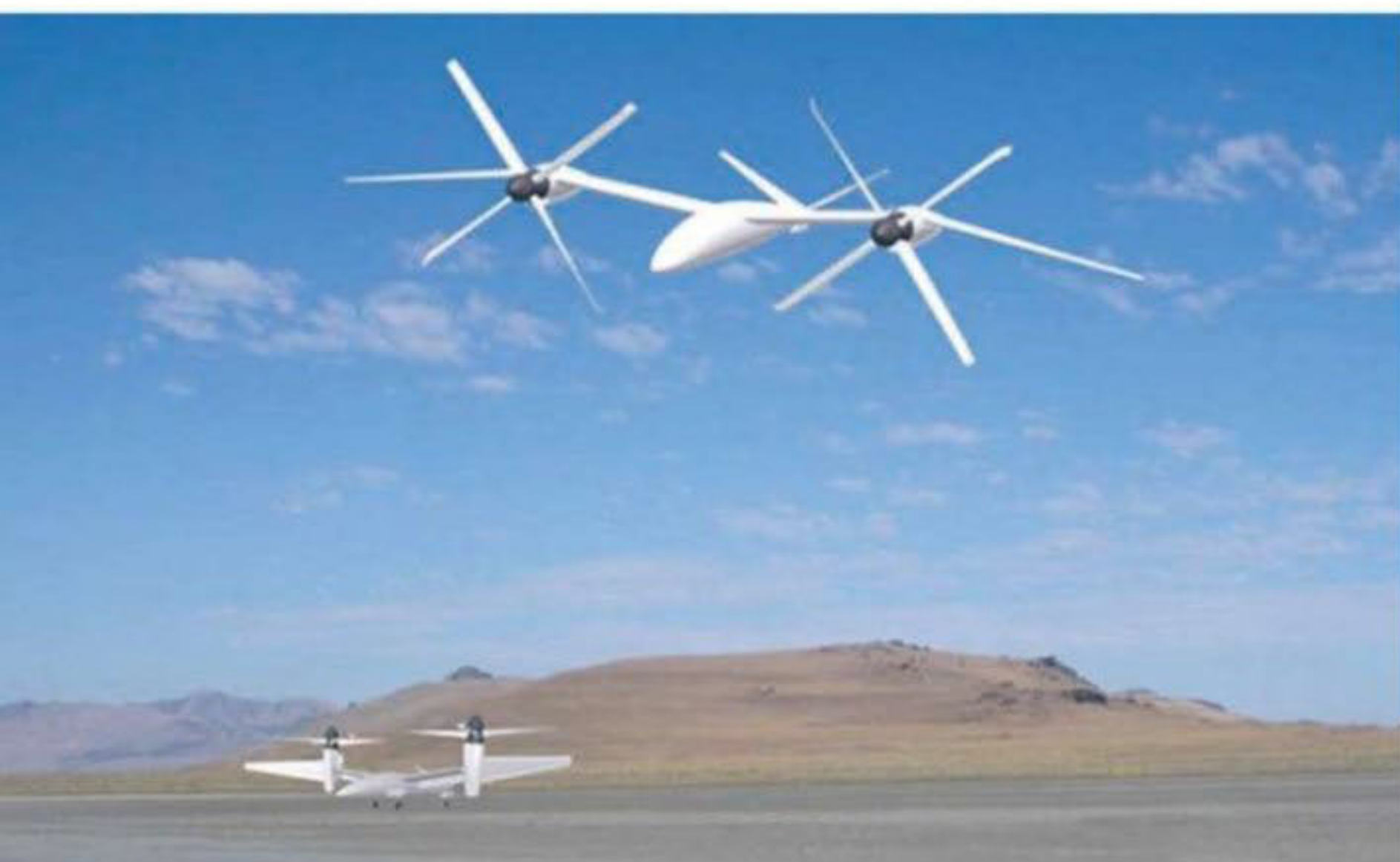
The Indian air force (IAF) has decided to "urgently" buy 106 PC-7 Mk. 2 Basic Trainer Aircraft (BTA) from Pilatus, pulling the plug yet again on state-run Hindustan Aeronautics Ltd. (HAL), which is also building an aircraft for training junior pilots. India is already taking delivery of PC-7 Mk. 2 aircraft from Pilatus under a contract for 75 signed in 2012. Under the "Buy & Make (Indian)" contracting category, Pilatus will have to form a joint venture or establish a production arrangement with an Indian company to execute the contract. A request for information (RFI) calls for delivery of aircraft and equipment to begin by 2015-16, with all 106 PC-7 Mk. 2s to be delivered by 2020-21. RFI responses are due April 21.

BUSINESS AVIATION

Textron Ties Bizav Firms

As Textron stitches together Cessna and Beechcraft under the newly created Textron Aviation, company executives still have numerous decisions to make—from which facilities to merge to potential employee layoffs. Textron closed on its \$1.4 billion purchase of Beechcraft March 14, a few months ahead of the anticipated mid-year closing schedule. As originally envisioned, Textron would form one entity from a financial reporting standpoint although early indications were that the brands would be maintained, and the management of the operations would remain somewhat intact. But that scenario evolved as the acquisition was completed, with Scott Ernest, who had been the president and CEO of Cessna, becoming the head of Textron Aviation. Beechcraft CEO Bill Boisture, meanwhile, left the company following the conclusion of the acquisition. "This was a planned part of the transition," the company says. Early appointments show a leadership team that is weighted heavily toward Cessna, with that company providing 11 out of the 14 senior vice presidents and vice presidents.

Correction: The date of the departure of Malaysia Airlines Flight MH370 from Kuala Lumpur was incorrectly stated in the March 17 edition (page 38). The aircraft veered from course and disappeared from most tracking screens on March 8.



DEFENSE ADVANCED RESEARCH PROJECTS AGENCY



By Richard Aboulafia

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COMMENTARY

Thinking Medium

The case for a scaled-up successor to the Boeing 757

At last month's Singapore Airshow, Boeing executives discussed the 200-280-seat segment as a potential market for the company's next new jet. Airbus also has examined a new jet in this class. There are valid reasons to believe this will be the next new jetliner that one or both companies pursue, and that it will open a pivotal battleground.

Consider the market. Boeing built 1,049 757s, including 55 stretched -300 variants. Of these, 978 are still in service, according to the *Airline Monitor*. There have been more retirements of Boeing 737NGs than 757s, even though the latter jets are much older. Retrofit work on 757s, most notably to install range-extending winglets, has provided solid business, and it's quite likely these planes will be used to a relatively advanced age.

Several factors contributed to the 757 line's shutdown in 2005. As major U.S. carriers moved toward faster turnaround times and more frequent departures at hubs, their needs skewed to smaller jets. At the same time, European charter operators with 757s fell prey to low-cost carriers using Airbus A320s and 737s. And Boeing, under serious profit pressure, was desperate to control costs by moving toward a simpler product line with fewer models.

But a lot has changed since 2005. Long-term demand for a jet in its class is strong, particularly for China's domestic market. Other new growth drivers include low-cost carrier expansion and North Atlantic market fragmentation: United and other carriers are successfully using 757s to serve new city-pairs.

Since a 757 replacement would likely be larger and more capable—



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probably with 210-240 seats and a 4,000-5,000-nm range—it would also go after the Airbus A300/A310 and Boeing 767 segment. More than 1,500 of these aircraft are still in service. Given the demand and projected system growth ahead, a larger 757 series could see sales of 2,000-4,000 over 20 years.

What would compete with a new jet in this class? The reengined 321neo and largest 737 MAX (now called the 737-9) can't match the range and payload. The Airbus A350 and Boeing 787 are optimized for much longer ranges and carry very large wings and other structures, making them less appealing for 3,000-4,000-nm routes. Boeing's shorter-range 787-3 was canceled in 2010, and the orderbook for Airbus's A350-800 has been cut by more than half over the last year.

A market opportunity like this offers strong profits, particularly if only one manufacturer pursues it. But a launch by either Airbus or Boeing is

unlikely until current twin-aisles and reengined singles have been brought to market. That means a 2017-19 launch at the earliest, with a service entry in 2022-24.

Airbus could follow the path Boeing took when it created the 757: take an existing single-aisle fuselage, add a new wing and engines and perhaps more powerful geared turbofans. Rather than try to find the cash to develop a 400-plus-seat twin-aisle jet to compete with Boeing's 777-9X, why not spend less and dominate the entire 200-280-seat segment? A product lineup from the 321neo to a new 230-seat jet to a reengined A330-200 would mount a seamless attack on the market. It would also take advantage of current product introduction timing, since the last A350 variant will arrive by 2017, while Boeing will still be working on the 777-8X until 2022.

For its part, Boeing could pursue a next-generation 757 using MAX technology and new engines. A relatively quick, off-the-shelf solution also represents a useful fallback plan for Boeing in the event 737-9 sales continue to lag A321neo sales.

In terms of technical characteristics—twin- versus single-aisle, composite versus metal primary structure—this new aircraft is far from defined. Would it have a relatively straightforward design, or use emerging new technologies such as out-of-autoclave composites, ultra-high-bypass engines or even a radically new airframe design?

Both manufacturers face a dilemma. If one seizes the up-front demand with a derivative jet, it risks being out-matched by an all-new and innovative design optimized for this segment 3-6 years later. Alternatively, if one pursues the high-tech approach, it might find that its competitor runs away with very strong up-front demand, while the new-technology model fails to command higher prices or sales.

Planners at both jetmakers are likely working overtime on customer requirements and timing for a jet in this class, while simultaneously examining technology roadmaps for relevant new features, subsystems and materials. After all, the two players in a duopoly can't ignore a market vacuum. ✎



By Bill Sweetman

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COMMENTARY

Generation Games

New Gripen may be the next wave

Lockheed Martin labeled the F-35 a “fifth-generation” fighter in 2005, a term it borrowed from Russia in 2004 to describe the F-22. Some of their rivals tumbled into this rhetorical trap and tried to argue that “fourth-generation” was just as capable. Whether it is true or not, making such a case is an uphill struggle.

But if “fifth-generation” means more than “the ultimate driving machine,” a sixth generation will emerge. Saab can argue that the JAS 39E Gripen, rather than some of the wildly expensive-looking artist’s concepts we have seen, is the first such aircraft.

The Gen 5 concept is almost 30 years old. It dates to the final turning point in the Cold War, when the Reagan administration accelerated the arms race, believing (correctly) that the Soviet economic engine would throw a rod first. The F-22 was designed for a challenging but simple war: If you were in a NATO fighter and the nose was pointed east, pretty much everyone headed your way was trying to kill you.

Defense technology led aerospace in those days, and aerospace drove many other technologies. Today’s gaming, simulation and movies are descended from 1980s military simulators.

The world has changed a bit. Operation Allied Force in 1999 presaged the air campaigns of the 2000s, when targets were soft but hard to find, and harder yet to pick out of the civilian environment. We can say little for certain about the nature of future conflict, except that it is likely to be led by, and revolve around, intelligence, surveillance and reconnaissance (ISR). For the individual pilot, sailor or soldier, that translates into situational awareness.

Demographics and economics are squeezing the size of the world’s militaries—nations with more than 100 combat aircraft are few and becoming fewer. There are no blank checks for overruns.



Much of the technology of 1995, let alone 1985, has a Flintstones look from today’s perspective. (My 1985 computer boasted 310 kb. of storage and communicated at a screaming 300 bits per second.) Software is no longer what makes machines work; an iPhone is hardware that is valued because of the apps that it supports. This technology is characterized by development and deployment cycles measured in months. In aerospace, the lead in materials and manufacturing has gone to the commercial side.

The conundrum facing fighter planners is that, however smart your engineering, these aircraft are expensive to design and build and have a cradle-to-grave product life that is far beyond either the political or technological horizon.

The reason that the JAS 39E may earn a Gen 6 tag is that it has been designed with these issues in mind. Software comes first: The new hardware runs Mission System 21 software, the latest roughly biennial release in the series that started with the JAS 39A/B.

Long life requires adaptability, both across missions and through-life. Like Ed Heinemann’s A-4 Skyhawk, the Gripen was designed as a small aircraft with a relatively large payload. And by porting most of the software

to the new version, the idea is that all C/D weapons and capabilities, and then some, are ready to go on the E.

The Swedes have invested in state-of-the-art sensors for ISR and situational awareness (AW&ST March 17, p. 28), including what may be the first in-service electronic warfare system using gallium-nitride technology. It’s significant that a lot of space is devoted to the identification friend-or-foe system. Good IFF is most important in a confused situation where civilian, friendly, neutral, questionable and hostile actors

are sharing the same airspace.

Sweden’s ability to develop its own state-of-the-art fighters has long depended on blending home-grown and imported technology. Harvesting technology rather than inventing it becomes more important as commercial technology takes a leading role and becomes more global. The JAS 39E engine is from the U.S., the radar from Britain, and the infrared search and track system is Italian. Much of the airframe may be built in Brazil.

However, what should qualify the JAS 39E for a Gen 6 tag is what suits it most for a post-Cold War environment. It is not the world’s fastest, most agile or stealthiest fighter. That is not a bug, it is a feature. The requirements were deliberately constrained because the JAS 39E is intended to cost less to develop, build and operate than the JAS 39C, despite doing almost everything better. As one engineer says: “The Swedish air force could not afford to do this the traditional way”—and neither can many others.

It’s an ambitious goal, and it is the first time that Sweden has undertaken such a project in the international spotlight. But if it is successful, it will teach lessons that nobody can afford not to learn. ☺



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COMMENTARY

Up on the Farm

The agriculture world wants more than just rain clouds overhead

The persistent drought in the western U.S. is very much part of the national consciousness; many are wondering about the impact on food pricing and availability. Rest assured that individuals like Robert Blair and Jim Hirsch will do their best to keep the ambered grain waving and the plains well fruited.

A fourth-generation farmer, Blair (bottom photo) attends to his 1,500 acres of “wheat, peas, lentils, garbanzo beans, alfalfa and cows” at the foot of the Rockies in Kendrick, Idaho. While last fall was drier than normal, he says there was a fair amount of winter snow and the melt should put the reservoirs at capacity. So, barring an unforeseen setback, the 2014 yield should be ample.

Meanwhile, Hirsch heads Air Tractor, which together with Thrush Aircraft, are the U.S.’s only dedicated ag-plane manufacturers. And they make a lot of them. According to the General Aviation Manufacturers Association, last year Thrush, which was bankrupt a decade earlier, turned out 51 turbine-powered machines (top photo). And Air Tractor delivered 174 units, making the company the No. 1 producer of civilian turboprop airplanes last year.

According to Andrew Moore, executive director of the National Agricultural Aviation Association, there are 3,000 ag aircraft, including helicopters, at work in the U.S. The size of the global fleet is unknown, but growing. Moore says half of the agplanes produced in the U.S. are exported, a trend likely to continue. Hirsch says sales of agplanes “are expected to grow in the coming years, driven primarily by sales gains in rapidly developing nations as farming sectors address the need to become more efficient and productive.”

That last part is imperative since the U.S. Agriculture Department projects that feeding the world will require 70% more food production by 2050, yet no new farmland is being created.

Blair believes he holds a key to



THRUSH AIRCRAFT

increased farmland productivity. It is available online and probably at some hobby stores—it’s called Skywalker and costs about \$100; assembly required.

Since the hand-launched aircraft operates below 400 ft. above ground level, remains within Blair’s line of sight—he actively controls it via a radio transmitter—and does not use it for commercial purposes, the Skywalker falls within hobby rules and not those applying to unmanned aerial vehicles (UAV). That said, there is nothing casual about its purpose at Blair Farms.



RHONDA BLAIR

Fitted with a camera, the aircraft is Blair’s scout, cruising over the wheat stalks and bean fields looking for insect or pest infestation, and assessing the crops’ general health. Its work is “a natural extension of the practices already

taking place in agriculture,” he says.

However, Blair notes that because the aircraft can view the entirety of the crops from above, it delivers far more comprehensive information than can be gained from walking the fields. Having employed Skywalker and other such aircraft for the past eight years, he is not only a convinced of their value, but eager to see them gain broad use. He even blogs on the subject at theunmannedfarmer.blogspot.com/

He has actually gone to Washington to encourage the FAA to accelerate civilian UAV acceptance, but has been frustrated by the agency’s plodding pace on the subject. Moreover, he is dismayed to note that despite projections of agriculture becoming by far the greatest user of civil UAVs going forward, there is not a single farmer on the UAV Aviation Rulemaking Committee. “Why does agriculture not have a seat at the table?” he asks.

He also implies that the wrong agency has set that table, noting that in Japan unmanned heli-agcraft—more than 2,300 of them, according to the Association for Unmanned Vehicle Systems International—used by farmers are overseen by that country’s department of agriculture, forestry and fisheries rather than its aviation agency.

Blair readily concedes that Japanese farming differs considerably from U.S. agriculture in that the former’s fields are often just an acre in size, and thus servicing them requires vastly different equipment than that used to tend to 1,000 acres or more. So while little helicopters can handle spraying rice paddies in Japan, it requires aircraft with heft—an AT-802A has a payload of 9,249 lb.—to service fields in the U.S.

Thus, once approved, ag UAVs will likely serve much the same function as Blair’s little Skywalker—imaging, detecting, monitoring, mapping and measuring. They could potentially apply material such as insecticide in specific areas, but weight will be a limiter.

So, for now, big hopper Air Tractors and Thrushes will be doing the hard fieldwork. But that’s not to say their makers aren’t working toward the oncoming wave of UAVs.

“They do not want to be the next Kodak,” Moore says. “So they are looking into it.” ☛



By Cathy Buyck

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COMMENTARY

Uphill Battle

Increased competition obstructs Brussels Airlines in its route to 2014 profitability

When presenting Brussels Airlines' results for 2013 and outlook for this year, CEO Bernard Gustin compared the carrier's efforts to become profitable to the grueling bicycle ride to the top of 1,912-meter-high (6,273-ft.) Mont Ventoux in the French Alps.



KEITH GASKELL

"We covered 40 to 50 percent of the slope; we still have challenges but we will get to the top," vows Gustin, an avid cyclist.

Brussels Airlines is still a young-carrier. It was formed following the demise of Sabena in 2002 (with new investors and no debt) and merged with low-cost airline Virgin Express in 2007. Putting the company on a solid financial footing is an uphill battle, however.

The airline has recorded losses in five of the past six years and parent company SN Airholding had to draw on a €100 million (\$130 million) line of credit from its 45% shareholder Lufthansa to restore negative equity at the end of 2012. Another €20 million was used last year, and a restructuring program was initiated to slash costs by 10% and implement corporate changes.

Net losses narrowed in 2013 to €21.95 million, from €59.95 million a year earlier, and the operating deficit shrank to €28.1 million. However, 2013 income benefited from approximately €15 million in financial aid from the Belgian government. This support has not yet been formalized or approved by the European Commission's competition watchdog.

When excluding the public aid, Brussels Airlines' financial performance fell short of its target to reduce net losses to less than €20 million in 2013. Meeting this year's profitability goal also looks uncertain because low-cost carriers (LCCs) are expanding their presence at Brussels Airport and yields on the airline's Africa network are softening due to increased competition, especially from Star Alliance partner Turkish

Airlines. Enplanements rose just 1% on its African routes last year.

Gustin insists that Brussels Airlines wants to become profitable on a "sustainable" basis. "If we had not invested in our long-haul network and widebody fleet upgrade we might have produced a profit last year, but we look to the future. Our actions are not driven by short-term gains," he asserts. The eventual goal is to sustain margins of 5-8%, which is a benchmark demanded of Lufthansa's business units.

The expansion of LCCs at Brussels Airport might spoil the plan.

Ryanair has launched a base at Brussels Airlines' home airport with four Boeing 737-800s and International Airlines Group's budget carrier Vueling will add several routes there in May and station one Airbus A320.

The new no-frills competition has prompted Brussels Airlines to expand its capacity with two additional Airbus A319s. They are on top of a new A320, which was budgeted last year and forms part of the carrier's fleet harmonization toward an all Airbus operation. The phase-out of all of its 12 BAe 146-RJ100s (see photo) is being brought forward by a year.

Brussels Airlines also is launching or relaunching 11

European routes. It is redesigning its website, plans to introduce a new loyalty program specifically for the European network and will add a fourth booking class, most likely with charges for previously free services, all later this year.

Gustin recognizes there will be over-capacity to certain destinations but says: "I do not see why a Belgian flag carrier has to retreat. The many innovations illustrate our ambitions. We are used to competing with LCCs in the Belgian market. We have lowered our cost base, and more and more passengers realize we offer a competitive product."

Maybe. But Ryanair and Vueling have lower unit costs and more cash to endure the competitive battle, leaving Brussels Airlines halfway up Mont Ventoux. 🚲



By Frank Morring, Jr.

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COMMENTARY

Commercial Outpost

Next steps on ISS may include private researchers

The U.S. decision to extend operational funding for the International Space Station (ISS) until 2024 is increasing the odds there will be some significant return on the \$100 billion orbiting investment. So is a growing awareness of its unique utility for industrial and academic research, and some long-delayed traction for the commercial-space incubator NASA set up to promote U.S. National Laboratory assets on the station. While it is still too early to know the precise mix of public discovery and private profits that return on investment will represent, there is growing evidence that the engineering marvel of the age will be more than an impressive showpiece like the great pyramids or Taj Mahal.



NASA JOHNSON SPACE CENTER

As big money for public science on the ISS starts to pay off with enticing results, extension of the station's planned lifetime already has encouraged commercial customers at the other end of the cost scale to plan more missions. Jeff Manber, the commercial-space pioneer who founded the NanoRacks venture, says some of his company's repeat customers were beginning to "hesitate" about buying more time on the station until the life-extension decision was announced.

NanoRacks, which has accommodation and generic equipment for experiments on the station and a team of experts who ensure those experiments meet NASA's safety and other technical requirements, is working with the Center for the Advancement of Science In Space (Casis), a Florida-based non-profit that NASA has mandated to promote the station as a commercial research center in orbit.

"We're trying to commercialize the station and inspire the nation by using a minimum of 50 percent of upmass and downmass and astronaut time for the benefit of mankind here on Earth,"

says Greg Johnson, a former space shuttle pilot who visited the ISS twice and has taken over the Casis helm after a series of false starts slowed its start-up (*AW&ST* June 25, 2012, p. 45). "It's a great value proposition, where NASA is paying for [transport] to and from the [ISS] and we have that astronaut time for free—upmass, downmass for free. We do have to pay for the implementation piece, but we're looking for commercial entities to make a business proposition of the [station]."

Casis has revived the old "space is in it" branding concept for companies that bring products to market that are derived from ISS research. A likely first user is Puma, which has conducted research in orbit that may find its way into golf clubs and other sporting goods. Because of the effects of the station's microgravity environment on microorganisms, pharmaceutical research there has been particularly promising, and Casis has focused early outreach work in Texas, Boston and other biotechnology centers to promote the ISS National Lab capabilities. Now it is moving into Silicon Valley in search of

both researchers and venture capital.

Both should be easier to find with the station life extension, said government and private-sector participants in a Space Transportation Association (STA) panel on the ISS status held in Washington March 14. Also boosting the prospects for more commercial work on the station are bandwidth upgrades for data links to station experiments and steps NASA is taking to increase average utilization of the U.S.-controlled station assets to 70% from about 50%.

The latest Orbital Sciences Corp. Cygnus capsule to arrive at the station was unberthed last month using the robotic controls in the station cupola by Koichi Wakata, now the station commander, and NASA's Mike Hopkins, who returned to Earth March 10 (see photo). Developed with \$500 million in NASA seed money, both the Cygnus and the SpaceX Dragon can accommodate more cargo than is being carried, Manber says, and the Dragon can bring payloads back to Earth.

In the longer term, it is starting to seem at least possible that someone will adopt the evolving commercial-spacecraft model NASA has promoted to orbit a commercial replacement for the ISS. Orbital Sciences has some concepts in mind for using Cygnus as a free-flyer, and SpaceX has proposed a "DragonLab" version of its capsule, which it is also adapting as a contender in NASA's commercial crew development competition.

But for now the transportation, crew time and other support Congress is funding to spark commercial activities in space is essential, say those who are using it. "That's one of the advantages that we have" Johnson argues. "I know SpaceX, with the DragonLab concept—that's a real challenge for them because they don't have that help from the government."

Ultimately, it may also be possible for industrial or academic researchers to spend time on the ISS without being selected as NASA astronauts, perhaps on the model of the industrial and military payload specialists who flew on the space shuttle, according to Sam Scimemi, the ISS director at NASA headquarters. "One model may be to have private astronauts doing private research," he says. ☐



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COMMENTARY

Wake Up

Options for action against Russia remain limited

Russian President Vladimir Putin's move to annex the Crimean Peninsula is a "wake-up call," says NATO Secretary-General Anders Fogh Rasmussen, who urged Europe to increase defense spending—particularly in the missile defense, cyber and intelligence, surveillance and reconnaissance arenas. "Developments in Ukraine are a stark reminder that security in Europe cannot be taken for granted," he said last week. Russia's actions must have consequences, he warned.

While Rasmussen's tough talk was typical among Western politicians last week, options for real consequences are few. Congress may not even be able to dislodge sustainment contracts for Russian helicopters already purchased for Afghan security forces. Lawmakers with helicopter manufacturers in their home states had lobbied against the sale of those Mi-17s in the past. And now Sikorsky advocate Rep. Rosa DeLauro (D-Conn.), and Bell Helicopter backers Sen. John Cornyn and Rep. Kay Granger (R-Texas) are using the Ukrainian crisis to cancel ongoing contracts with Russian-owned Rosoboronexport for the rotorcraft, spare parts and maintenance. In a March 19 letter to Defense Secretary Chuck Hagel, the lawmakers argue that an executive order by President Barack Obama allows defense officials to end current deals. Past objections to the helo sales were waived by the Defense Department, which argued that it is in the national interest to purchase the Mi-17s, given the Afghans' familiarity with the system. ☞

SPEAK NO EVIL

SpaceX delayed its third commercial cargo flight to the international space station (ISS) because of "payload contamination" problems in the unpresurized "trunk" of its Dragon space-

EPA/LANDOV



'Developments in Ukraine are a stark reminder that security in Europe cannot be taken for granted.'

—ANDERS FOGH RASMUSSEN

craft, but don't try to find out what those problems are. "We've had some issues with payload contamination that we will be addressing," says Sam Scimemi, ISS program director at NASA headquarters, during a March 14 Space Transportation Association presentation. "We're going to have to assess that and replace some parts and get the rocket ready for launch again. Our current launch date right now, I believe, is March 30."

For its part, SpaceX says only that "open items" forced the delay from March 16. After some prodding, NASA says the contamination involves the beta cloth used to protect exposed payloads, and did not impinge on two optical payloads in the Dragon trunk. Those are the Optical Payload for Lasercomm Science, a testbed designed to study high-data-rate communications between space and the ground using laser light,

and the High-Definition Earth Viewing experiment to study the effect of space radiation on commercial HD video cameras. "We do not anticipate anything that would prevent us from being ready to fly as soon as a window has been identified to launch SpaceX's Falcon rocket," states NASA on March 20, after four days of pestering. Industry sources say the contamination may be oil from the sewing machines used to stitch the protective beta cloth. Apparently it did not penetrate the beta cloth material.

For confirmation, NASA says to go ask SpaceX, which is flying the payloads as part of its \$1.6 billion commercial resupply services contract with NASA, using the Falcon 9 rocket and Dragon developed for the purpose with NASA seed money. "It's their vehicle," says NASA. SpaceX's response: "Hope to get back to you soon." ☞

PAY AS YOU GO

Even as the Obama administration pushes to have the FAA fund itself with the traveler-paid Airport and Airway Trust Fund, the White House predicts the fund's balance will grow steadily over the next decade. White House budget documents lay out a road map to wean FAA from general-fund contributions. As of 2015, the FAA budget request would have the trust fund cover 93% of FAA's operations, as well as its Airport Improvement Program, facilities and equipment, and research, engineering and development accounts. The fund began fiscal 2014 with an unexpended balance of \$13.2 billion.

The trust fund—topped up with ticket, fuel, cargo and other user taxes—would continue to grow under the White House budget, particularly as it looks to raise revenue via a \$100-per-flight air traffic control user fee. However, the fee has no chance of clearing Congress, which has rejected the proposal numerous times.

"With or without the proposed \$100 user fee, the FAA clearly does not have a revenue problem based on the administration's forecast," says Jim Coon of the Aircraft Owners and Pilots Association. But Paul Feldman of the General Aviation Manufacturers Association is concerned that the budget would not reinvest the increased revenues back into the aviation system. ☞

Crossed Wires

MH370 case highlights need for better civil-military and international airspace cooperation

Adrian Schofield **Auckland**, Jeremy Torr **Singapore**
and Bradley Perrett **Beijing**

The hunt for Malaysia Airlines Flight MH370 has thrown a harsh light on the fragile nature of internal and cross-border relationships in Southeast Asia, as a lack of coordination hampered both detection of the flightpath and response to its disappearance.

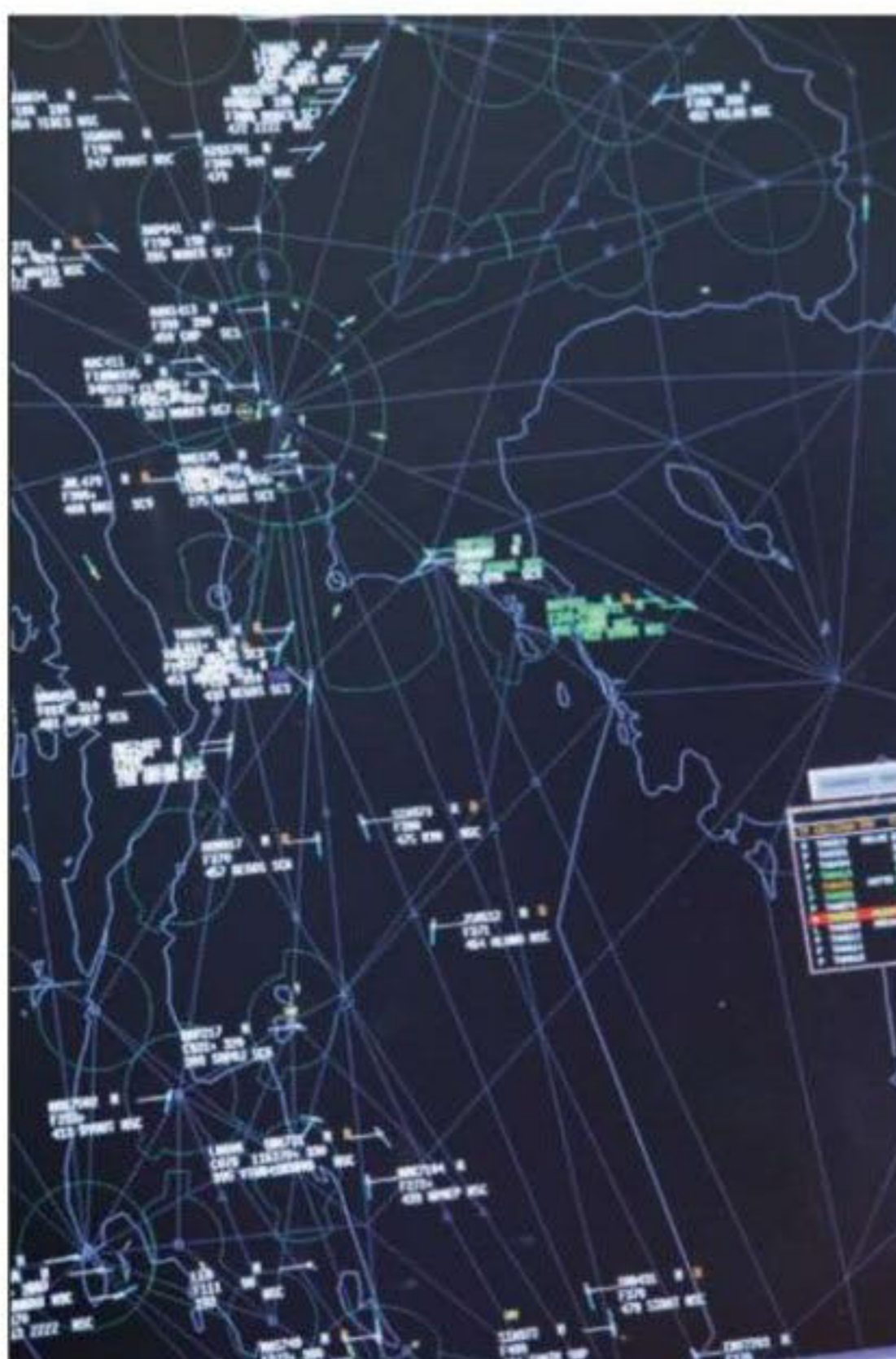
The miscommunication among various agencies and countries during the MH370 search has been almost farcical at times and is likely to prompt changes in how various organizations collaborate during emergencies. It took tragic incidents to spur reform in other places, too, such as the U.S. after the 9/11 terrorist attacks. Cross-border cooperation is a tough nut to crack, but improved civil-military coordination is something for which many states are striving—with different degrees of success.

Although the countries involved in the initial MH370 search are nominally part of the Association of South East Asian Nations (Asean), the lines of direct contact at most levels between them are strained by strong national interests. The glacial progress of movement to an Asian open-skies commercial agreement illustrates this well.

While Malaysian Transport Minister Hishammudin Hussein says the level of cooperation between nations has been “unprecedented,” the fact that Thailand’s military tracked MH370 yet did not communicate the data—“because it wasn’t asked,” it said—indicates serious problems. Thai military radar noted a “blip” that could have been MH370, but this was not even mentioned to any Thai authorities outside the military for 10 days.

More than 40 hr. after the disappearance, the Malaysian chief of police told media that “not every country whose nationals were onboard has responded to requests for information.”

Foot-dragging by Indonesia when asked for permission for search-and-rescue aircraft to overfly its territory also highlights what are deep and enduring suspicions of neighboring coun-



A Thai air traffic controller's screen shows aircraft tracks over the Gulf of Thailand and the South China Sea, where MH370's last radio contact occurred.

tries' intentions when conducting any kind of operations across borders.

The fact that the boundary areas of early search efforts crossed maritime sectors that are under dispute by some of the key players—China, Vietnam and the Philippines—made full and immediate disclosure of the radar data, surveillance levels and

intelligence capability less than likely.

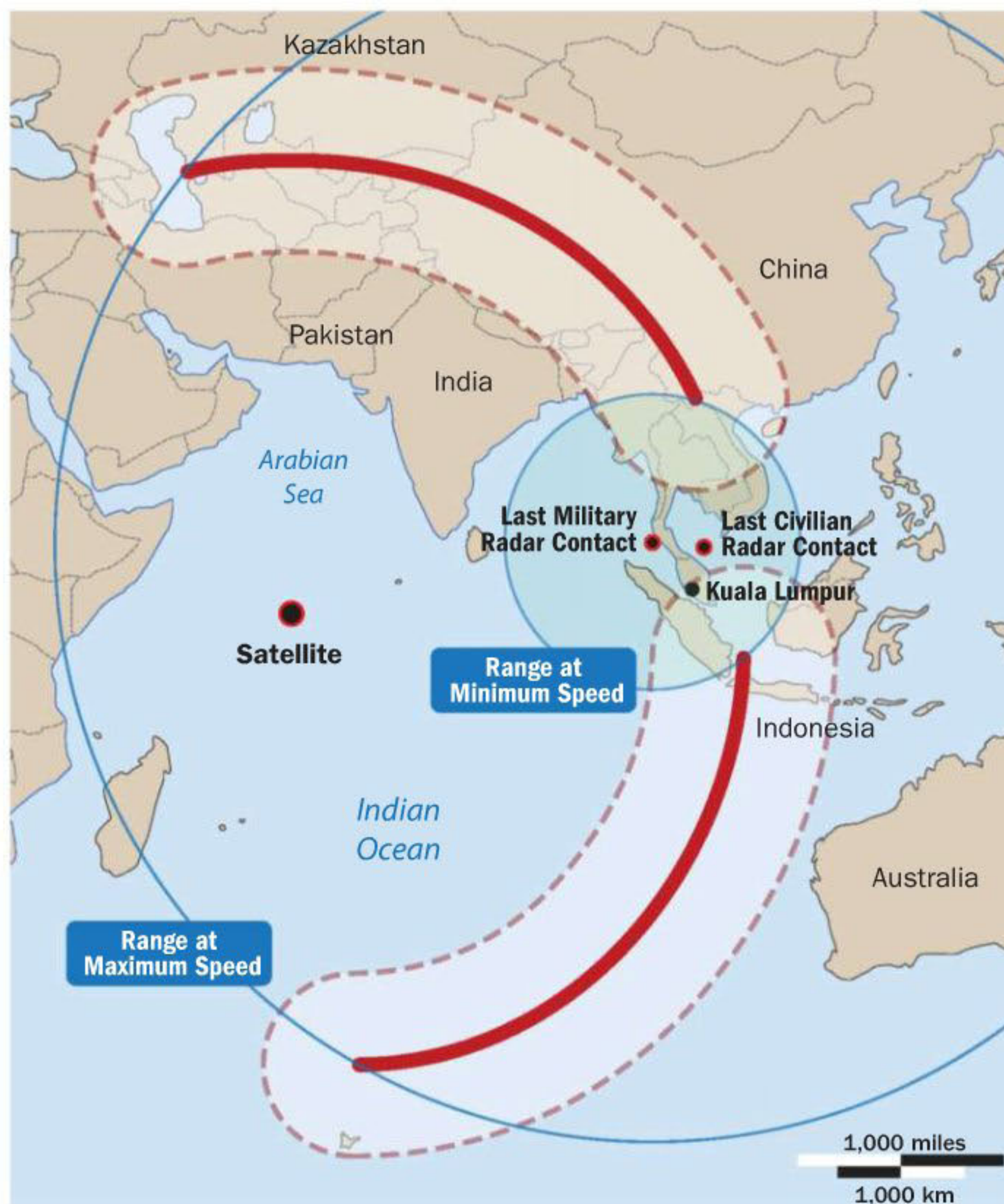
Another major issue in Southeast Asia is the degree of autonomy enjoyed by the various services of specific countries. The army, air force, navy, internal security agencies and air navigation service providers (ANSP) do cooperate, but often not as closely as elsewhere in the world.

Although Malaysian military radar tracked a then-unidentified aircraft across its airspace early on March 8, this was not linked into the investigation by the civilian aviation authorities for almost two days. The Thai military's delay in disclosing radar data to Thai civil authorities also highlights internal issues.

Problems unveiled by the MH370 response are not necessarily new, nor are they unique to Southeast Asia. For example, ANSPs around the world have been attempting to address the issue of civil-military cooperation for many years. Because civil and defense agencies have different objectives for surveillance, they often operate separately from each other. National security concerns keep defense surveillance data from being used by civil agencies, and vast amounts of airspace are closed to civil air traffic due to defense requirements. In India, for example, this can be as much as 35% of total airspace.

However, efforts are underway globally to improve the civil-military disconnect, and in some countries major improvements have been made. The flexible use of airspace (FUA) concept is being applied to military airspace zones, allowing commercial traffic to fly through these areas when they are not being used by the military. While surveillance data-sharing by defense agencies is still not common, many ANSPs have established multi-agency teams to ensure cooperation during crises, and defense representatives are often stationed at civil air traffic management (ATM) centers.

In a recent speech, Jeff Poole, director general of the Civil Air Navigation



- Possible position at last contact with satellite
- Possible range in 59 min. of flying at 490 kt. (910 km/hr.)

Source: Malaysia Airlines and government officials

Services Organization, drew attention to constraints caused by military airspace restrictions in the Middle East, where only about half the airspace is available for civil traffic.

Poole notes that in Europe, the U.S. and certain parts of Asia, the progressive opening of military airspace to civilian operations "has been managed responsibly to the benefit of both sides." This has led to FUA, shorter routes, cost savings and fewer delays. "The case is clear, and we are working hard with states to accelerate progress," says Poole.

The main platform for efforts to improve civil-military cooperation globally is the International Civil Aviation Organization (ICAO), which crafted a set of policy principles and

guidelines on the issue in 2011 that is still regarded as the standard. ICAO has been holding meetings in various parts of the world to promote these concepts. States "will benefit from a strong commitment to civil-military collaboration," which has the potential to increase safety, airspace capacity, national security and operational efficiency, the policy document says.

ICAO advocates the exchange of surveillance and flight identification data between military and civil ATM units, direct communication lines, and even joint airspace design and technology procurement. Better coordination procedures as well as improved communications technology will play a key role, it asserts.

The U.S. has one of the most so-

Listen to Aviation Week editors discuss the role of military and civil radars in the MH370 search on our latest Check 6 podcast. Download it and past Check 6 podcasts from the iTunes store at ow.ly/uMUWe

Follow continuing coverage of the international investigation into the disappearance of Malaysia Airlines Flight MH370 at AviationWeek.com

phisticated interagency coordination networks, although it was found to have had flaws during the response to the terrorist attacks of Sept. 11, 2001. The commission established to assess the response identified several areas where communication between agencies was poor. This has now changed, with multiple joint entities working more effectively at operational and strategic levels.

One of the most important of these is the Domestic Events Network, a multi-agency teleconferencing system that allows instant communications in the event of airspace violations, failure of aircraft to communicate with controllers and any suspicious aircraft identified as "tracks of interest." FAA and military representatives are posted at each other's facilities, and the FAA shares radar data with the North American Aerospace Defense Command.

Canada also has some of the best interagency cooperation. ANSP Nav Canada has an agreement with the Department of National Defense allowing it to use surveillance data from the North Warning System radar chain. Nav Canada has used this to extend its own coverage area off the country's northeast coast. The two agencies exchange domestic radar feeds, and Nav Canada also exchanges surveillance data with the FAA.

Enhanced civil-military ATM coordination is a major element of Europe's Single European Sky plan, and there is a strong military presence at Eurocontrol headquarters. Among European nations, Germany has an almost completely integrated civil and military ATM system, at least at the en-route level.

Meanwhile, Australia is pursuing joint airspace design and technology procurement, and its proposed new ATM system, known as OneSky, will be used by both civil and military operators. Thailand is taking a smaller step

in this direction. As part of its ATM upgrade project, ANSP Aerothai plans to supply to the Royal Thai Air Force a work station compatible with its new system to improve coordination.

The Australian example is significant, given its prominent role in the search for MH370. Australia has not said how closely its military surveillance branches have been involved in the MH370 operation, although Prime Minister Tony Abbott said, "all of our agencies that could possibly help in this area are scouring their data."

The Royal Australian Air Force and other armed services as well as possibly the national signals-intelligence service seemingly became all the more effective in the search due to information from other countries telling them roughly where to look. When tasked with looking in the southern Indian Ocean, the Australian Maritime Safety Authority (AMSA) says it "defined a possible search area with information available to us from a range of sources both nationally and internationally."

AMSA did not disclose the providers of the information, but a conceivable military source would be signals-intelligence systems, which can locate and track aircraft from their radio emissions. High frequencies and long ranges challenge the process, however, especially for terrestrial receivers.

Satellites, with huge fields of view, are also used for the purpose. Australia has no signals-intelligence satellites but probably gets much information from those operated by the U.S.

Civil-military cooperation is far less of an issue within China, where the military is likely to take the lead in any major search operation. The Air Traffic Management Bureau of the Civil Aviation Administration of China operates secondary radars and some primary radars, but it would have every reason to supply its information to the air force. Moreover, the Chinese military has a strong commitment to civilian rescue operations.

International cooperation is another matter, as the Chinese military seems to regard the outside world with varying degrees of hostility and suspicion and is probably more secretive than any other major Asian military except North Korea's. For example, if it had intelligence from a sensitive source, it would be at least very careful in sharing the information. ☐



What happened inside the Boeing 777 cockpit (similar to this one) of Malaysia Airlines Flight MH370 is at the center of the investigation.

Remote Target

Investigators continue to delve into possible crash scenarios for Malaysia Airlines Boeing 777

Jens Flottau **Frankfurt**, Guy Norris **San Diego** and Amy Svitak **Paris**

Two weeks after Malaysia Airlines flight MH370 disappeared, aviation safety experts continue to toil over plausible causes. But even if debris from the aircraft is recovered soon, it may be months before a clearer picture emerges about what happened onboard the Boeing 777.

The March 20 sighting of large objects in the Indian Ocean, approximately 1,350 nm off Australia's west coast, was perceived as a possible breakthrough in the multinational search, but the Australian Maritime Safety Authority says it will be several days until a ship equipped for debris recovery can be on the scene. Analysis of satellite images initially led to the discovery of two objects—one about 79 ft. long—that could be part of the aircraft.

But there are few solid facts regarding MH370's last flight. The aircraft took off from Kuala Lumpur at 12:30 a.m. on March 8 with 239 people onboard its scheduled 6.5-hr. flight to Beijing. While on airway R208 approaching the IGARI waypoint, the crew's last communication with air

traffic control at 1:19 a.m. ("All right, good night") seemed routine, but the aircraft disappeared from civil secondary radar around 10 min. later. Between 1:07-1:37 a.m. the Aircraft Communication Addressing and Reporting System was either turned off or failed.

Investigators are convinced the aircraft turned west and was caught by military radar over the Strait of Malacca around 45 min. later, then its trace was lost. The last signal from the aircraft was picked up by an Inmarsat satellite at 8:11 a.m., more than 7.5 hr. after takeoff and nearly 6 hr. after the last officially confirmed primary radar sighting.

The parts suspected to be part of the missing 777 were found toward the southern end of the two arcs spanning from Kazakhstan to China. An area ranging from Indonesia into the remote South Pacific was identified as a possible location for the wreckage. If confirmed, the sighting means the aircraft had flown north before turning southwest and then southeast for several hours.

The recovery operation would likely prove to be as difficult as that for Air France flight AF447 in 2009-11 in the South Atlantic. The area is not only remote, the sea is 3,500-5,000 meters (11,480-16,400 ft.) deep. In the case of AF447, the flight data and cockpit voice recorders were found and recovered late into the extensive two-year search.

Locating wreckage could help narrow the leads as far as crash causes are concerned, but at this stage, investigators are still pursuing many paths. The Malaysian government's stance is that someone onboard took control of the aircraft, but the international aviation safety community counts that view as one of many possibilities. Boeing is assisting investigators with a number of potential causes, including crew hypoxia or asphyxia. The likely source of such an event would be a progressive fire, emanating in the electronics equipment bay or other areas of the lower deck space.

Part of the reasoning for that line of thinking is the 777's observed initial left turn, which was made toward

a 13,000-ft.-long runway on Langkawi, together with a prolonged flightpath with no further communications from the flight crew.

However, among many conundrums associated with this and other fire-related theories Boeing is wrestling with how to square the apparent randomness of the way in which the communications system ceased to operate within the length of the flight. Although the gradual disabling of the transponder and other communications devices could be explained by a progressive fire, it is puzzling how such an event could occur without affecting the 777's three main flight-control computers and an eventual loss of control.

But given the fact that the approximate positioning data from the Inmarsat satellite is not consistent with the last known track of MH370, Boeing is also evaluating theories that involve deliberate control of the aircraft.

Space-based remote-sensing assets have been assisting in the hunt for Flight MH370, with multiple satellites from many nations imaging the search

area in an attempt to locate signs of the aircraft or a potential crash site.

On March 11, China's meteorological agency requested activation of the International Charter for Space and Major Disasters, a group of 15 national and international space organizations that supply space-based remote-sensing assets free of charge in response to natural or technical disaster relief efforts. From that point on, satellites from various nations have been supporting the search to locate signs of the aircraft.

As part of the effort, commercial remote-sensing service providers such as Berlin-based BlackBridge and DigitalGlobe of Longmont, Colo., have been using their crowd-sourcing platforms to engage the public in the search. DigitalGlobe tasked its ultra-high-resolution WorldView-1, WorldView-2 and GeoEye-1 satellites to capture images over the Indian Ocean, and uploaded archived and new imagery to its Tomnod crowd-sourcing site, where amateur data analysts could peruse pictures and tag potential signs of wreckage. 

MARITIME PATROL

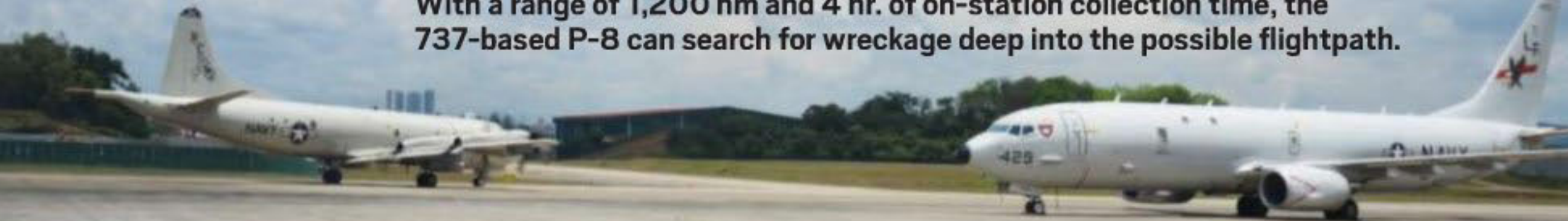
Amy Butler **Washington**

The new P-8, a linchpin of the U.S. Navy's low-profile maritime patrol force, has been pushed into the limelight from its traditional mission of submarine-

reconnaissance],” says Lt. Cmdr. Nicholas Sherrouse, a Pacific Fleet spokesman. “These capabilities make it the ideal aircraft to aid in the search for the Malaysian

radar optimized for littoral surveillance, has six modes acknowledged by the Navy: surface search (including simultaneous tracking and scanning), periscope

With a range of 1,200 nm and 4 hr. of on-station collection time, the 737-based P-8 can search for wreckage deep into the possible flightpath.



hunting to join the massive search for Malaysia Airlines Flight MH370, which disappeared March 8.

The Boeing 737-based P-8s operated by the Navy and India are likely conducting the deepest airborne searches into the huge swath of area suspected to contain a crash site. The P-8 is a “long-range aircraft capable of broad-area, maritime and littoral anti-submarine and anti-surface warfare and [intelligence, surveillance and

Flight MH370.”

The Navy declared initial operational capability with the first P-8A Poseidon aircraft in November; Boeing has delivered 13 of 117 P-8As, which are replacements for aging P-3 aircraft. Six are deployed to Kadena AB, Japan, at least one of which will be flying out of Kuala Lumpur to support the search.

The P-8's AN/APY-10 radar, a repackaged APS-137 mechanically steered

detections, color weather, navigation, synthetic aperture radar (SAR) and inverse SAR, Sherrouse, says. Likely, the ISAR and scan modes are the most relevant to locate floating debris, according to an industry official.

The P-8 is also deploying sonobuoys, carried internally, to listen for the acoustic signature of the 777's flight data recorder. The P-8 can deploy 129 sonobuoys per sortie versus the P-3's 84. 

Battle Lines

Is the Pentagon push for the stealthy F-35 overshadowing the need for more EW funding?

Amy Butler Washington

Despite a squeeze on investment accounts, the Pentagon's fiscal 2015 budget strategy prioritizes funding for the stealthy F-35—but at what cost, some in industry ask.

Defense Secretary Chuck Hagel has made clear the spending plan is a result of making hard choices and trades.

However, this virtually singular focus is jeopardizing U.S. dominance in electronic warfare (EW) capabilities, according to some industry officials, who note that even a stealthy aircraft like the F-35 requires some protective jamming support to penetrate the “bubble” of protected enemy air space. A pinch on research, development and procurement funding coupled with a necessary focus on addressing counterinsurgency threats for operations in Afghanistan and Iraq for more than a decade have contributed to a loss of focus at the Pentagon on EW planning, they say. “We stopped doing some campaign analysis,” acknowledges Al Shaffer, acting assistant secretary of defense for research and engineering.

Critics of the Pentagon's EW strategy point to the fiscal 2015 budget's termination of the U.S. Navy's ties to Boeing's Super Hornet production line. The service likely will buy only its planned 138 EA-18G Growlers, the Pentagon's newest airborne EW system, and deploy five to each carrier air wing. Navy officials have put funding for 22 more Growlers on their fiscal 2015 wishlist, but without relief from the spending constraints of the Budget Control Act, Boeing will be on its own to continue building the aircraft, unless the Navy can buy more Growlers. Congress approved funding for 21 ship sets of EA-18Gs in the fiscal 2014 budget.

Meanwhile, the Air Force is also planning to mothball seven, or half, of its EC-130 electronic attack aircraft in fiscal 2013, saving \$315.8 million. Air Force Maj. Gen. Jim Jones, director of operations, plans and requirements, says that the service “can't afford to program to a no-risk force, [and further investment in stealth] is a piece of that. . . . All of these capabilities

add up to a more survivable capability.” When questioned about whether the Air Force would backfill the lost EC-130s with some other capability, Jones declines to provide information, acknowledging that this is likely an “unsatisfying” answer. This could point to a capability being developed in the classified world.

Much of the concern of skeptics is centered on the emergence of very-high-frequency (VHF) radars, which uniquely can be used to detect stealthy aircraft. “All ‘stealth’ means is delayed detection in [a specific] frequency,” says one industry official. With a VHF system, “you are essentially the size of your aircraft from long range,” the official notes. The concern is that these long-range radars can pass data to fire-control systems—including active, electronically scanned array radars—that are capable of launching air defense weapons. The integration of the two could compromise the advan-

tage stealth brings, which is to make the aircraft hard to target rather than making it invisible.

“We are starting to see the emergence of some stressing capabilities to our conventional forces,” Shaffer says. That “other countries are going out of band is a threat and is a challenge to our systems. Make no mistake about it,” he says.

“VHF radar can't do fire-control, but they can see you,” says Mike Gibbons, Boeing vice president of F/A-18 and EA-18G programs. “With low-frequency radars, they can tell which way to look, and they can scramble their super-cruising aircraft out to you. At that point, stealth isn't going to help you.”

As it shifts focus away from counterinsurgency operations, the Pentagon is planning to dust off and update its campaign plans for more stressing engagements, such as addressing the anti-access, area-denial problem posed by new air defenses being developed and fielded by Russian and Chinese manufacturers. In doing so, the Pentagon likely will adjust its force structure plans for EW, including a possible increase in the number of Growlers needed, as well as ongoing work for the F-15 Eagle Passive/Active Warning Survivability System (Epaws), Raytheon Miniature



Air Launched Decoy-Jammer (Mald-J) version and podded or towed decoy options. The Navy, for example, is investing in podded Digital Radio Frequency Memory (DRFM) jammer systems through the Filthy Badger and Filthy Buzzard projects.

Fleet structure studies are done annually, and any changes would be briefed to Pentagon leadership for possible adjustment in the fiscal 2016 budget this summer, Shaffer says.

"All aircraft can be seen by certain radars. The trick is to disrupt the [kill] chain when someone can lock weapons on you. We are talking about the 'perishability' of stealth," Gibbons says.

Growler advocates argue that the EA-18G, with its wide-spectrum EW and electronic-attack capabilities should be the "quarterback" for future strike packages, with the electronic-warfare officer in the backseat essentially managing the electronic battle.

During a flight demonstration last summer, Boeing showed that two EA-18Gs were capable of passively detecting a threat emitter and passing "very accurate" targeting data for a strike within "minutes." Company analysis suggests adding another Growler to the engagement would allow for generating target coordinates in seconds. This operational concept could con-

dense the time element of the kill chain and get at the "counter-shutdown" problem for air defenses, when threat emitters intermittently radiate and then shut down to avoid being targeted by radar-seeking weapons such as the AGM-88E Advance Anti-Radiation Guided Missile.

In its campaign to restore funding for the Growler, Boeing will have to walk a careful line. The company has to make the case that without more Growlers, even the stealthiest aircraft in the Pentagon's fleet are vulnerable to emerging air defenses. This is a thorny and challenging argument to make as it quickly veers into classified territory. And its Pentagon customer is loath to acknowledge that its multibillion-dollar investment in stealth aircraft could be made vulnerable by comparatively small investment in networked air defenses. Boeing is already aggressively engaging Congress to lobby for more Growler money and has launched a grass-roots advocacy campaign website.

Although F-22s and F-35s are the most capable platforms at penetrating air defenses, they are not silver bullets and still require capable escorts to standoff at the edge of a hostile range to control the electronic battlefield, Growler advocates say. They suggest

doubling the number of Growlers in each carrier air wing to 10. There is "plenty of room" on the future carrier deck to accommodate the additional aircraft, the industry official says.

While carrying the most advanced and fused avionics available, the F-35 is able to influence only the electronic battle within the frequency of its own Northrop Grumman AN/APG-81 radar. But if an F-35 encounters a threat not in its database or outside its own radar band, it likely would not address it—whereas an electronic-warfare officer on an EA-18G could discern its capabilities and suppress it, if needed, the industry official says.

A final fleet determination has not yet come out of the Navy for Growlers, but Shaffer says the plans in place are sufficient for now. "We maintained our EW focus and in some cases have been looking to accelerate," he says, noting investments in Mald-J and Epaws and hinting that classified work may be underway.

During a March 12 hearing, Chief of Naval Operations Adm. Jonathan Greenert said he sees a "growing need" for more Growlers. The questions are: When it will be announced? And when will it be funded? ☐

With Guy Norris in El Segundo, Calif.

Growler advocates are pushing the Navy to double the number of EA-18Gs on carrier decks to 10.



U.S. NAVY

Hard Lessons

Lack of training and inexperience with 'Dutch roll' tied to KC-135 loss in Kyrgyzstan

Tony Osborne *London*

The loss of a U.S. Air Force Boeing KC-135 Stratotanker over Kyrgyzstan in 2013 has prompted significant changes to flight and emergency training for air force tanker crews.

Three USAF personnel died when the KC-135R, call sign "Shell 77," crashed just 11 min. after takeoff from Manas International Airport, on May 3, 2013. The aircraft was one of several KC-135s forward-based in the former Soviet republic flying aerial refueling operations for combat aircraft supporting ground troops in Afghanistan.

Accident investigators concluded in their March 6 report that while the

primary causal factors were a factor, those problems had been exacerbated by crew inexperience and by subpar organizational training programs, crew composition, and cumbersome procedural guidance.

The problems began shortly after the afternoon takeoff from Manas. As the aircraft got airborne the crew immediately began to experience a flight condition known as rudder hunting, which prompted the aircraft's nose to yaw left and right by 1 deg., an issue caused by a malfunction with the aircraft's series yaw damper (SYD)—part of the KC-135R's flight-control

augmentation system (FCAS). The crew identified the SYD as a potential source of the issue but instead of turning the system off, they attempted to correct the yawing motion by using rudder and aileron inputs as well as turning on the autopilot, causing the oscillations to worsen. Some yawing issues had been reported during the aircraft's transit flight to Manas from RAF Mildenhall, U.K.

ing away from the rear of the aircraft, immediately sending the KC-135 into an 83-deg. nose-down attitude. As the aircraft broke through the clouds, eyewitnesses on the ground saw the starboard wing separate, which caused the exposed fuel to explode. One of the aircraft's engines landed within 30 ft. of a bystander on the ground.

Much of the wreckage was strewn across a 2.5-mi. area across mountain-

tion, meaning each pilot must only discuss this topic and is not required to perform the maneuver."

Post-accident, engineers and pilots involved in the probe found they could not recreate in the simulator the conditions experienced in the crash, an issue that is now being addressed. Prototype modifications already have been fitted to simulators at Scott AFB. Other KC-135 simulators around the U.S. will be modified following the award of a contract in February.

The changes to the simulator will improve the way KC-135 sims move, giving them a higher fidelity to such action on actual aircraft. Engineers have developed seven new rudder malfunction scenarios to allow more effective training to overcome the malfunction.

Three U.S. Air Force personnel were killed in the crash of a KC-135 in Kyrgyzstan in 2013.

Arquette says that since the introduction of the KC-135R, the need to familiarize crews with the issue of Dutch roll had virtually disappeared because the "assist systems" introduced to that version—installed to help crews in the event of an engine failure with the more powerful CFM56s—meant that such issues were rarely experienced or reported. Crews flying the older KC-135A had been better trained to deal with the phenomena; even though that version was more unstable in flight, it did not need the assist systems because the asymmetric effect of engine failure on the older model had less effect on the aircraft's flight characteristics.

Since this accident, AMC has carried out checks on the SYD and FCAS across the 431 KC-135-class aircraft within the fleet.

AMC, Boeing and the Air Force's Special Programs Office say they are rewriting the sections of the flight manual regarding rudder-systems operation and malfunction identification that can occur during flight. KC-135 crews are now said to be aware of the issue and are expected to report any rudder anomalies they experience in flight.

According to AMC, since the Shell 77 accident there have been 36 events of aircrew-reported rudder anomalies, of which Flight Data Recorder analysis confirms seven instances of mild rudder oscillations that are said to be similar to those associated with the Shell 77 crash. ☐



After the autopilot had been turned on a second time and failed to reduce the effect of the oscillations, the captain assumed control and began to use the rudder in a bid to correct the now-considerable Dutch roll effect—where the aircraft yaws several degrees to the left and right.

The report states that a series of alternating small rudder inputs caused by Dutch roll-induced acceleration forces was in reaction to the pilot's foot pressure on the rudder pedals, which sharply increased the oscillations. These fluctuating rudder movements, coupled with slight right-rudder use while rolling out of the turn, compounded the Dutch roll severity and produced what officials describe as extreme airframe stress.

"The cumulative effects of the malfunctioning SYD, coupled with autopilot use and rudder movements during the unrecognized Dutch roll, generated Dutch roll forces that exceeded the aircraft's design structural limits," the report states.

The forces resulted in the structural failure and separation of rear fuselage bulkheads 1560 to 1440 with both vertical and horizontal stabilizers break-

ing away from the rear of the aircraft, immediately sending the KC-135 into an 83-deg. nose-down attitude. As the aircraft broke through the clouds, eyewitnesses on the ground saw the starboard wing separate, which caused the exposed fuel to explode. One of the aircraft's engines landed within 30 ft. of a bystander on the ground.

Announcing the board of inquiry's findings at Scott AFB, Ill., Brig. Gen. Steve Arquette, inspector general of the Air Force's Air Mobility Command (AMC), said that analysis of the accident showed that the crew lacked the experience to diagnose the phenomena of Dutch roll, [and] had been hampered in their attempts to recover because of the "cumbersome" nature of the emergency procedures.

"The crew encountered a condition that they had not realistically experienced in training, and when coupled with decisions based on their relatively low recent experience levels, were presented with an unrecognized hazardous and difficult situation to overcome," said Arquette.

Emergency manuals for the KC-135R contain no fewer than 21 emergency procedures discussing rudder control difficulties, but they are spread out over 177 pages, the report points out.

Furthermore, "knowledge and experience of Dutch roll is limited in the training program," the report states. "The proficiency level required for Dutch roll recognition is familiariza-

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Getting Defensive

New data show Russia and China military exports surging

Michael Bruno **Washington**

Four years into the Obama administration's high-priority U.S. exports push and the U.S. aerospace and defense industry's earnest efforts to expand sales internationally, new data show moderate success as well as major warning signs.

According to widely regarded analysis from a Swedish defense think tank comparing defense exports in 2009-13 and 2004-08, the U.S. remains the world leader and grew its output 11% between the two five-year periods, which mark the White House handover from George W. Bush to Barack Obama.

But Russia is gaining market share, and in one measure the former Cold War adversary has become the towering leader in selling weapons to the largest import market, India, according to the Stockholm International Peace Research Institute (Sipri). A Chinese export surge, meanwhile, has vaulted it ahead of France and the U.K.

Sipri says the five largest suppliers of arms, gifts and production under license in 2009-13 were the U.S. with 29% of total, Russia (27%), Germany (7%), China (6%) and France (5%). In 2004-8, the U.S. supplied 30%, Russia 24%, and China just 2%. Sipri says five-year stretches are best for comparison because they smooth out annual aberrations and allow time for announcements to prove true or not.

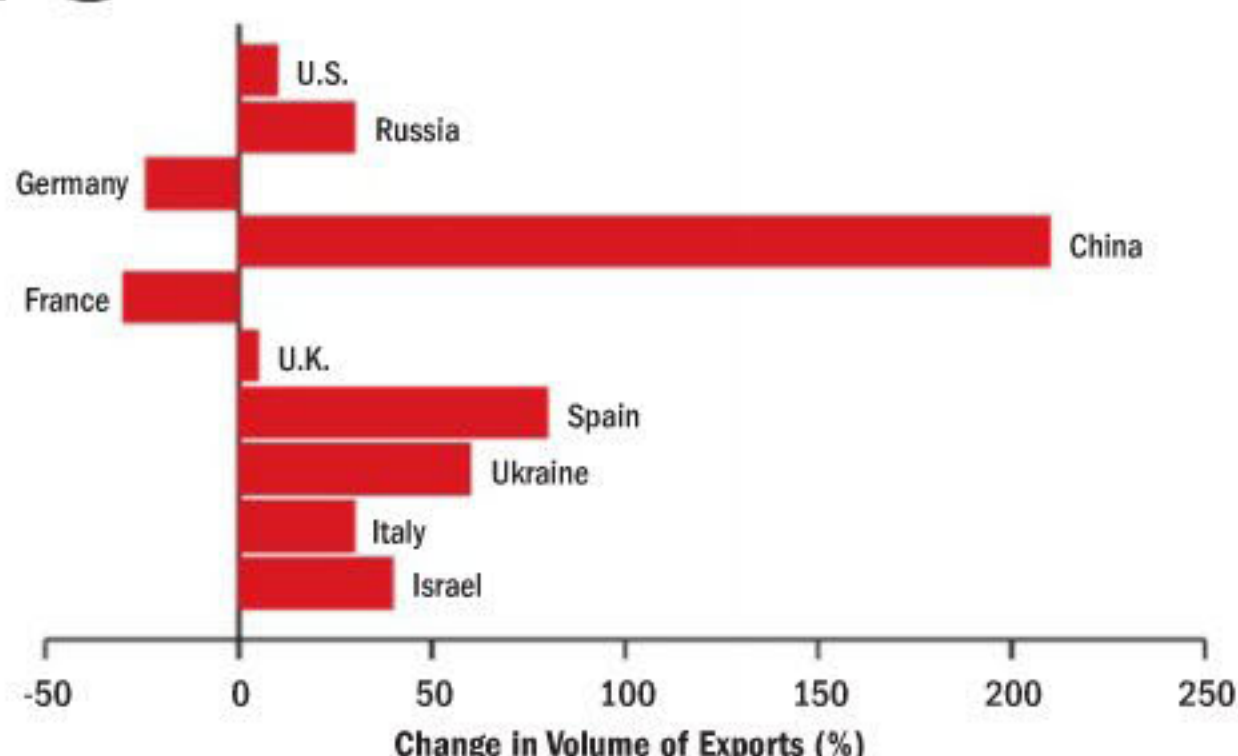
Russian exports grew 28% between the 2004-08 and 2009-13 periods, and in the latter timeframe Moscow became the largest exporter of warships worldwide—supplying 27% of the total, including an aircraft carrier to India—and claimed 75% of total Indian arms imports. In contrast, the U.S. accounted for 7% of Indian imports in 2009-13, marking “the first time [America] became the second-largest arms supplier to India,” Sipri states.

“Russia has maintained high levels of arms exports despite the crisis in its arms industry in the post-Cold War period,” says Sipri’s senior researcher Siemon Wezeman. Moscow delivered arms to 52 nations, but India, China and Algeria together took in more than half of Russian exports. Aircraft made up 43% of Russian exports, including 219 combat airplanes in 2009-13.

China, meanwhile, surpassed France and grew 212% between the two time periods. Sipri says China supplied major arms to 35 states in 2009-13, mainly “low- and middle-income” countries. In fact, almost three-quarters of Chinese exports went to Pakistan, Bangladesh and Myanmar. But NATO member Turkey’s initial selection last year of China’s HQ-9/FD-2000 surface-to-air missile system over Western and Russian alternatives—a choice some observers believe could still be reversed—proved noteworthy.

Indeed, the surge of Russian and Chinese exports underscores a deepening concern in the Pentagon about not only the high-technology capabilities of those countries, but also the potential to run into their hardware elsewhere in the world. “One of the concerns about China is not just that they are modernizing—we don’t anticipate a conflict with China, certainly—but [that] they export,” Pentagon acquisi-

Growth in Top Military Exporters
2004-08 vs. 2009-13



Source: Stockholm International Peace Research Institute

tion czar Frank Kendall told Congress in January. “And the weapons systems they develop we would face potentially with other people.”

What’s more, Chinese advances in surveillance, hypersonic weapons and air defenses could alter current funding plans for major U.S. weapons programs, and even their export potential, notes Capital Alpha Partners analyst Byron Callan. “It may take several more years for these advances to result in credible systems that could be fielded,” he says of China. In contrast, U.S. major defense acquisitions traditionally take decades. “China should be in a position to export these, too, and that will influence international demand,” Callan says.

Along those lines, Sipri analysts say it is apparent that both China and the U.S. are using arms exports for foreign influence, particularly in the Asia-Pacific region. Overall, the flow of arms to Africa, Latin America and Asia and Oceania increased “significantly” between the two time periods, while there was a “notable” decrease to Europe. Arms transfers to the Middle East remained essentially unchanged, Sipri says.

Still, the latest data reflects the Obama administration’s 2010 effort to double total U.S. exports and streamline export licensing, as well as to use military sales as a key tool in the 2012 strategic “pivot” to Asia-Pacific following the post-9/11 wars. Leading and mid-tier U.S. defense contractors also have made a pronounced effort to seek more international sales since the last recession and subsequent depression in Pentagon spending. In 2009-13, aircraft represented 61% of U.S. exports, including 252 combat aircraft, Sipri shows.

Nevertheless, Sipri’s analysis adds data to anecdotal evidence shared by U.S. officials and companies in recent years about the challenges they face in selling more abroad. Andrew Shapiro, the longest-serving assistant secretary of state for political-military affairs until his retirement last April, told Wall Street investors in February that countries are looking for other providers and do not want to be “too beholden” to the U.S.

U.S. technology tends to be the most capable and most expensive, he says, which is not what foreign customers always want. “For many of our partners, the high-end systems are unaffordable,” Shapiro says. “Particularly for countries facing counterinsurgency, counterterrorism types of issues, you don’t need the most sophisticated fighter.” To U.S. companies looking to boost the bottom line with exports he notes: “You need to build in more risk, and you need to be diversified.”

Power Play?

Pentagon guards Russian Atlas V engine options as discord with Moscow deepens

Amy Butler Washington

Recent tensions over Russia's move to annex Crimea have prompted some to question the reliability of U.S. access to the Russian-made RD-180 engine, which is used to power one of two rockets that loft national security payloads into orbit.

Russia is a source for these engines as well as other aerospace materials, such as titanium. The U.S. government has placed targeted sanctions on 11 Russian and Ukrainian officials—the most comprehensive of such measures since the end of the Cold War—as a response to Russia's bold move into Crimea. But the dispute has thus far not affected the supply chain for the United Launch Alliance (ULA) Atlas V rocket.

"We hold a license to manufacture and deliver RD-180 engines," says Matthew Bates, a spokesman for Pratt & Whitney, which formed a joint venture with Russian engine manufacturer NPO Energomash in 1997 called RD Amross. The sole purpose of RD Amross is to provide the engines to the U.S. "A deviation from the contracted, agreed-upon delivery amount would represent a contractual breach," says Maureen Schumann, a Pentagon spokeswoman.

If Russia were to hold the RD-180 hostage, the Defense Department estimates it would need \$1 billion over five years to establish production on U.S. soil.

The RD-180 sourcing plan was established over years of regulatory review once Lockheed Martin, which developed the Atlas V in the late 1990s, selected the engine as its propulsion system. To mitigate concerns about supply, the U.S. Air Force maintains a stockpile of roughly two years' worth of engines, ULA CEO Mike Gass told lawmakers this month. The stockpile was approved as a change to the U.S. policy with regard to foreign sourcing in 2000.

The policy today is three-pronged. In addition to the stockpile, the Pentagon also has a plan to "gracefully" transition to U.S. production if needed. And, finally, should the supply be interrupted, Pentagon officials can



It would take five years and \$1 billion for the Pentagon to establish production of the RD-180 engine in the U.S.

prioritize what missions would use Atlas V while a production facility is being established stateside.

The coproduction requirement for the RD-180 that was set early in the program was eventually lifted by the Pentagon in part because missions could be offloaded to the Delta IV family, Schumann says. The Pentagon has long held to a strategy of "assured access" to space by operating two distinct rocket systems.

The Delta IV was originally developed by Boeing as a competitor to the Atlas V, but both rockets were subsumed into ULA in 2006 when the government approved a monopoly for such missions in the U.S. However, the

Delta IV is a less attractive option for some payloads because its RS-68 propulsion system is less effective. "For some missions [such as lofting Lockheed Martin Advanced Extremely High Frequency and Mobile User Objective System satellites on the A2100 bus] this would be more expensive than using an Atlas V because it would require a multi-core heavy launch vehicle instead of a single-core vehicle," Schumann says.

Defense Secretary Chuck Hagel said he would review the Pentagon's policy on the Russian sourcing in response to queries from Rep. Robert Aderholt (R-Ala.) during a House Appropriations Defense subcommittee hearing March 17. The Air Force regularly reviews supply for both the Atlas V and Delta IV Evolved Expendable Launch Vehicles (EELV), Schumann says.

The diplomatic volley with Russia has piqued scrutiny of the supply strategy.

Not one to miss such an opportunity, Space Exploration Technologies (SpaceX) CEO Elon Musk has suggested that the Pentagon eliminate its dependence on the Russian engine by using the SpaceX Falcon 9v1.1 in place of the Atlas V. The SpaceX rocket is still in the process of being certified by the Air Force to compete to launch national security payloads.

Although raising the issue amid political tensions over Crimea may grab headlines, it remains to be seen whether this new backdrop will fracture the

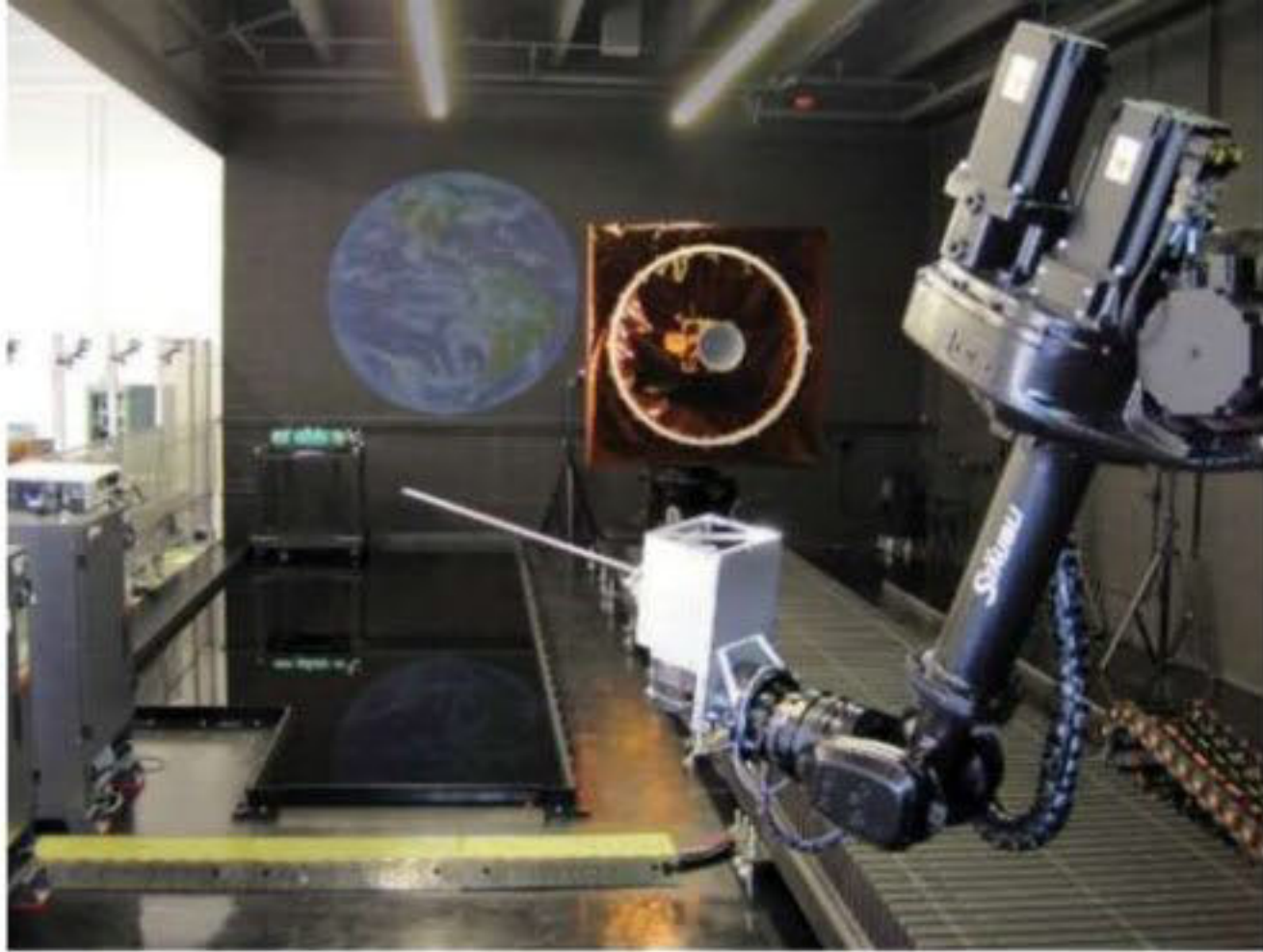
Pentagon's stalwart support for maintaining the Atlas V and Delta IV.

It has become an almost annual drill for budgeteers to suggest canceling the Atlas V and relying on a single supplier for financial reasons, but the Atlas V remains intact.

Musk's argument for replacing the Atlas V is hardly new; Boeing used it when competing against Lockheed Martin for work during the first round of EELV competitions.

But this dynamic could be changed if SpaceX can make good on its proposition of supplying launches to the Pentagon at a lower cost despite the rigorous oversight required for mission assurance. ☛

UNITED LAUNCH ALLIANCE



VIVISAT

Orbital MRO

On-orbit satellite servicing will soon become a reality

Frank Morring, Jr. **Washington**

The days of dumping communications satellites into graveyard orbits simply because they are out of fuel are coming to a close, with implications that go beyond the revenue streams of the big satellite operators.

ViviSat, a satellite-servicing startup developing life-extension vehicles for end-of-life commercial communications satellites in geostationary orbit, has booked two customers for three missions, and expects to start building its specialized spacecraft by the end of 2014. The company hopes to advance beyond a "jet-pack" lashed onto the target's kick-motor nozzle and start using robots for refueling and simple repairs. After that the imagination is the limit, with robotic spacecraft that do maintenance, repair and overhaul (MRO) to keep satellites in business indefinitely.

"It has really gone from... 'could this be done' to 'when are you going to be ready,'" says Bryan McGuirk, chief operating officer of the ViviSat joint venture of ATK Space Systems and U.S. Space.

The company has "a number of clients" who may reserve a fourth "Mission Extension Vehicle" (MEV), McGuirk says. Once that mission is booked, he says, ViviSat will pursue its final financing and begin bending metal. Given the expected start this year, a first flight should come about three years later, according to CEO Craig Weston.

McGuirk declines to identify the satellite operators that have reserved MEV missions, or the amount of financing ViviSat needs to build spacecraft and begin operations. ATK will assemble the MEVs at its Beltsville, Md., facility, where a robotics laboratory has recently been upgraded to perfect the software needed for rendezvous and proximity operations (photo).

Joe Anderson, director of MEV services at the ATK unit, says the vehicle will be designed to approach a customer's spacecraft using optical sensors and a laser ranger to navigate. At the end of its approach at "centimeters per minute," it will halt about 1 meter away from the target's apogee kick motor, extend a probe into the motor nozzle to grapple the spacecraft, and pull it toward the MEV until the servicing spacecraft's four "legs" brace it against the target's launch adaptor ring.

The resulting connection will be purely mechanical, with no electrical or data hook ups. The MEV will take over the

ViviSat has used this robotic setup to test its satellite life-extension hardware and software, and to show customers and insurers that the game-changing gear will work.

customer-spacecraft's station-keeping and attitude control for as long as 15 more years. There are "more than 200" satcoms that will run out of fuel by 2022, and are candidates for life extension with the addition of an MEV.

"If we did not exist, they would just run out of fuel," McGuirk says. "The current solution is they would purchase a new satellite, and on average that costs \$300 million."

Instead, McGuirk says, customers will be able to lease the spacecraft to avoid the up-front capital costs, opening up a new kind of market in geostationary orbit. ViviSat uses its laboratory mockups of a full-scale MEV and a generic commercial satcom to demonstrate its technique to potential customers and insurers, according to Weston.

Plans call for the first MEV to demonstrate its capability in the graveyard orbit about 300 km higher than the geostationary arc occupied by operational satcoms. It will use one of the inaugural customer's satellites that has reached the end of its fuel supply but has been kept alive for the test, before descending to the target bird.

Weighing approximately 2,000 kg at launch, with a body measuring 5 X 6 ft., the solar-powered MEVs will ride one or two to a launch vehicle, and carry enough fuel for the rendezvous, berthing and extended operations on more than one satellite. McGuirk says ViviSat's concept has been "widely accepted" by insurers, but the prospect of proximity operations raises eyebrows among civilian and military spacecraft operators who worry about collision, tampering and radio-frequency interference.

"Any satellite can be used to tamper with another satellite, whether it is interference [or] whether it is collision. Any satellite is potentially a space weapon," argues Dennis Wingo, an engineer and writer specializing in private space ventures. "How do you then constrain the growth of satellite servicing when any satellite can be used in that same manner?"

In fact, spacecraft servicing is receiving a lot of positive attention from the U.S. government, even as the FAA wrestles with setting up safety and other regulations for emerging commercial-space activities. NASA is running an experimental testbed on the International Space Station to evaluate robotic techniques for satellite servicing, and the Defense Advanced Research Projects Agency is pushing a three-pronged effort called Phoenix that hopes to build specialized spacecraft in orbit from modular "satelets."

NASA will make its future large space observatories robot-serviceable, says Ben Reed, deputy project manager in the Satellite Servicing Capabilities Office at Goddard Space Flight Center. Eventually satellite manufacturers can take a similar approach, he says, despite Wingo's contention that "the incumbent satellite manufacturers do not have any vested interest in doing this."

Before they start building-in serviceability, Reed says, manufacturers can make use of target decals and Velcro thermal-blanket closures to make their spacecraft easier to find and fix.

"Robotic servicing in GEO is inevitable," he says. "We have experience over three-plus decades of human and robotic servicing in orbit, going all the way back to the parasol on Skylab—a cooling sunshade astronauts installed in 1973. ☛

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Beyond Bubbles

Market dynamics may shield huge Airbus and Boeing backlogs from a new downturn

Guy Norris **San Diego**

Booms are followed by busts. This is the conventional wisdom of an industry that has weathered a roller coaster ride in fortunes with solar cycle-like predictability since the 1950s. It is also why Airbus and Boeing, uncharacteristically speaking with one voice, are trying to reassure the anxious market, investors and the supply chain that this time will be different.

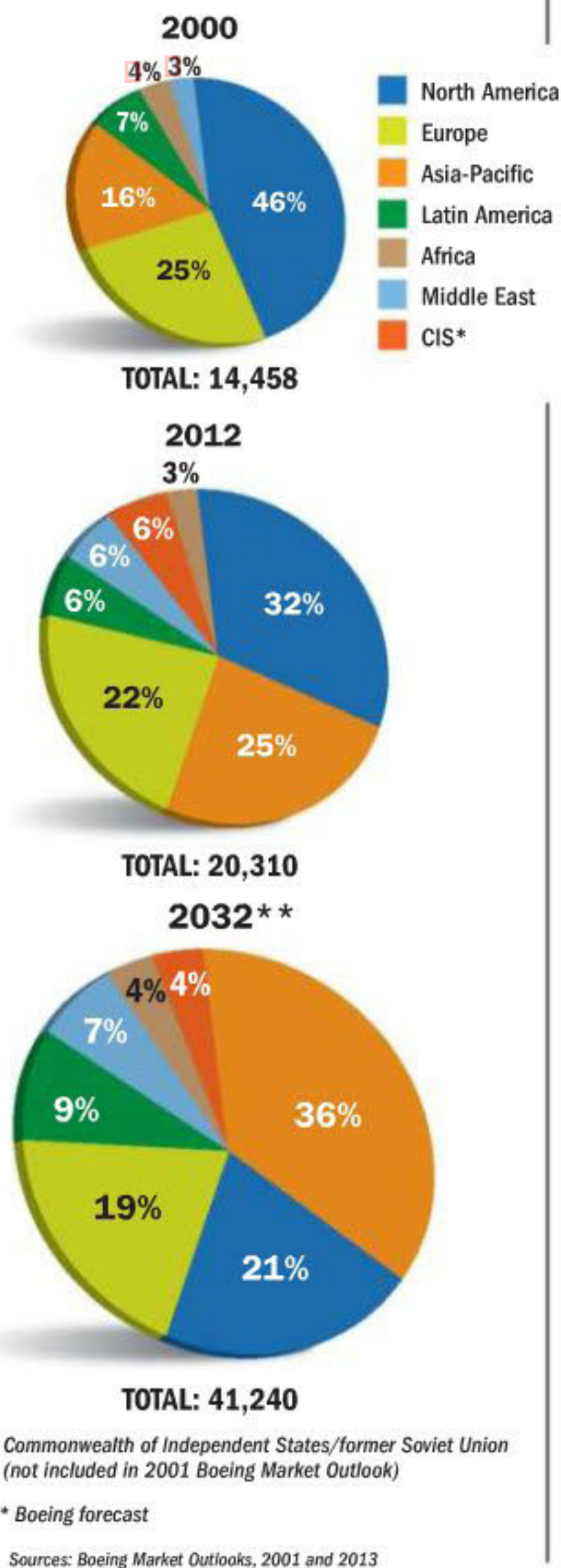
The two manufacturers are raising production to all-new levels in response to record orders, but both Airbus and Boeing insist the global air transport industry is more resilient than ever to market fluctuations and the potential threat of a "bubble," which could have drastic ramifications for the combined backlog of more than 10,000 aircraft.

Compared to the fragility of the backlog during earlier order-delivery cycles, there are "a number of reasons to be reasonably optimistic," says Airbus' senior vice president of leasing markets, Andrew Shankland. Speaking at the International Society of Transport Aircraft Trading Americas 2014 conference in San Diego, Shankland notes global gross domestic product (GDP) has already grown to 3.2% in 2014 versus 2.3% in 2013—a year that saw Airbus take 1,619 net orders.

Revenue-passenger kilometers and freight traffic have also shown early signs of climbing beyond 2013 levels and have to date grown to 5.4% and 4.6%, respectively, in 2014. "It has been very encouraging to see," says Shankland. Other factors, such as fuel costs and financing, which in past years have contributed to the severity of boom and bust cycles, are also favorable he adds. "There is plenty of financing available and fuel is relatively stable."

Echoing many of these observations, Randy Tinseth, Boeing vice president of marketing, says the "market is looking a lot better today. We are being cautiously optimistic as we move forward. Today's average load factor is 79.1 percent worldwide and we expect traffic growth to be around 6 percent for the year." Like Airbus, Boeing also

Commercial Airplanes in Operation



reports signs of a continued slow recovery in the cargo market, which has been in the doldrums since 2011. "Over the last six to eight months we have seen progress," he adds. "Airlines are also profitable, led by the U.S., and both the leasing and secondary markets are also faring well."

Boeing finished last year with a record order backlog of around 5,100 airplanes, valued at nearly \$400 billion, and expects to deliver as many as 725 aircraft in 2014. Airbus, which forecasts deliveries of 630 aircraft this year, has an even larger order backlog of almost 5,560. The backlogs represent more than eight years of work for both companies.

However, Adam Pilarski, senior vice president of Avitas, cautions that "we are in a bubble environment," and asks "are the existing orders and deliveries rational?" While he believes the order-

book is sustainable if fuel prices stay high and new environmental rules are introduced, Pilarski says the overall importance of the fuel factor could diminish as oil becomes "less relevant in the future" to the global energy budget. "We have also seen a relatively weak recovery so far. Aircraft values are not doing well yet. We are just getting to the level where aircraft values are reaching base values," he adds.

Pilarski, who has warned of a bubble before (*AW&ST* April 2, 2012, p. 30), also points to several potential vulnerabilities in the orderbook across various market sectors ranging from low-cost carriers in Asia to high reliance on groupings of carriers in specific regions. The three largest Middle East-based operators—Emirates, Qatar Airways and Etihad Airways—for example, took 1.4% of the orders in 2000 and 5.3% in 2013, but will account for 8.9% of the orders in 2023.

However, while agreeing there are potential weaknesses in the orderbooks of the two companies, some leasing companies believe the overall growth in global demand for new lift capacity will more than compensate. CIT Aerospace Transportation and International Finance President Jeff Knittel says the backlog for Asian low-cost carriers could be particularly vulnerable. "Asia is the high-opportunity, high-risk space where the winners and losers have not yet shaken out. In some cases, it is pretty obvious who the winners are. Asia is a new frontier and not

all will-win, and not all trees will grow to the sky.”

Despite reassurances from the airframe manufacturers, Knittel says, the threat of a bubble—particularly one that impinges on older aircraft—is “something we look at a lot. If you are a manufacturer and you see high fuel costs, low interest rates, abundant liquidity and profitable airlines, then you are probably not going to be selling into a better space. That will not continue forever, so the question is: When capital is constrained and in-

terest rates rise, will that carry on?”

Unlike previous cycles, the current expansion phase is seeing a greater wave of retirements of older aircraft than before. In addition, Knittel sends “kudos to the manufacturers for managing the risk in the orderbook. If you think about downturns in the past there were ‘whitetails’ (unsold aircraft) everywhere. In the last downturn, how many whitetails did you see? Very few,” he adds.

Steven Udvar-Hazy, chairman and CEO of Air Lease Corp., concurs, say-

ing there are “more aircraft flying today that are older than 20 years than ever, so there is a huge replacement cycle.” He also agrees that there are “certain customers who over-ordered aircraft and others that got left at the bus stop. So our feeling is the market will eventually find the right order level and those other buyers that cannot take them all will figure out a way to defer them.

“If we have a slowdown, then I guarantee you that Airbus and Boeing will slow their production rates,” he adds. ☛

Momentum Movers

Airbus is ‘at crossroads’ for the A330’s future, says key aircraft lessor

Guy Norris **San Diego**

Although Airbus remains publicly ambivalent about its willingness to develop a reengined A330, a growing sector of the market is voicing support for the move.

Leading U.S. lessor CIT Aerospace is among the latest to throw its weight behind the gathering group of operators and other potential customers that would like to see the Airbus big twin get a new lease on life. Speaking at the International Society of Transport Aircraft Trading (Istat) Americas 2014 conference here March 18, CIT Transportation and International Finance President Jeff Knittel says the A330 “is at a crossroads, and we think Airbus needs to make some decisions.”

Airbus remains unmoved by the clamor, at least on the surface. Commenting on the speculation over prospects for a new engine option (neo) variant, Airbus Senior Vice President for Leasing Markets Andrew Shankland says, “There’s a lot of discussion on the A330neo, but not in Toulouse.” Airbus delivered more A330s last year than in any single year since it entered service in the 1990s, he notes, and the advent of the planned high-gross-weight and regional variants indicates that the existing version has adequate margin for additional flexibility. Airbus sees “the A330 going on with new developments for a long, long time,”

Shankland acknowledges. “We are always analyzing everything including reengining—but you shouldn’t take that as a sign we plan to do that.”

CIT is one of the largest customers for the A330, with 41 either in service or on order, and it was the launch customer for the heavier 242-metric-ton variant that will be introduced in 2015. “We are still very bullish about the prospects for that,” says Knittel, adding that the introduction of a neo variant will not necessarily impact the near- or mid-term market for the current ver-

sions or the heavier and soon-to-be-developed regional versions. “Just because one iteration of an aircraft comes out does not mean the end of the world for the rest,” he says.

CIT sees the A330neo as a fundamentally viable prospect because it fits into a niche that enables profitability in the 250-300-seat market on shorter ranges where the longer-range optimized A350 and Boeing 787 families might be penalized. “The A350-800 is not as efficient as they’d like, so they need to do something,” says Steve Mason, CIT vice president for aircraft analysis. “The obvious one is to reengine the A330, and, from an Airbus perspective, it may be the biggest bang for the buck.”

Mason also says the reengined A330 and A350 markets are not necessarily the same: “We see them as segments that don’t overlap too much. The im-



CIT believes reengining could give A330 sales a valuable lift.

AIR TRANSPORT

portant thing is that Airbus act quickly." Failure to move swiftly and make a launch decision within the next six months or so could cause Airbus to miss the launch window. "That would damage the business case," Mason says.

Airlines including AirAsia and Delta Air Lines have already expressed strong support for the proposed re-engining, and Delta also has revealed that it intends to issue a request for proposals (RFP) for new aircraft within the next two weeks. "There is a huge need for a small widebody," Delta CEO Richard Anderson tells Aviation Week. "We really need Airbus to step up and reengine."

Delta is specifically pushing the case for a new 275-seat aircraft that would have been optimized for a range of 5,000-5,500 nm or less. Delta's RFP, which covers around 50 new widebodies as part of a broad replacement strategy for Boeing 767-300ERs and 747-400s, will include evaluation of the A350-900 and -1000, all three 787 models, current A330 versions as well as the A330neo.

Not all lessors are in agreement over the case for the A330neo, however. Steven Udvar-Hazy, chairman and CEO of Air Lease Corp., appears highly skeptical. "We don't believe it is rational for us to take the A350-800 and the A330neo. Airbus has not made that decision at a senior level and, if they do, I believe the focus going forward will be on the A350-900 and further enhancements to the A350-1000," he says. In the mid-2000s, as head of International Lease Finance Corp., Udvar-Hazy was influential in forcing Airbus to redesign the A350 with a wider fuselage. "I don't see the A350-800 surviving if they do the A330neo," he adds.

CIT, on the other hand, appears convinced that Airbus will go forward with a revamp of the A330. "Our view is that Airbus will probably do something like reengining, which will entail strengthening the wing and the landing gear," Mason says. The result would be a "very capable aircraft" that could enter service as early as 2017 or 2018 should Airbus decide to launch this year, he adds.

An early launch decision is essential if Airbus is to take maximum marketing advantage of the gambit in terms of timing and capital advantage, says Knittel. However, the over-

all plan is "not as easy as some people may suggest," he concedes.

Part of the answer will hinge on whether Airbus is tempted to invoke wholesale A330 systems and interior changes if it opts to reengine or will instead stick to the minimal change model adopted for the A320neo, which is focused mostly on engine and related wing-structure changes.

"The beauty of both the [Boeing 737] MAX and [A320]neo has been the ability of Airbus and Boeing to avoid scope creep," says Knittel. "I was not a firm believer in the manufacturer's ability to say 'no'—engineers are not accountants. So both Airbus and Boeing have to be commended for showing a great deal of discipline in changing the fewest things. If you're going to address capital cost, you can't have dramatic changes in the aircraft. That

model certainly worked with the A320neo."

Reengining would involve unavoidably significant structural changes to the A330 wing, Mason says. A sole-source choice of either a General Electric GENx-1 or Rolls-Royce Trent 1000 TEN derivative is most likely, CIT says, but both new engines will be heavier than the current propulsion systems. Mounting different engines on the same wing is not new to Airbus, though.

As it studies the reengining option, Mason says Airbus will "get more confidence" from its A320neo design experience as well as the modifications to the common A330/A340 wing that enabled it to accommodate the much larger Rolls-Royce Trent 500 for the A340-500/600 in place of the CFM56-5 on the original A340-200/300. ☒

Limiting Factors

Looming shortage of skilled personnel may lead Indonesia to limit aircraft imports

Jeremy Torr Singapore

There is good news and bad news for the airline industry in Indonesia. On the upside, the country is experiencing an unprecedented growth of passengers, airlines and aircraft orders. But its civil aviation regulators are concerned that there will not be enough skilled personnel to handle the increase.

Herry Bakti, head of the country's Directorate General of Civil Aviation (DJPU), says: "There are too many aircraft coming in [to Indonesia]. It is easy to buy aircraft—but our job is to consider who will run and operate them."

And Bakti goes beyond merely stating the problem, he outlines a remedy for the situation in the short-term. "At the moment there are not enough trained people to go round. So we may have to limit numbers of aircraft being imported, no matter how many [orders] have been made."

The revelation that regulators could simply refuse to grant import and operational licences for aircraft that step beyond the DJPU's regulated safe-manning levels could prove troubling for airlines. Especially if financial

growth is predicated on keeping all that valuable hardware in the air.

Makers and leasing companies have been particularly successful in Indonesia when it comes to aircraft sales in the last couple of years. The country's airlines account for hundreds of aircraft orders. Lion Air has ordered 234 A320s and 230 Boeing 737s, flag-carrier Garuda Indonesia is aiming for a fleet of 350-400 aircraft by 2025, and Sriwijaya Air is looking to take at least 45 737-800s and Embraer 190s in the next few years.

But, says Bakti, staffing shortages loom as a result of this dramatic growth—most significantly in the low-cost carrier (LCC) sector.

Bakti emphasizes that the DJPU is prepared to restrict the number of import permits for new aircraft if LCC personnel training fails to meet the demands of the agency's standard safety operating procedures.

The DJPU needs to ensure due diligence has been adhered to when it comes to ongoing safe operation, flight and maintenance, Bakti says. "The operator has to [prove] it has the staff,

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[and that they have] the training and skills to operate that aircraft safely, as well as the aircraft it already flies with.”

This caveat, said Bakti, extends across all aviation personnel—including pilots, safety sign-off officers and all crew operations.

Indonesia is not alone. The shortage of trained staff is becoming an increasingly restrictive bottleneck across many southeast Asian countries.

According to Chow Kok Wah, senior vice president of line maintenance at Singapore International Airlines Engineering Co., current levels of “explosive growth” across the region are already having an impact on staffing.

“We are seeing [staffing] challenges in Singapore and because of that, labor rates are already going up here,” he says. Chow says many MRO operators are consequently looking to move to countries where the cost of doing

will need 3,000 new engineers to keep up with current growth levels, but training courses there certify only around 700 technicians a year, he warns.

Lion Group, obviously recognizing the potential problem, has established its own training center with 30 personnel (technicians and instructors) processing 860 cabin crew, 150 pilots, 160 ground staff and 300 technicians at any one time, says the group director of technical operations, Henry Mudigdo.

Lion is stepping up its training capacity in a bid to keep the DJPU happy. It recently signed a \$250 million deal with Airbus that will eventually see 21 new Airbus, Boeing and ATR flight simulators providing pilot training at the Angkasa Aviation Academy at Jakarta’s Soekarno-Hatta International Airport. “We currently have 30 personnel including technicians and instructors [at the] center,” says Mu-

are coping as of now,” he says. “But if growth continues as it is, then we could have a problem with [the number of inspectors] too,” adds Bakti.

The DJPU is prepared to recruit overseas to fill vacancies and to step up recruitment and training from local sources within Indonesia. But Bakti admits that salaries are about the same as paid to pilots, so competition would likely be strong.

“We are quite capable now, and have a good mix of [young engineers in training] and experienced [inspectors]. We will join in International Civil Aviation Organization training projects, too; but we can of course bring in hires from overseas if we have to,” he reiterates.

Although the staffing shortage is particularly acute in Indonesia, the dearth of personnel extends beyond the country and region.

Bakti emphasizes that “this is a glob-



business is lower; some MROs are contemplating the proposed expansion of maintenance facilities on Batam and Bintan islands, near Singapore. But that move would only compound the problem for Indonesia’s native carriers.

Richard Budihadianto, president & CEO of GMF, Garuda Indonesia’s MRO offshoot, echoes the concerns of his competitors. “The biggest problem is manpower,” he says. “Infrastructure and equipment is easy. But manpower poses a serious gap—even if [we] double the manpower we will only be able to expand by 50% of what is planned.”

Budihadianto estimates Indonesia

digdo. “This deal with Airbus will expand our [training capacity] fivefold.”

But Bakti warns that it may not be enough. “If there is not [the staff] to run these all these new [ordered] aircraft safely then they will stay on the ground,” he asserts.

Approximately 150 inspectors work across the nation’s 20 scheduled and 40 charter airlines. Bakti says that this group “ensures compliance across the industry,” but that the DJPU is striving to bring on at least 25 more inspectors each year to handle the influx of new aircraft and airline personnel.

“It is a big challenge for us, and we

Lion Air is one of many Indonesian-based operators awaiting aircraft orders in the face of looming safety inspector shortages.

al human resources problem,” which is why he welcomes the recent Lion Air and Airbus training agreement.

“We are emphasizing that in the aviation industry we have to take things in order: first safety, next security, then service. If we get these three in the right order we will [have] a good business,” Bakti says.

If not, there could be a lot of parked aircraft at Soekarno-Hatta. ☛

Forensic Fuel

Airline industry acts to counter accident trends

John Croft **Washington**

Preliminary airline accident statistics from the International Civil Aviation Organization (ICAO) for 2013 are cause for optimism, as accident numbers and fatalities declined and the air transport industry is addressing key trouble areas with a host of safety initiatives.

Set for official publication in early April, the results will show a four-year low of 173 deaths in scheduled commercial aviation globally as a result of nine fatal accidents, a steady decrease from 626 deaths caused by 19 fatal accidents in 2010. In total there were 90 accidents of scheduled aircraft weighing more than 12,500 lb. in 2013, down from 99 in 2012, 118 in 2011 and 104 in 2010.

The relative distribution of the three main causes of fatal and non-fatal accidents—controlled flight into terrain (CFIT), loss of control in flight (LOC-I) and runway safety-related—have not changed substantially, although the

share of runway and LOC-I accidents spiked in 2013 while CFIT accidents abated somewhat. It remains to be seen whether the changes are cyclical or indicative of deeper troubles as multiple efforts to counter LOC-I and runway safety are in full swing or ramping up.

In 2013, LOC-I was identified in only 3% of the accident totals, but it accounted for 33% of the fatal accidents and 60% of the fatalities, compared to 2%, 22% and 13%, respectively, for CFIT.

Historically, most loss-of-control situations are preceded by an “upset” in aircraft pitch or roll, and most of the

upsets are caused by stalls, according to Jeff Schroeder, the FAA’s chief scientific and technical adviser for flight simulation systems. In a review of 75 airline LOC-I accidents between 1992 and 2008, stalls led to 36% of the upsets, the highest factor after flight control issues, which caused 21% of the accidents.

Schroeder presented in January the results of studies that he had conducted in 2013 testing pilot responses to various stall scenarios in a Boeing 737-800 full-motion simulator (see [page 37](#)), work that will be part of the FAA’s updated performance rules for simulators, expected out in preliminary form this summer.

The realization that pilots are not properly responding to stalls and upsets is at the root of a massive international undertaking to retool pilot training, an effort that went into overdrive after three airline crashes in 2009: Colgan Air Flight 3407 near Buffalo, N.Y.; Turkish Airlines Flight 1951 near Amsterdam; and Air France Flight 447 in the Atlantic Ocean about 500 nm from the Brazilian coast.

Based on a 2010 mandate from the U.S. Congress in response to the Col-

	Global Accidents*		CFIT Accidents			Runway Safety-Related Accidents			LOC-I Accidents		
	Accidents	Fatalities	% All	% Fatal	% Fatalities	% All	% Fatal	% Fatalities	% All	% Fatal	% Fatalities
2010	104	626	3.3%	21.1%	32.2%	57.0%	26.3%	23.3%	5.0%	21.1%	27.6%
2011	118	372	1.6	12.5	24.4	44.8	0.0	0.0	3.2	25.0	29.5
2012	99	388	3.0	22.2	36.8	43.4	11.1	0.3	1.0	11.1	8.3
2013	90	173	2.0	22.0	13.0	62.0	22.0	6.0	3.0	33.0	60.0

* On aircraft above 12,500 lb. operating scheduled commercial flights

Source: International Civil Aviation Organization preliminary data

On landing last August, a Korean Air Boeing 737-900 overran Runway 10 at Niigata Airport, Japan. ICAO says there are about two runway excursions per week worldwide, leading to \$900 million in damage per year.

gan Air accident, the FAA in November 2012 finalized a pilot training rule that gives airlines until 2019 to begin teaching pilots to recover from upsets, stick-pusher activations (for aircraft that are equipped) and full stalls in a full-motion flight simulator at least every 24 months. Pilots today must practice “approach to stall” at least once per year, requiring a recovery at the first indication of a stall, in many cases signaled by a stick shaker device (see video accompanying following article). The agency issued new stall training guidance in 2012, noting that “a growing causal factor in LOC accidents is the pilot’s inappropriate reaction to the first indication of a stall or stick-pusher event.”

The new training rule will also require that most simulators be upgraded with extended aerodynamics models to support stall training to an angle of attack 10 deg. past the stall break, although the FAA has not yet defined to what extent the devices will have to be modified in advance of the 2019 training deadline (see [page 40](#)).

The global community is following the FAA’s lead as well, with recently approved guidance from the International Civil Aviation Organization (ICAO) that expands upset prevention and recovery training (UPRT) in recurrent training and for a type rating, and recommends in-aircraft UPRT for a commercial pilot’s license. The FAA stopped short of mandating in-aircraft training in its rule.

Accidents occurring on or near the runway continue to dominate aircraft-damage statistics in ICAO’s 2013 preliminary data. They accounted for 62% of accidents and 6% of fatalities, up from 43% and 0.3%, respectively, in 2012. It is an area in which regulators, airframers and avionics makers are developing technology and offering training preventatives. Among runway safety events, excursions (“veer-offs” to the side of the runway and overruns) are by far the largest element. According to the International Air Transport Association, runway excursions accounted for 28% of the 594 commercial aviation accidents in 2004-09, resulting in 483 fatalities.

ICAO earlier this month launched a new runway safety implementation kit and is preparing a “GO-Team” program to establish “focused” teams at world airports. Airbus is now offering a runway protection overrun system

as an option on many of its aircraft and says it has several “saves.” Boeing plans to begin offering its own branded preventative starting with the 737NG family next year (see [page 42](#)).

Bridging all three types of accidents will be an “effective pilot-monitoring” effort from a government and industry safety team that will recommend airlines voluntarily follow 20 best practic-

es for monitoring of an aircraft’s flight path (see [page 40](#)). NTSB member Robert Sumwalt, a key advocate for the program, says inadequate monitoring is a focus in the investigation of both the Asiana Airlines Flight 214 crash at San Francisco last July and UPS Flight 1534 crash at Birmingham, Ala., last August. The group’s final report is due out by June. ☛

Stall Tales

Airlines and pilot-training providers reprogram upset prevention and recovery training

John Croft **Minneapolis**

The expression “Old habits die hard” is harshly true when it comes to a pilot’s response to a stall. Until recently, airline pilots around the world had been trained to minimize altitude loss when faced with the warnings signs of a stall. Training sequences became rote, and pilots were anticipating the stall warning with hands on the throttle and a trim setting that would ease pitch control when power was added.

The price of such training practice became clear in 2009, when three stall-related crashes—of the Colgan Air Flight 3407 Bombardier Q400 near Buffalo, N.Y.; Turkish Airlines Flight 1951 Boeing 737-800 in Amsterdam; and Air France Flight 447 Airbus A330 in the Atlantic northeast of Brazil—made clear to regulators, the industry and pilots, that what was practiced in training was not effective in recovering from stalls in real life.

Airlines and training providers, with modernized guidance and rules from regulators, are now implementing new training programs and technologies designed to de-program pilots of the ingrained responses. Included are efforts to surprise or startle pilots with an unexpected unusual attitude or an automation action that sets off a stick shaker, stick pusher or other stall prevention system when least expected. While other factors were present in the three 2009 crashes, incorrect or insufficient recovery from a stall scenario was a common thread in the crash sequences.

The training standards before 2012



Tap the icon in the digital edition of *AW&ST* to watch a video of Safety Editor John Croft learning the difference between legacy and modern stall recovery training in a Bombardier CRJ900 simulator, or go to AviationWeek.com/video

unwittingly led to stall recovery success in terms of lost altitude rather than the need to reduce angle of attack and aerodynamic load on the wing by immediately pushing the elevator control forward—the universally accepted solution to stalls that had been ignored in training.

To succeed, pilots would begin the maneuver at a medium altitude, slow down and hand-fly the aircraft, with the elevator trim set so it would not cause pitch-up problems when full power was brought in on the first warning of a stall. The net result was a programmed reaction to give power more priority than pitch, a fatal mistake in many accidents. Actual stalls were not required nor were they allowed in the simulators because the aerodynamic models driving the systems did not accurately reflect the non-linear behavior of an aircraft in the stall and post-stall regime.

Stall training before 2012 “was a choreographed event,” says Paul Kolisch, supervisor of flight operations training at regional carrier Endeavor Air, a wholly owned subsidiary of Delta Air Lines. “It was akin to synchronized swimming.”

An intense focus on the problem after the 2009 accidents led the industry to convene experts and the U.S. Congress

to mandate several actions from the FAA, including new flight-training rules that are based on the efforts of several rulemaking committees and technical groups. The new rules require airlines to teach not only the proper response to a stall warning, but also prevention and recovery from simulated, fully de-

plete the extended envelope training provisions required by this final rule, that accident would likely have been mitigated," says the FAA in the rule, noting that the captain may have been surprised by the activation of the stick shaker, pulling the control column aft rather than pushing it forward.

proper handling of stalls to avoid the upsets that typically follow. The course will include flights in APS's Slingsby T-67 Firefly aerobatic trainers.

"We have a potential situation in the future, where we will be bringing in less and less experienced pilots into the cockpit," says Brad Bennetts, an SAA senior first officer, Airbus A340 line pilot and UPRT project manager, who also flies competition aerobatics. "We feel that UPRT is an absolute necessity, but it has to be done properly."

Starting in 2019, airline pilots will have to receive hands-on, instructor-led full-stall training in full-motion simulators, an action that will require upgraded simulator models and instructor-monitoring tools.

With grant money from its insurance company, the airline last year sent Bennetts as well as its chief pilot and senior in-

structors to an APS "train the trainer" program in Phoenix, a five-day course that includes four UPRT flights in an aerobatic Extra 300 and two sessions in a full-motion simulator to work on transferring the in-aircraft skills to the simulator. "Train the trainer" is designed to take a simulator instructor and make him a subject-matter expert," says McNeace.

The FAA did not mandate that pilots receive in-aircraft stall or UPRT training in the new rule, an action critics of in-aircraft training say points to the potential for negative training between a straight-wing aerobatic propeller aircraft and a swept-wing jet. McNeace disputes that notion. "The discipline needed to recover both types of aircraft is almost virtually the same," he says, adding that the aerodynamics "are 90% the same between the prop and the jet." Advocates of in-aircraft training believe the experience can help pilots understand the physiological stresses and g-forces that accompany upsets, regardless of the size and wing characteristics of the aircraft.

Bennetts says SAA considered giving all its pilots in-aircraft training to

veloped stalls and upsets, including "instructor-guided, hands-on" training in full stalls and stick-pusher activations. Upsets, which the FAA says are most often caused by a stall, occur when an aircraft's pitch or roll angles exceed the normal bounds of 25 deg. nose up, 10 deg. nose down and bank angles of more than 45 deg.

The core principles of the training emerged from an FAA advisory circular published in 2012 that was echoed by regulators globally: reduce the angle of attack when "confronted with a stall event" without being overly concerned with a "predetermined" value for altitude loss. The FAA also called on industry to create "realistic scenarios" for stall training—code for trying to surprise or startle pilots while flying on autopilot—and for making stick-pusher training part of the program for equipped aircraft.

Similar changes are underway in ICAO guidance, driven in part by the new FAA rules and work of the International Committee for Aviation Training in Extended Envelopes (Icatee).

"Had the [Colgan Air Flight 3407] flight crew been required to com-

plete the extended envelope training provisions required by this final rule, that accident would likely have been mitigated," says the FAA in the rule, noting that the captain may have been surprised by the activation of the stick shaker, pulling the control column aft rather than pushing it forward.

Ten new students—instructor pilots with South African Airways (SAA)—are set to begin a professional pilot UPRT three-day training course with McNeace this spring as part of a new safety initiative within the airline to teach existing and newly hired pilots the correct methods of stall and upset recovery. The "prevention" aspect of UPRT relates to

JOHN CROFT/AW&ST PHOTOS



experience g-force issues with UPRT, but the \$4,300 price for each pilot was prohibitive, “especially for an airline in financial woes,” he notes. Instead, instructors will try to ingrain in pilots “muscle memory” of a recovery technique that makes unloading the wing the first priority, he says.

Starting in July, SAA’s instructor cadre will begin putting the airline’s 800 pilots through Bennett’s UPRT training module as part of a one-day initiation, followed by recurring simulator training every six months. The airline began developing the training two years ago, with help from Sunjoo Advani, president of Netherlands-based International Development of Technology. Included in the introductory session will be a 1.5-hr. briefing, 4-hr. simulator session and 1.5-hr. debriefing. Afterward, UPRT training, including high-altitude stall scenarios with an element of surprise, will be built into the regular six-month sessions in the airline’s four simulators. Bennetts says the carrier’s Airbus pilots receive approach-to-stall training during initial conversions, per the Airbus “footprint,” but rarely practice stalls afterward. That will change with the new program.

The FAA itself has discovered evidence of the unsatisfactory stall training in pilots during an unrelated study last year that looked at whether lower-

South African Airways pilots will receive a new iPad application developed by Aviation Performance Solutions to explain the fundamentals of upsets and recoveries as laid out in latest revision of the airplane upset recovery training aid.

cost generic or type-representative stall models may be adequate to upgrade full-motion simulators for the stall and upset training mandate. The gold standard is a “specific” model created by flight-test data, although aircraft manufacturers may not be willing to part with that data and the information may cost-prohibitive to obtain for aircraft that are out of production.

The agency brought in 45 line pilots from Southwest Airlines, American Airlines and Delta, among other carriers, and put them through stall scenarios in its Boeing 737-800 full-motion simulator, augmented with the different extended envelopes. Pilots were divided up to fly the various models, in which

each pilot “trained to proficiency” in stall recovery: apply nose-down pitch control first (and hold until the stick shaker stops), then apply roll control, followed by adding more thrust if needed. Each pilot flew two planned stall maneuvers, followed by a third, unannounced stall caused by a rapidly increasing (74 kt. in 5 sec.) severe tailwind on an instrument approach on the autopilot into a demanding airport (Reagan Washington National Airport).

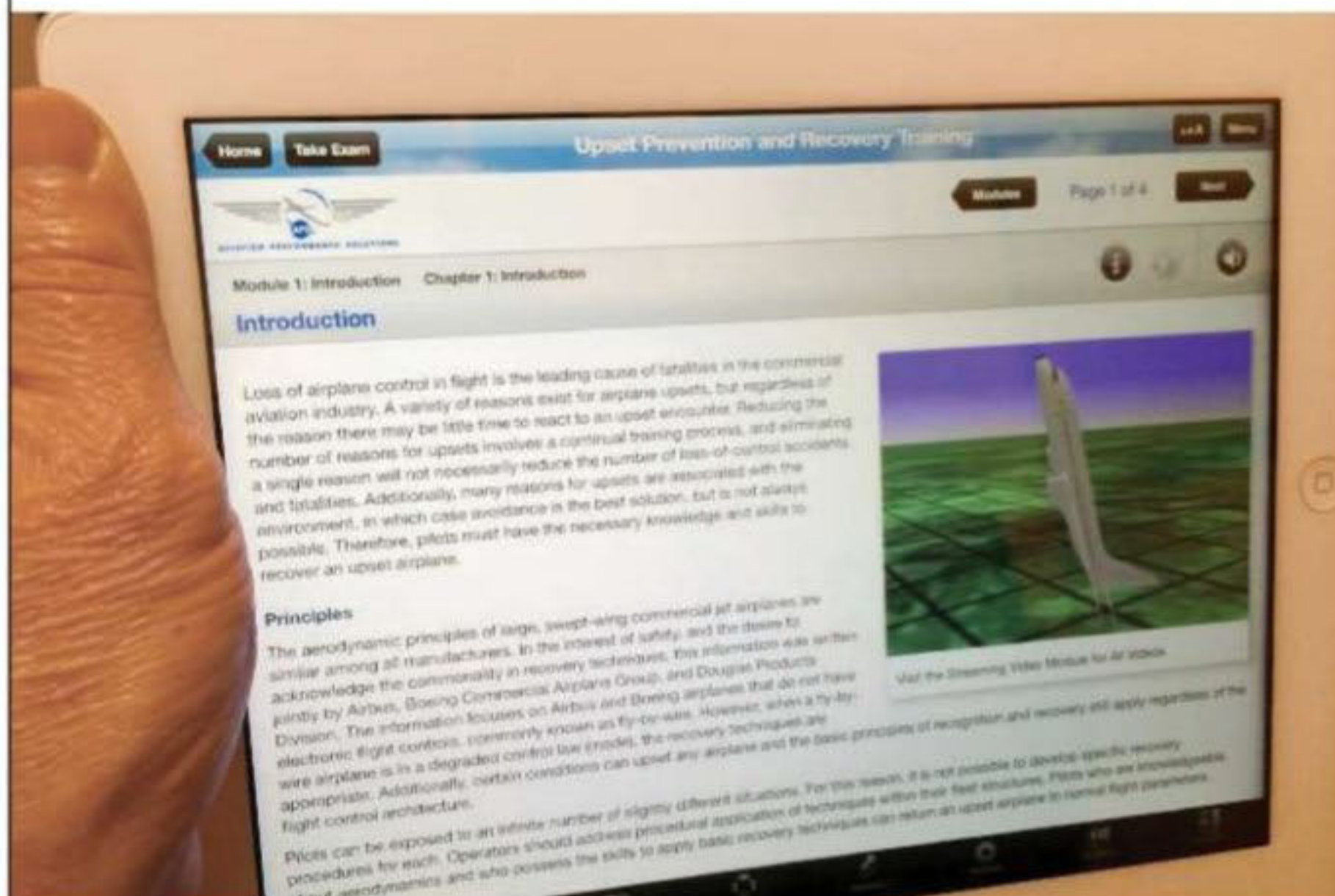
“The results from the surprise scenario turned out to be one of the most valuable parts of the experiment,” says Jeff Schroeder, FAA chief scientific and technical adviser for flight simulation systems and lead author in a report on the study, presented at an American Institute of Aeronautics and Astronautics conference in January. “Instead of the choreographed maneuver training, where pilots are told, ‘now we are going to do stall training,’ the surprise scenario revealed what might happen if confronted with an unexpected stall in real life.”

Schroeder says only 10 of the 45

prised by the tailwind stall, he notes. “It is exactly this type of scenario training that is needed in today’s airline training programs,” Schroeder says. The same pilots, after being given hands-on stall recovery training, performed better.

Creating scenarios that produce the physiological response of surprise or startle in a pilot, while not introducing negative training in the recovery of the aircraft, will be key to effective next-generation flight training. Endeavor Air’s Kolisch says his simulator instructors have already integrated realistic scenarios into their six-month simulator checks for more than 2,000 line pilots flying the Bombardier CRJ200 and CRJ900. Distractions he likes to use to mask an impending surprise include a malfunction on the engine-indicating and crew-alerting system just before the stick shaker activates, introducing distracting conversations as airspeed bleeds off or even dropping a heavy book on the floor during a critical operation.

Some scenarios are ready-made for confusion, including low-altitude stalls,



pilots applied the stall recovery “template” correctly on the surprise stall. The other 78% had issues with the correct recovery sequence. “Some pilots did not want to drop the nose below the horizon to eliminate the stall, and this experience hopefully served to reinforce the fact that an airplane can be stalled at any attitude or airspeed,” he says. Most of the pilots in the study “strongly agreed” that they were sur-

where the terrain-awareness warning system alerts the pilot to “Pull up!” in direct contrast to the stall recovery technique. Once the stall warning fires, the pilots are expected to disconnect the automation, lower the nose, add thrust and “clean up” the aircraft later. “You may not surprise everyone, and you may not surprise anyone more than once or twice, but one time is really valuable experience,” Kolisch says. 📺

Super Sim

Stall-capable simulator traits due soon

John Croft **Washington**



It will be summer before an FAA preliminary rule to upgrade full-motion simulators with extended models to handle full stall training hits the streets, and nearly five years before airlines have to officially put the updated machines to work. Despite the long grace period, the industry is taking a proactive stance on the safety improvements triggered by new flight-training rules, finalized in November and designed to help pilots recognize and recover from fully developed stalls and attitude upsets, often caused by stalls.

As U.S. airline pilots gain proficiency in recoveries from full stalls in 2019, instructors will need new real-time tools to guarantee the simulators remain in validated envelopes.

"We're finding that there are a variety of different airlines and training organizations trying to do some of this work in lieu of formal requirements," says Jack Ralston, president of Bihle Applied Research, a developer of extended simulator models for civil and military aircraft. "A lot of actual users are anxious to get started." The FAA will issue a preliminary version of the formal requirements, known as the Part 60 rule, this summer, but a final rule could take a year or more to complete.

In the meantime, industry has some

Flightpath First

Pilot-monitoring working group sharpens focus

Sean Broderick **Washington**

As industry tackles areas like runway safety and inflight loss of control, which are seen as ripe for safety improvement, a working group is zeroing in on ways to minimize the most common contributor to airline accidents: inadequate flightpath monitoring.

In late 2012, the group was created with the goal of churning out a final report with recommendations and training aids within a year. The panel soon realized that its original focus—pilot monitoring—was too broad, explains Steve Dempsey, the co-leader and a Delta Air Lines 737 captain and human

factors working group chair.

"Monitoring in general is well beyond the scope of any singular project," Dempsey says. "We determined the highest threat to safety—the one thing all accidents have in common—is deviation from the intended flightpath."

While recent accidents and general trends have triggered actions on upset recovery (see [page 36](#)) and runway safety (see article below), monitoring has lagged as an action item. The NTSB issued its first monitoring-related recommendations in 1994, and followed up with more after several investigations—notably of the 2009

Colgan Air crash near Buffalo, N.Y. But aside from a few changes to advisory material, regulators have done little to address the long-running challenge.

Frustrated by the lack of progress, NTSB board member Robert Sumwalt in 2012 challenged industry to tackle the problem itself.

"We have hit these things in a couple of different iterations, yet we are still seeing accidents, even as recently as last year—two major air carrier accidents in the U.S. where inadequate monitoring is a focus of the investigation," Sumwalt said.

The ongoing investigations into July 2013's Asiana Flight 214 crash, followed by the UPS Flight 1354 accident five weeks later, have identified inadequate monitoring as a contributor. This underscores why Sumwalt has given the issue its own unofficial tagline: "The problem that never went away."

fairly solid clues from the FAA in terms of what will be required of simulators in 2019 when the flight-training rule goes live. In January, the agency's National Simulator Program (NSP) published preliminary guidelines to qualify a simulator for the full-stall maneuvers. Simulators today must correctly represent an aircraft in the "approach to stall" regime, where recovery is initiated at the first indication of the stall, typically at the activation of the stall warning system or stickshaker, occurring at or below the stall angle of attack.

The NSP says the 2019 full-stall simulator models should mimic the actual aircraft to "at least" 10 deg. beyond the stall angle of attack and exhibit the same degradation in pitch, roll and yaw stability as the actual aircraft in a stall. Judging how well the simulator performs will be a subject matter expert (SME) pilot "with relevant experience in the aircraft," typically a test pilot who has performed many stalls.

Guidance on the types of stall models that might qualify comes from an FAA study last year. The agency brought nine SMEs—test pilots with stall experience—to its Boeing 737-800 simulator in Oklahoma City to evaluate stall models of varying complexity, hence cost to develop. The group evaluated the standard as-delivered 737-800 simulator model, but with a more pronounced "buffet," the rumbling that

occurs as airflow separates on the top of the wing near stall; a Bihle-developed "representative" model built from computational aerodynamics, wind-tunnel data and input from a test pilot with "extensive" stall experience in the 737; and a "specific" model Boeing built from 737-800 flight-test data from "hundreds" of fully developed stalls, including turning stalls. Given the flight-testing required, a specific model will be more costly to develop than the representative model, which could be built to emulate a variety of aircraft with similar characteristics (low- and under-wing engines, and conventional tail). In some cases, flight data may not be possible to obtain for aircraft that are out of production.

On average, the test pilots "somewhat agreed" that any of the models could be used for stall-recovery training, but "wide differences of opinion arose between the particular models," say the authors of the study, including Jeff Schroeder, FAA chief scientific and technical adviser for flight simulation systems. It could be that more than one model is needed, Schroeder concludes. "Some preferred to be challenged by what could happen in a stall. Others preferred the more benign, typical responses," he says. "This is an important training question; do you show what could happen or what happens on average? Perhaps the best answer is to show one of each." The tests confirmed

what Bihle's and other experts had suggested, that representative stall models are feasible when flight data are not available.

What the test pilots did largely agree on was that the correct buffet response is important to training. "Even after more than doubling the buffet response [of the unmodified simulator], most of the test pilots believed the buffet cue was less in the simulation than in the aircraft," says Schroeder.

Along with developing representative models, Bihle also has come up with a technology to upgrade simulators without changing the basic system, an external "stall box" the FAA used for the model testing in Oklahoma City. Ralston says the stall box overwrites the existing simulator model when the aircraft reaches certain thresholds near and beyond the stall, and would not require the basic simulator to repeat its qualification. The system can also drive tablet-based displays of yoke, throttle and attitude positions, and g-force envelopes to help instructors keep pilots within valid bounds of the extended simulator model and to replay pilot performance afterward.

For the stall box, Ralston envisions a two-tiered system where airlines would pay one price without the box active and a higher price for an activated stall box. He says, "You would not have to dedicate a single simulator for full stalls." ✈

The working group does not expect its findings will eliminate all monitoring flaws, but it does hope its recommendations—the final report is expected to contain about 20, covering philosophies and practices—will help operators mitigate the biggest risks.

Besides narrowing the monitoring scope to flightpath-related variables, the group made a subtle but important terminology change. It began with an unofficial moniker as the "active" pilot monitoring working group. Soon, members realized that emphasis should be placed on "effective" monitoring—doing it correctly, not just doing it. The group even created a loose definition, Dempsey says: Effective flightpath monitoring is recognizing issues before they lead to flightpath deviations.

The semantics may seem trivial, but Sumwalt—whose work on monitoring began when he was at US Airways two

A working group has zeroed in on flightpath monitoring techniques as part of the global aviation safety improvement effort.



JOHN CROFT/AW&ST

SAFETY SYSTEMS

decades ago—says they help drive the organization-level philosophical shift pilots need to be better monitors.

“People say ‘we’re doing pilot monitoring,’ but when you scratch the surface, you find [they have only changed] the term ‘pilot not flying’ to ‘pilot monitoring,’ and that is it,” says Sumwalt, re-

ferring to a 2003 change in an FAA guidance he helped write. “Name change alone does [nothing. There must be] a systemic, comprehensive change to the philosophy of managing the flight deck.”

The report also tackles what Dempsey describes as two “cultural misconceptions” that are hurdles to

more effective monitoring.

The first is that managing the flight-path is synonymous with controlling it. But this leaves the crew’s task cycle incomplete, because there is no feedback provision to confirm that the correct inputs have been made and the correct path is being followed, he explains.

Exit Excursions

Boeing and Embraer deploy runway safety tools

John Croft **Washington**

A joint safety effort between Boeing and Embraer launched in late 2012 is yielding its first fruits to help with runway excursions, events where an aircraft veers off or overruns the runway. Products of the collaboration include new training aids and updated operating procedures for both manufacturers’ aircraft and, coming in late 2015, new flight-display safety tools for the Boeing 737NG.

Issues with incursions have been growing globally. The International Civil Aviation Organization’s analysis of accidents in 2013, slated to be published in early April, reveals that 62% of the 90 airline accidents that occurred on scheduled runs last year were related to runway safety, up from 43% in 2012 and 45% in 2011. Within “runway safety,” excursions are the worst offender. An Airbus analysis of “landing roll” incidents in 1985-2010 showed a doubling of incidents during that period, with overruns dominating by a factor of two over hard landings, the next-largest cause. Airbus already has energy-based options for its Runway

Overrun Protection System for the A380 and A320. The system presents visual alerts and audio call-outs on the head-up and primary flight displays (PFD), warning pilots while they are still airborne of runways that are too short, and calling for maximum braking or thrust reversing on the ground. Along with extending the options to the A330 and A350, Airbus is researching advanced technologies, including real-time runway condition alerting.

Boeing and Embraer decided to target runway incursion mitigations, and independently researched accident data in their fleets. They found that contributing factors for different landing phases were “very consistent across two completely different aircraft manufacturers and airplane types,” says Marisa Jenkins, Boeing’s flight deck surface operations principal investigator.

The runway situation awareness tools (RSAT) teams, one at Boeing and one at Embraer, set out to mitigate “each and every” contributing factor of excursions and to ensure

maximum fleet penetration with affordable products as soon as possible to the forward-fit and retrofit market. Jenkins says the RSAT program was a “very different approach to mitigating excursions than we have done the past,” where solutions were focused on flight-deck technology alone. In this case, in order to maximize fleet penetration and get the solutions out as quickly as possible, Boeing and Embraer created two paths—longer-term flight-deck changes and near-term procedural and training guidance updates that have already been issued.

In February they jointly released a 20-min. training video on myboeing-fleet.com, a proprietary website for customers. The video addresses the best practices for avoiding runway incursions, focusing on understanding common mistakes on an approach, touchdown and rollout that can lead to an excursion. Obvious issues aside—too high or too fast on the approach and landing long on a wet or slippery runway—the video also explains how delays in deploying deceleration devices, particularly reverse thrust, can seriously compromise the stopping distance. For the 737NG, engines are typically spinning at flight idle on touchdown (approximately 30% of maximum speed) and the speed decreases to ground idle (about 20% N1)

Contributing factors to runway excursions were consistent across Boeing and Embraer fleets, thus solutions could be shared fleet-wide.



The second misconception is that monitoring is done only by the pilot not flying the aircraft. Pilot duties are “far more alike than the titles “pilot flying” and “pilot monitoring” suggest; both pilots have a key responsibility to monitor the aircraft’s path, Dempsey says.

The recommendations will be based

in part on what the group believes is the most comprehensive monitoring dataset. Derived from thousands of Line Operations Safety Audit (LOSA) reports, the aggregated data will underscore how effective monitoring can cut down on undesired-aircraft states. The results confirm what Sumwalt discovered

during LOSA audits at US Airways in the early 2000s, when data showed that, with better monitoring, about 20% of errors and 66% of undesired aircraft states would not have occurred.

The report is now slated to be released by mid-year. “We’re on the one-yard line,” Dempsey says. ☛

2-4 sec. after touchdown. If the thrust reversers are selected immediately after touchdown, the engines require 2-4 sec. to spool up to maximum reverse thrust, compared to 11 sec. for a spool up from ground idle.

The best practices for thrust reversers echo changes Boeing made to its flight-crew training and operations manuals across the fleet, with a new mandatory thrust reverser “normal” or “non-normal” call-out after touchdown. “The most surprising piece of data that we got from accident analysis was the significant portion of overruns where the pilots either did not put out the thrust reversers, put them out late, or pulled them back early,” says Jenkins. She says the checklist item will make sure pilots “understand what condition their thrust reversers are in once they touch down.”

Boeing also added a new landing-distance calculation step in the approach checklist, helping pilots to consider changes that may have occurred at the destination airport since departure. “Doing another calculation real-time right before you do the landing is extremely important to having the pilot get their head in the game for what they are going to see once they touch down,” says Jenkins. To help make the calculation, Boeing developed an installed option using the forward displays for the computation, as well as a portable solution on the iPad that computes airplane-specific landing calculations using a Boeing application. “For some of our customers, [the display option] is a very big change we are not sure they are willing to accept,” says Jenkins.

Boeing is also developing anti-excursion technology for the flight deck, starting with its most widely used commercial jetliner, the 737NG. According to the Aviation Week Fleet Database, there are 5,060 737NGs in service, representing 21% of the 24,452 jets in use, the largest percentage held by a particular model. Boeing plans to make the excursion preventatives available as forward-fit for the 737NG and the 737 MAX, and as retrofit for the existing 737NG fleet.

Jenkins says Boeing analyzed Honeywell’s SmartRunway safety aids, already available as an option for the 737NG, as a starting point and came up with a complementary system. Boeing will package its new features as one option, and Honeywell’s technologies as a separate package that can be purchased together or individually. “We [took] Honeywell’s solution and ran it through a series of tests in our cab with pilots,” says Jenkins. “We then made a Boeing operating solution that integrates very well with our airplane and the existing call-outs.” SmartRunway call-outs include long-landing and too-short runway alerts. The long-landing alert triggers when the aircraft is aligned with a runway that the database identifies as being shorter than a pre-defined limit set by the operator.

Technology upgrades for the Boeing 737NG include a flightpath vector, conformal runway edge lines and an extended runway centerline (not pictured) plotted on the primary flight display.

Boeing’s option will include four new sources of information plotted on the PFD: The flightpath vector, a standard feature on most head-up displays; conformal runway edge lines; a runway centerline leader that extends 12-14 nm out from the runway; and runway-remaining “billboards” that appear after touchdown, marking thousands of feet remaining. Other alerts include an in-air overrun warning, an energy-based computation designed to initiate a go-around by the crew and a speed-brake warning on touchdown. “We noticed on our data analysis that sometimes excursions are caused by speed brakes not going out as you would expect them,” says Jenkins.

The overrun warning will also work on the ground, alerting pilots to use all available deceleration devices—speed brakes, thrust reversers and maximum braking—to stop. For the 737NG, Boeing will offer landing-distance calculations on the iPad rather than the forward displays, as the impact of the changes to the avionics architecture made it “extremely unfeasible,” Jenkins notes.

Along with SmartRunway, a Honeywell option for the 737NG in 2015 will include SmartLanding, which alerts pilots visually and aurally to an unstable approach, based on gear, flaps, speed and vertical-speed thresholds.

Boeing plans to begin offering the RSAT packages to customers this summer, with certification and entry into service on the 737NG expected by the end of 2015. The retrofit package will include a “runway inhibit” switch that turns off certain features, a switch that existing SmartRunway customers already have installed. Customers with the Boeing option can choose which features are on or off. ☛



Aviation Week

57th Annual Laureate Awards



Aviation Week President Greg Hamilton (far right) and *Aviation Week & Space Technology* Editor-in-Chief Joseph C. Anselmo (far left) join this year's Laureate winners.

“USAF Prepares Industry for Cutbacks,” warned an *Aviation Week & Space Technology* headline, followed by a story that discussed the death of aircraft companies, shuttering of facilities, a Pentagon briefing to industry leaders with “a blunt warning of things to come” and a diminished role for manned aircraft in national defense. That article didn’t appear recently, however. It was written in 1957—the first time the Laureate awards were presented.

Despite a similarly gloomy backdrop this year—the Obama administration’s unveiling of a fiscal 2015 defense budget proposal that would shrink U.S. Air Force and Army aviation fleets, delay Navy aircraft and slip satellite procurements—the mood was decidedly upbeat as 350 aerospace and aviation luminaries from around the globe gathered March 6 at the historic National Building Museum in Washington for Aviation Week’s 57th annual Laureate Awards.

Aviation Week editors recognized more than 25 individuals and teams who have made outstanding contributions to an industry built on boldness and innovation. Winners were announced in each of six categories: Aeronautics, Avionics and Systems, Business and General Aviation, Commercial Transport, Defense and Space. Also presented were two honors whose recipients had been previously announced: the Aviation Week Heroism Award, and the Philip J. Klass Lifetime Achievement Award, which was bestowed upon two industry pioneers.

Aviation Week President Greg Hamilton kicked off the black-tie event by presenting special awards to four of Tomorrow’s Leaders—one student each from the U.S. Air Force Academy, Naval Academy, Military Academy and Coast Guard Academy (page 52). Next, Editor-in-Chief Joseph C. Anselmo and Executive Editor James R. Asker bestowed the Klass award on Bombardier Chairman Laurent Beaudoin and communications satellite pioneer Harold Rosen (page 51). The evening wrapped up in dramatic fashion as London Bureau Chief Tony Osborne presented the Heroism Award to a Royal Canadian Air Force rescue crew (page 50).

It was a strong evening for French speakers. In addition to Beaudoin, Europe’s Neuron unmanned combat air vehicle team, led by French defense armaments agency DGA and Dassault Aviation, won the Defense Laureate (page 47) and Jean-Yves Le Gall, the former chairman and CEO of Ariane-space and current head of the French space agency CNES, took home the Laureate for space (also on page 47).

Nominations for the awards are solicited each year from within the aerospace, defense and aviation industries, and from editors across Aviation Week’s family of digital and print publications. Boeing and Orbital Sciences were executive sponsors of this year’s event, while BAE Systems, Northrop Grumman and the Future Airborne Capability Environment were sponsors. 🌐

ALL PHOTOS BY CHRIS ZIMMER

Aeronautics & Propulsion

Stealthy, Unmanned and on Deck

The U.S. Navy/Northrop Grumman X-47B Unmanned Combat Air System (UCAS) team broke a barrier in 2013, proving that a stealthy, unmanned aircraft can operate on and around the aircraft carrier deck and clinching the Laureate for Aeronautics and Propulsion.

On a tight \$1.4 billion budget, the team's work culminated in a series of trials demonstrating that a relative GPS system and digital interface between aircraft and carrier could safely and repeatedly allow for landings, takeoffs and operations on a carrier deck at sea. The work has blazed a trail that opens the door for the Navy to marry the range and persistence of unmanned aircraft with the reach of an aircraft carrier.

The competition for this category was strong, however. Also nominated for the honor was the F135 Integrated Flight and Propulsion Control System



Representing the X-47B UCAS team: Navy Capt. Beau Darte (left) of Naval Air Systems Command; and Carl Johnson, Northrop Grumman's UCAS vice president

team, which quelled skeptics last year.

During its second round of flight tests at sea, the F-35B—with its unique lift-fan design for dynamic inversion—proved the stealthy aircraft

can eventually operate off the Pentagon's small-deck amphibious ships; the single-engine fighter racked up 95 vertical landings and 94 takeoffs thanks to the innovative design. Its performance positions the F-35B to someday take over missions of the Marine Corps' venerable AV-8B Harrier.

The efforts of AgustaWestland's Advanced Concepts group were also of note in 2013. The team, led by James Wang, demonstrated substantial advances in electrical vertical lift through Project Zero. During the trials, the team executed a 5-min. sortie for a vertical-lift system using electrical power.

Finally, NASA was commended for drafting a seminal plan to tackle its own aeronautics challenges, despite budget limits, thanks to the leadership provided by Associate Administrator for Aeronautics Jaiwon Shin and his team. They have laid out an aeronautics path forward—a thorny task in an agency focused on space—to push the technological envelope amid global competitive pressures and environmental concerns. ☐

Avionics & Systems

Special Vision

The RTCA Special Committee 213 (SC 213), winner of Aviation Week's 2014 Avionics and Systems Laureate, is not so much a committee as it is a "Skunk Works" composed of the makers, users and regulators of advanced vision systems worldwide.

The members of SC 213 develop consensus-based minimum aviation systems performance standards (Masps) for enhanced vision and enhanced flight vision systems (EFVS), synthetic vision systems and combined vision systems (fused enhanced and synthetic vision systems). Masps are the backbone for minimum operational performance standards that are used by the FAA to create new or upgraded operating rules and technical standard orders (TSO) that set the system parameters and give a company assurance its products will gain FAA approval.

Formed by the FAA in 2007, SC 213 has a core membership of more than two dozen vision system experts. They work in parallel with industry research,



SC 213 honorees (from left): Trent Prange, FAA; Tim Etherington, Rockwell Collins; Jennifer Iversen, RTCA; Hal Moses, RTCA; Patrick Krohn, Universal Avionics Systems Corp.; and Glenn Connor, Discover Technology

development and testing of the technologies, providing a knowledge base that adds a level of maturity to the standards. That expertise has created an environment that gives the group enhanced credibility with the FAA and European Aviation Safety Agency.

Enhanced vision systems use forward-looking infrared or radar-based sensors to help pilots boost situational awareness for terrain, obstacles and the runway environment in low visibility and at night. EFVS, by combining high-performance sensors with a head-up display, provides "credit" for lower landing minimums in instrument conditions by substituting sensor vision with natural vision.

SC 213 is developing the standards that will allow pilots, with the appropriate sensors and training, to land and taxi in visibilities down to 300 ft. or lower. Synthetic vision systems provide a 3-D forward view from the cockpit using terrain, obstacle and runway databases and could soon lower the minimums for the instrument portion of an approach, based on SC 213 Masps.

The technologies also are key to global plans for next-generation air transportation systems that aim to boost capacity and maintain high levels of safety.

Other laureate finalists were: Airbus for its runway overrun protection system; Navair for the future airborne capability environment; and Northrop Grumman for its Guardian directed infrared countermeasures system. ☐

Business & General Aviation

A Bigger, Broader Future

General Electric has long been big in big engines, specializing in turbofans for airliners and fighters. But the company wants to compete across the power range, and the man leading its move into small engines is the 2014 laureate for business and general aviation.

Bradley Mottier, vice president and general manager of GE Aviation's Business, General Aviation (BGA) & Integrated Systems unit, is recognized not only for guiding the move into the small-engine market, but for using his passion for aviation to provide leadership to an industry facing challenges.

Mottier joined GE when it acquired Unison Industries, a manufacturer of ignition systems for aero-engines, in 2002. He had joined Unison 20 years earlier as a development engineer, and was CEO at the time of its acquisition. In 2005, Mottier was named to lead GE's Aviation Services business.

In 2008, GE accelerated its move into general aviation by acquiring Wal-



**Bradley Mottier, vice president/
general manager of GE Aviation's
Business, General Aviation (BGA)
& Integrated Systems unit**

ter and developing the Czech engine manufacturer's M601 to the H80, a rival to Pratt & Whitney Canada's dominant PT6. By then, GE also was developing the HF120 turbofan with Honda to compete with Williams's popular FJ44.

Led by Mottier, GE's BGA unit cemented its position in 2010 when it unseated Rolls-Royce and its all-new

Passport was chosen to power the latest Global 7000/8000 versions of Bombardier's long-range, large-cabin business jet. The HF120 was certified and the Passport entered testing in 2013.

For Mottier, as chairman of the General Aviation Manufacturers Association, 2013 also saw passage of the Small Airplane Revitalization Act requiring the FAA to modernize Part 23 certification—a move expected to cut costs and boost safety for GA aircraft and close to his heart as an aircraft owner and pilot.

Also nominated were Kenn Ricci and Mason Holland. As the principal behind Directional Aviation Capital, Ricci has assembled a formidable business aviation conglomerate ranging from fractional ownership through jet cards to aircraft upgrades. He purchased FlexJet last year.

After losing his deposit on an Eclipse 500 very light jet when the company ceased operations, Holland assembled a group of investors and bought the assets out of bankruptcy. With Holland as chairman/CEO, the new Eclipse Aerospace was set to restore support and field upgrades for in-service aircraft and to restart production—achieved in 2013. ✪

Commercial Air Transport
Driving Change

One sentence probably best sums up what makes Willie Walsh tick: "I guess the difference between me and many other airline CEOs is that I have the determination to tackle these issues and some others don't," he told Aviation Week last year. When others pull back to avoid conflicts, he chooses to aggressively fight for what he believes is crucial. His remarkable success record bears out this particular style of corporate leadership.

Walsh, the recipient of this year's commercial laureate award, is chief executive of International Airlines Group (IAG), the company that owns and controls British Airways and Iberia. And although he is only 52, his experience in the airline industry spans 35 years. The Dublin-born executive joined Aer Lingus as a cadet pilot in 1979 at age 17, advancing to become a Boeing 737 captain. But alongside his pilot career,



**Willie Walsh, chief executive of
International Airlines Group**

he studied management and business administration. Early on, it was clear he was not going to stay a line pilot for long.

Having navigated his initial corporate assignments with Aer Lingus admirably, Walsh was sent to Spain to run leisure airline Futura, which was owned by the Irish carrier. He did so

well that he returned to Ireland as Chief Operating Officer at age 39.

That Walsh is in his current position as one of the most senior international airline executives has a lot to do with what followed upon his return to Aer Lingus. He was appointed CEO of the airline in October 2011, only weeks after the September 11, 2001, terrorist attacks, which led to a temporary but harsh suppression of air travel demand, even in Europe. But he restructured the airline, making it more low cost; in so doing, he saved it from bankruptcy.

In late 2005, he became CEO of British Airways where he undertook a similar, although not as dramatic, restructuring that made the airline significantly more competitive. After the merger with Iberia and the creation of IAG, Walsh now heads up the combined group. And when the need to turn Iberia around became increasingly clear, it was he who navigated the tough negotiations with unions, deep capacity cuts and myriad other streamlining efforts. Iberia's 2013 financial results are tangible proof that the carrier is now back on track. ✪

Defense

Working Together

In late 2012, Dassault Aviation and the French defense armaments agency (DGA) made history, sending Neuron, Europe's first stealthy unmanned combat air vehicle (UCAV) into flight. The feat, which required political finesse and helped establish Europe as a place for unmanned technology, earned the Neuron team Aviation Week's 2014 Defense Laureate.

Rather than create new technologies, the challenge of Neuron was to integrate Europe's best on the UCAV while seeking the best value for the money. The aircraft is designed to attack targets such as air defense systems and mobile ballistic missiles that remain on the move. Neuron draws stealth from Dassault's radar-absorbent materials and structures and has stealth-compatible air data systems, a Selex-Galileo electro-optical midwave infrared targeting system and a Rolls-Royce Turbomeca Adour engine that is



Neuron team representatives Jean-Pierre Devaux (left), of the French defense ministry, and Benoit Dussaugey, of Dassault Aviation

also being used to power BAE Systems' Taranis UCAV.

While half the technology demonstration was financed by France, the team also had to navigate the policies and economies of partners in Italy, Greece, Spain, Sweden and Switzer-

land on a budget of about \$500 million. Dassault and DGA confronted considerable obstacles along the way. In 2005, Forecast International cast doubt on the project, suggesting that Sweden and Italy could pull their funding.

Still, the program weathered potential financial derailment and navigated the bureaucracies of several European governments. The Neuron team streamlined the UCAV's development as well as procurement difficulties that have slowed other collaborative programs such as Eurofighter's Typhoon.

Other nominees in the category included the U.S. Missile Defense Agency, whose integrated flight test showed how the fire-control system for the Terminal High-Altitude Area Defense system can be used as a forward-based missile warning asset; the Saab Gripen Demonstration Program, for its cost-effective improvements on the JAS 39E; and Northrop Grumman for its "switchboard in the sky," the Battlefield Airborne Communications Node that provides communications to ground forces even in the harshest conditions. ☛

Space

Performance Perfecter

Jean-Yves Le Gall, the newly named president of France's Centre National d'Etudes Spatiales (CNES), is Aviation Week's 2014 Laureate for Space, based on his work as chairman and CEO of Arianespace. Named to the helm of Europe's world-beating launch service provider in 2007, Le Gall turned around the performance of the Ariane 5 during his tenure at the company. Under his leadership, Arianespace accomplished 54 consecutive successful missions. Le Gall also spearheaded the move to launch Russia's Soyuz rocket from the European launch center in French Guiana, a previously inconceivable alliance between Moscow and Paris.

In his new government job at CNES, the 54-year-old engineer is championing a more affordable successor to the heavy-lift Ariane 5.

The Space Laureate is the latest in a long list of honors for Le Gall, who is ranked a knight in France's Legion of Honor, an officer in his country's



Jean-Yves Le Gall, former Arianespace chairman

National Order of Merit, and holds the Order of Friendship from the Russian Federation.

Le Gall overcame a tough field to win the Laureate. Finalist Orbital Sciences Corp., under the leadership of Executive Vice President Frank Culbertson, gave NASA a second way to deliver cargo to the International Space Station with its Antares launch vehicle and Cygnus commercial cargo capsule. To

accomplish the task, Orbital's team tapped suppliers in Italy, Russia and Ukraine, not to mention their own production facilities and a lot of ingenuity.

Another finalist, a U.S. Air Force/United Launch Alliance team, was nominated for achieving the highest operational tempo in a single year since the Evolved Expendable Launch Vehicle program started flying in 2002. It orbited 11 missions with the Atlas V and Delta IV launch vehicles, a big improvement over the frequent failures that blighted U.S. space launch in the 1990s and a record the team expects to beat this year with 13 launches in 12 months.

China earned a Laureate nomination for its continued progress as only the third nation with a launch-to-landing human spaceflight program. Led by former Space Laureate Yang Liwei, the first taikonaut in space, and Director General Wang Zhaoyao, the China Manned Space Agency has conducted five flawless human missions as it advances plans for a Mir-class space station, with the China Academy of Launch Vehicle Technology developing the powerful Long March 5 rocket that will be needed to orbit the station's core module. ☛



The National Building Museum in Washington was the site for Aviation Week's Laureate Awards dinner, which drew 350 senior aerospace and airline executives, program managers, inventors and government officials from around the globe.



Heroism Award

Out of the Box

Conducting operations in bitter Arctic winters is a part of everyday life for the Royal Canadian Air Force's (RCAF) search-and-rescue helicopter crews.

Every year, RCAF SAR crews pluck hundreds of people from dangerous situations on sea and land across the vast Canadian wilderness. But one operation particularly resonated with Aviation Week's Laureate judges. The mission, on Feb. 9, 2013, tested the crew in challenging conditions, but

rapidly diminishing. The three men had already been exposed to the conditions for more than 20 hr. before the call to aid was sounded.

Rescue 912's crew planned their mission and launched an hour later, flying with a 200-ft. ceilings and 0.5-mi. visibility. Due to high winds, it took 30 min. to make the 40 nm flight to the coordinates received from the Joint Rescue Coordination Center in Halifax. The crew arrived near the scene and found Indian Bay engulfed in a blizzard.

which immediately made the helicopter more stable. Flying backward, the pilots relied on the rear crewmen to help them navigate the last 2 mi. to the rescue site. As the crew neared their goal, the hunters fired off marker flares designating their position.

The hovering had resulted in higher fuel burn, which triggered a "bingo" fuel warning—the fuel level required to head to their diversion airfield. It was decided that, as a last resort, they would secure the hunters and then all would land on the rugged shoreline to await another rescue team. As the pilots fought to maintain a steady hover, a crewman was hoisted down into the storm.

Facing a -22C wind chill, static off the rotors and rotor wash, he quickly prepared the distressed men and got them hoisted up onto the aircraft. With everyone safely onboard, Rescue 912's

RCAF Capt. and Cmdr. Aaron Noble (left) and Capt. Jonathon Groten accept the Laureate for Heroism on behalf of the Rescue 912 crew.

crew executed a straight-ahead maximum-rate climb to clear the surrounding hills, but faced a tough decision about a safe-harbor landing area. The choices: Attempt to reach Gander air base or aim for an alternate site. With the weather reportedly improving at Gander, the crew opted to go there, a decision that also was prompted by the need to get the now hypothermic hunters medical attention as soon as possible.

The crew made a near-flawless instrument-landing-system approach and upon touching down—with fuel slightly above the minimum allowed—were met by medics and ambulances who whisked the three struggling survivors to a hospital, where all fully recovered.

The crew of Rescue 912 comprised the commander, Capt. Aaron Noble; first officer, Capt. Jonathon Groten; flight engineer, Sgt. Bradley Hiscock; SAR team leader Master Warrent Officer Jeffrey Warden; and second SAR technician, MCpl. Mark Vokey. Cpts. Noble and Groten accepted the award on behalf of their crew. 🇨🇦



their courage, resourcefulness and quick thinking prevailed and has won them plaudits on both sides of the Atlantic.

Just after 9:20 p.m. that day, the crew of Gander, Newfoundland-based Royal Canadian Air Force Rescue 912—an AgustaWestland CH-149 Cormorant search-and-rescue helicopter—was called upon to extricate three bird hunters whose 16-ft.-long aluminum boat had become iced-in in Indian Bay as they attempted to make their way back to land. A winter storm was building and conditions were quickly worsening; gale force winds of more than 45 mph were gathering and up to 1.5 ft. of snow was forecast. The chances of survival for those stranded in the wilderness were

They flew several miles past the hunters to transition to a hover just 100 ft. over open water before turning back to pinpoint the stranded men. At this juncture, the rescuers were faced with 0.4-mi. visibility. Within roughly 8 mi. of the hunters' last known position, crewmembers had to work together to navigate the many narrow inlets and small islands to reach them.

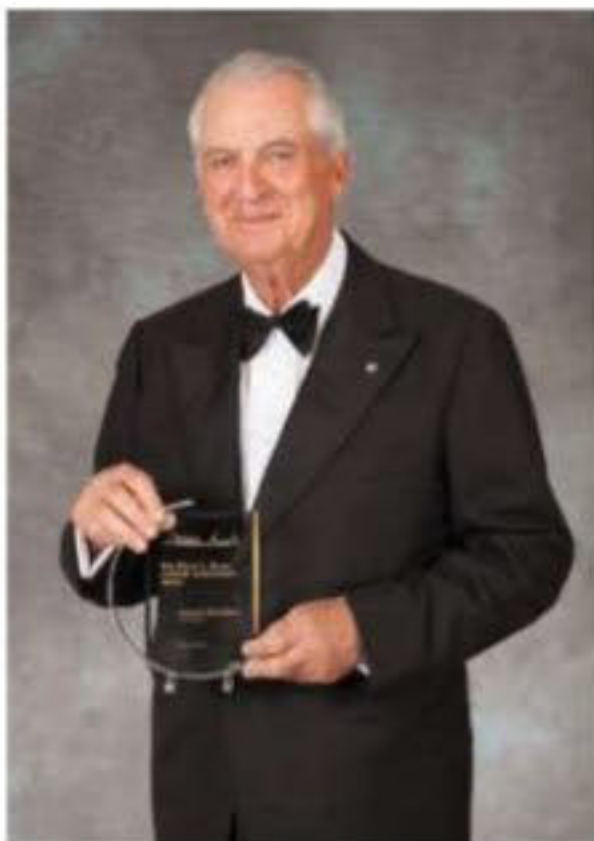
Creeping along at just 5 kt., the rotorcraft was buffeted by 50-mph winds, causing severe turbulence. Twice, a mission-abort was considered, but with just 2 mi. to go to reach the stranded men, the crew tried an impromptu, out-of-the-box maneuver. They turned the helicopter around 180 deg. and flew nose-first into the storm,

From Snowmobiles to Regional Jets

In 1966, shortly after the death of his wife's father, Laurent Beaudoin became president of the family business, a Canadian snowmobile company. Just 28 years old, he had to fill the big shoes left by the visionary Joseph-Armand Bombardier. Beaudoin would prove up to the task—and then some.

In the ensuing years, Beaudoin took Bombardier public and used acquisitions to build a formidable rail transportation empire. Then, in 1986, the company entered the aircraft business with the acquisition of Canadair, a manufacturer of Challenger business jets and amphibious fighting aircraft. It was the start of a buying binge that would see Bombardier acquire once-great aircraft companies for rock-bottom prices—and infuse them with cash to reinvigorate their product lines. By 1992, Bombardier had added to its portfolio the operations of companies such as Short Brothers, Learjet and de Havilland.

In 1994, Beaudoin accepted Aviation Week's Laureate for Aeronautics and Propulsion for the airframer's impressive number of new aircraft, including the Canadair Regional Jet (CRJ), Global Express, Learjet 45 and 60, Challenger 604,



Laurent Beaudoin,
Bombardier Chairman

CL-Dash 8 and the de Havilland Dash 8 Series 200. "The Bombardier group of companies have launched enough new aircraft programs to catch the eye of the entire industry," Aviation Week editors noted at the time.

The CRJ would prove to be truly revolutionary. Certified in 1992, the 50-seat aircraft spawned a new market—regional jets—and made jet travel possible for passengers in smaller markets around the world.

Beaudoin has faced his share of difficulties. A painful restructuring in the early 2000s slowed new product development, giving Bombardier's Brazilian rival, Embraer, a chance to catch up. But Bombardier has not lost its boldness. In 2008, the company launched the CSeries, challenging Airbus and Boeing in the lower end of the A320 and 737 families. The CSeries made its first flight last September, and Bombardier recently announced its 200th order, although the aircraft's service entry has been pushed back at least 12 months due to development delays.

Twenty years after receiving his first Laureate, Beaudoin was presented the Philip J. Klass Award for Lifetime Achievement, named for *AW&ST*'s legendary Cold War-era avionics editor. But the event was hardly a send-off. While Bombardier is now led by his son, Pierre, Beaudoin remains chairman of the board—and a guiding force in the company's flight plan. ☛

The Father of Satcom

The aerospace industry is replete with innovators, but occasionally there comes someone whose ideas and accomplishments make the term "innovator" seem not broad enough. Harold Rosen is that sort of innovator.

A team led by Rosen produced breakthroughs that kick-started an entire sector of the aerospace industry. That sector remains the most important commercial application of space technology. More than anyone, Rosen deserves to be called the father of the communications satellite.

Born in 1926, Rosen knew he wanted to be an engineer even as a boy in New Orleans. After earning a bachelor's degree at Tulane University and two advanced degrees at the California Institute of Technology, he went to work for Raytheon on missile guidance and control systems.

By 1956, he was at Hughes Aircraft. But it was 1957, the year of Sputnik, that changed Rosen's life profoundly. Like so many Americans, he felt challenged and inspired by the Soviet Union's launching of the first artificial satellite.

A friend told Rosen of science fiction writer Arthur C. Clarke's idea that if a spacecraft were placed in an equatorial orbit of Earth with a period of exactly 24 hr., it would appear to be stationary to an observer on the planet's surface. That

would make it an ideal relay point for radio communications. Rosen and his Hughes team were not the only ones to recognize the potential of Clarke's 1945 idea, but there were big obstacles to turning it into reality.

Other groups developed paper concepts that turned out to be impractical. Because the orbit is so far away—22,240 mi. from Earth's surface—it was difficult to conceive of a platform that would be small enough to launch with rockets of the day. And a major problem was making the platform stable. Rosen's team was able to chart a course to miniaturizing key components. And Rosen came up with a breakthrough idea to stabilize a satellite: Make it spin.

With support from NASA and the U.S. Defense Department, the Hughes team built Syncom I, which was lost in a launch failure in 1961. Five months later, Syncom II, the first geosynchronous satellite, was in orbit. It went into service as a relay for telephone calls in 1963. By 1964, Syncom III, the first truly geostationary satellite, was relaying live television to the U.S.

from the Tokyo Olympics.

Rosen led Hughes's satellite unit, now part of Boeing, until 1992. After retiring, he and his brother Benjamin created Rosen Motors to develop fly-wheel technology to capture energy from braking for an automobile hybrid propulsion system. He is still active today, working on concepts to cool the planet to abate the effects of global warming. ☛



Harold Rosen,
former head of Hughes's
satellite unit

Tomorrow's Leaders

Acknowledging Future Leaders Today

Many of the advances in aerospace can be traced to those who serve or once served in their country's military. The fact is that national defense has been a key impetus to technological achievement throughout the industry's history, and its practitioners have helped provide welcome security from external threats as well as inspiration for the people under their protection.

With that in mind, along with our deep commitment to those young peo-

Daniel Eichner is a cadet captain and the battalion commander overseeing the daily operations of more than 350 fellow cadets at the U.S. Military Academy in West Point, N.Y. An exceptional student, he has maintained a 4.33 GPA in mechanical engineering, with an aeronautical focus. The Islip, N.Y., native is president of the Tau Beta Pi honor society, has earned his air assault badge and trained with the 75th Ranger Regiment. Following his commissioning on May 28, Second Lt.

gional Student Conference in April. Upon graduating, he plans to pursue a master's degree in engineering and then attend Air Force flight school.

While hiking and pursuing other outdoor sports in her native Washington state, Nicole Garrett often saw helicopters heading to or from the mountains on rescue and medevac missions, and at some point it clicked: That is what she wanted to do. Accordingly, she applied for and was accepted by the U.S. Coast Guard Academy in New London, Conn., where she is studying mechanical engineering. She is an officer of the academy's aviation club, and its American Society of Mechanical Engineers club, is president of a Native American diversity club, and is a proficient member of the combat arms shooting team. A member of the class of 2015, upon graduating she intends to realize her dream by being assigned

Tomorrow's Leaders Award

recipients (l to r): Daniel Eichner (USMA), Christopher Shannon (USFA), Nicole Garrett (USCGA) and Christopher Voss (USNA)



ple who will someday take our industry to even greater heights, Aviation Week has long sponsored the Laureates honoring Tomorrow's Leaders. These awards recognize members of the four U.S. military service academies who have demonstrated overall excellence—they are all in the top 5% of their respective classes—as well as a keen interest in pursuing various careers in aerospace while in uniform and quite possibly later, as civilians.

Aviation Week President Greg Hamilton opened the awards program by presenting this year's awards—classic gimbaled brass compasses, meant as symbolic career guides—to an eager, deserving quartet of future officers who have already accomplished much.

Eichner will head for flight school at Fort Rucker, Ala., where, upon graduating, he hopes to become an AH-64 Apache pilot.

With an impressive GPA of 3.98, Cadet First Class Christopher Shannon is the No. 1 Class of 2014 cadet in the U.S. Air Force Academy's Department of Aeronautics. In addition, he worked with the academy's Prof. Tom Yechout on NASA's Maravia earth return capsule in subsonic flight and participated in the academy's prestigious Cadet Summer Research Program, working at NASA's Johnson Space Center in Houston. He is now analyzing the results of his research and will present his findings at the American Institute of Aeronautics and Astronautics Re-

to flight training and, eventually, duty as a helicopter pilot flying patrol and rescue missions.

Midshipman First Class Christopher Voss has excelled at astronautical engineering at the U.S. Naval Academy in Annapolis, Md., earning internships at the National Reconnaissance Office and the Massachusetts Institute of Technology's Lincoln Labs. He is the communications lead for the Academy's CubeSat, which is named the "USS Langley" in honor of the first aircraft carrier, a naval vessel that altered the course of national defense. As the world's first open source web server in space when it launches at the end of this year, the newest USS Langley is expected to alter the course of history as well. Already selected for pilot training, upon graduating from the academy, Voss will be heading south to Florida's Naval Air Station Pensacola in his quest for wings of gold and assignment as a carrier-based F-18 Hornet pilot.

With aspiring—yet already proven—achievers such as these four, the future of aerospace looks secure indeed. 

A massive reorganization by European conglomerate Finmeccanica is likely to centralize control of its units, including AgustaWestland, maker of the AW609 commercial tiltrotor.



Cutting Losses

Finmeccanica to regroup to maintain its presence and profitability

Tony Osborne **London and Milan**

Italy's long-struggling aerospace and defense giant, Finmeccanica, is changing shape as it works to overcome debt and the effects of reduced government spending.

With its public image partly tarnished by last year's bribery scandal involving former Chairman and CEO Giuseppe Orsi in the sale of VIP helicopters to India, Finmeccanica's board has ushered in a new management team. Now the company is pursuing a plan to focus solely on its core defense and space businesses and shed some non-core areas such as rail unit Ansaldo STS. Finmeccanica divested itself of power unit Ansaldo Energia last December.

Limited restructuring work was carried out last year, including head-count reductions at several business units and shuttering of sites in Italy and the U.K. But earlier this month, the new board, led by Chairman Gianni De Gennaro, approved a plan to begin a transformation similar to that of its biggest European competitor, Airbus, which restructured into the Airbus Group at the beginning of 2014.

Finmeccanica's challenges are four-fold. Defense spending in key markets has shrunk more quickly than the company has been able to downsize, partly due to its decentralized operating method. The 30% government share means it has struggled to consolidate, while its debt of more than €3 billion (\$4.2 billion) complicates cash flow as it services debt obligations.

The changes are likely to affect Finmeccanica's best-known units—helicopter manufacturer AgustaWestland, airframer Alenia Aermacchi and defense electronics firm Selex ES. They will lose some autonomy as finance, external relations, strategy, legal and audit operations are centralized under a "strategic controller." The aim is to deliver a more consistent order backlog for technologies, products and markets as

well as to increase the return on invested capital and ensure higher profitability, sustainability and cash-flow generation. The company hopes to achieve at least €300 million in cost savings in 2014-15.

"European aerospace and defense company transformation efforts are [moving] in the right direction, with portfolio pruning to increase focus and trimming of unprofitable businesses to improve shareholder value," says Tom Captain, vice president of aerospace and defense at Deloitte. "The European aerospace and defense industry is in need of consolidation, because the governments cannot afford to carry all of them, due to declining requirements in home markets. There is just not enough work to go around to sustain the current level of employment and revenues."

Some areas will not be touched by the changes. U.S.-based defense contractor DRS Technologies and Italian industrial plant builder FATA each will be managed independently, with DRS maintaining its focus on growing its U.S. business.

Finmeccanica says the plan will make the company more sustainable, noting that shorter reporting lines will help in "increasing the organization's effectiveness and improving management efficiency." Company officials say Finmeccanica will "be able to enhance its role in international markets and in the reconfiguration processes of the sector of reference worldwide, and it will also strengthen the growth of the Italian high-tech manufacturing industry."

Nonetheless, the company had a strong 2013, particularly in its aerospace and defense business. Results released March 19 show revenues were down overall, but €17.5 billion in new orders were generated, compared to €15.8 billion in 2012, and Finmeccanica recorded a €74 million profit, after two years of losses.

While Finmeccanica says it is satisfied with the results, train-maker AnsaldoBreda is a drain on the group's profitability and cash generation, and Selex ES is still recovering after cutbacks a little more than a year ago. The company says it expects flat demand in the domestic A&D sector this year but sees favorable opportunities in emerging markets for helicopters, civil aeronautics and space services. ✎

AGUSTAWESTLAND

Taking a Break

Runway work in Dubai forces Emirates to scale back expansion

Jens Flottau **Berlin and Frankfurt**

Emirates has seen significant double-digit growth each year since it started in 1985, but this year promises to be more muted due to infrastructure work at its main hub.

The airline is being forced to pause its growth strategy and park 20 aircraft for 80 days—May 6-July 20—because of temporary capacity restrictions at Dubai International Airport. The number of movements possible will be limited by much-needed resurfacing work that will put the airport's two parallel runways out of service alternately: The southern runway will be closed May 1-20, and the northern runway May 21-July 20.

Emirates Chief Commercial Officer Thierry Antinori says the airline will ground mainly Airbus A330s and A340s as well as some Boeing 777s, but not A380s. Its biggest aircraft are undergoing a wing-modification program needed to make permanent fixes to wing-rib feet and ribs to prevent cracking. That measure takes several aircraft out of service at any given time, too. Antinori says Emirates will continue to serve all of its destinations during the period.

The runway work will markedly curb the airline's expansion, however. While Antinori still expects around 10% growth in the 2014 financial year starting April 1, it would have grown 13% without the operational limitations. That compares to 35% growth over the past two years and the introduction of 20 new destinations.

The runway shutdown is not the only operational and commercial challenge Emirates is facing. Antinori says the latest alliance with Qantas is working well, but he points out that some of its competitors are "not always rational," observing "big capacity increases, fares dropping and some overcapacity" among them. Although Antinori does not specify which carriers he has in mind, they are likely Etihad Airways and Qatar Airways, both of which have put more capacity into the Australian market. Nonetheless, Antinori says Australia still offers "some of the most profitable routes for us." Elsewhere, Emirates is facing currency weakness in emerging markets such as India.

The carrier nevertheless plans to introduce 5-8 more cities this year. Since January, Emirates launched services to Boston; Taipei, Taiwan; and Kiev, Ukraine. Flights to Chicago; Kanu, Hawaii; and Abuja, Nigeria, will soon follow.

Emirates operates 45 A380s and has 140 of the type on order; 13 are to be phased in between now and April 2015, and the 50th aircraft is scheduled to arrive this May. "The [A380's] load factor is 2-3% higher than the rest of the fleet and the yield is better," Antinori says. Airbus likes to attribute the yield to more passengers being prepared to fly in the A380, but in Emirates' case, it is linked to its relatively large first- and business-class cabins—seating 14 and 76 passengers, respectively—that shift the mix in favor of premium travel.

Unlike many other carriers, Emirates has no plans to give up first class, although it does operate two-class aircraft and is considering two-class A380s that would seat around 650 passengers for some medium-/long-haul and lower-yield markets. "We will stick with first. We need it," Antinori says, noting that Emirates operates some very-long-haul flights, such as Dubai-Los Angeles (more than 15 hr.), and its first class is not only a brand promoter but also an upgrade option for frequent business travelers.

There are no plans to introduce a premium economy cabin, which many of Emirates' rivals offer. "Our economy is already premium," Antinori quips. The decision to go to an 11-abreast configuration on the A380s is still under consideration, he says.

The airline has been operating several different business-class versions across the various fleet types, but Emirates' inflight product is not as heterogeneous "as some think," Antinori asserts. It should become more homogeneous as A340-500s exit the fleet soon and with its last four A340-300s operating mainly to India and on short-haul services within the Persian Gulf and Middle East region. Emirates also has pulled from that market its A330s, formerly the workhorse for its European network, flying them only to Kiev, Warsaw and Larnaca, Cyprus. The remaining 21 A330s are now mainly deployed within the Persian Gulf region, Eastern Mediterranean and Africa. Emirates operated 29 A330-200s at one time but, after keeping them active much longer than originally planned because of delivery delays for other programs (mainly the A380 and A350), it is starting to retire them.

Nevertheless, average aircraft capacity has crept up significantly from 300 passengers only a few years ago. It is now at 400 seats, reflecting the introduction of a large A380 and 777 fleet. ☺

Emirates plans to ground 20 widebodies, including some of its oldest Boeing 777s, to cope with temporary runway restrictions in Dubai.



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July 16—Farnborough Civil Manufacturing Briefings. Farnborough (England) air show.
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April 8-10—MRO Americas. Also, **April 9—MRO Military.** Both at Phoenix Convention Center. events.aviationweek.com/current/mro/index.htm

April 11—Society of Experimental Test Pilots' East Coast Section Symposium. NAS Patuxent River, Md. www.setp.org/table/east-coast

April 14-17—Asian Business Aviation Conference and Exhibition. Shanghai. www.abace.aero/2012/

April 30—American Institute of Aeronautics and Astronautics' (AIAA) 2014 Aerospace Spotlight Awards Gala. Washington. www.aiaa.org/gala2014

April 30-May 1—Speednews 12th Aerospace & Defense Industry Suppliers Conference. Jonathan Club. Los Angeles. speednews.com/aerospace-and-defense-industry-suppliers-conference

May 5-9—AIAA's SpaceOps 2014: 13th International Conference on Space Operations. Pasadena (Calif.) Convention Center. www.aiaa.org/spaceops2014

May 12-15—Association for Unmanned Vehicle Systems International's Unmanned Systems 2014. Orange County (Fla.) Convention Center.

www.auvsishow.org/auvsi2014/public/Content.aspx?ID=1394&sortMenu=102000

May 13-15—Flight Test Safety Workshop. Savannah, Ga. www.setp.org/table/workshop/

May 19-22—National Space Symposium. Berlin. www.nationalspacesymposium.org/

May 20-25—ILA Berlin Air Show. www.ila-berlin.com

May 22—Aerospace States Association's Annual Meeting. The Space Foundation's offices, Colorado Springs. www.aerostates.org

May 22—Society of Experimental Test Pilots. Wright Patterson AFB, Ohio. www.setp.org/table/great-lakes/

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Advani, an aerospace engineer and pilot, is the owner and president of International Development Technology; he has chaired an international team on upset prevention and recovery.

The largest cause of commercial aviation fatalities is loss-of-control-in-flight (LOC-I). Following high-profile accidents including Colgan Air Flight 3407 and Air France Flight 447, several working groups helped the International Civil Aviation Organization (ICAO) develop the soon-to-be-released *Manual of Aeroplane Upset Prevention and Recovery Training*—a major step toward implementing a mitigation strategy that targets LOC-I.

Unlike controlled-flight-into-terrain accidents, which were reduced through implementation of enhanced ground proximity warning systems, LOC-I cannot be resolved through technology alone. It requires better awareness, recognition and avoidance, and recovery training. In today's cockpit, the pilot's training is the final safety net to prevent LOC-I.

LOC-I is often the result of aerodynamic stalls. Whether a stall is initially due to crew mismanagement of energy, inattention, inaccurate flight path

“There is aerodynamic stall. Then there is another characteristic of most loss-of-control events. Call it ‘brain stall.’”

monitoring or weather-induced events, it is critical for flight crews to reduce back pressure. In addition to flight-envelope protection (if available), an aircraft will provide warning signs as the angle-of-attack approaches the critical level, after which a stall occurs. There are rapid increases in aerodynamic buffet, reduced control effectiveness and stability, and possible “roll off” as one of the wings loses lift sooner or more abruptly than the other. It is particularly that last action that seems to catch pilots off guard and tempt inappropriate actions, and for which training needs to be reconsidered.

The recently released Stall Recovery Template provides the memory items for pilots to use in recovering from an impending or existing stall: disengage the autopilot and auto-thrust, apply forward pressure and nose-down trim as needed, level the wings, apply thrust as appropriate, retract speed brakes/spoilers and return to the desired flight path.

These maneuvers are being taught in what is known as an “Approach-to-Stall,” where the training exercise exposes pilots to an impending stall, typically in a pre-announced manner, asking them to “recover now” and thereby demonstrate their abil-

ity to follow that template. Because the recovery action from an approach-to-stall and an actual stall is the same (basically, reduce angle-of-attack to regain control), teaching the maneuvers should reduce the resulting control losses.

It all seems so easy. Unfortunately, there is one subtle difference in most LOC-I events: It's called startle. It can lead to “brain stall.”

When pilots face an unexpected event—and with the impressive levels of reliability these days, these are indeed very rare—often there is a cognitive freezing that causes confusion or reversion to reactions developed earlier. Even the most seasoned pilot may end up acting inappropriately.

A recent FAA study showed that one-quarter of pilots exposed to an unexpected stall applied the template correctly. This study, intended to assess the training effectiveness of varying levels of stall representation in full-flight simulator math models, found that several of the line pilots who had previously been trained/briefed on this procedure, fought against the aerodynamics, exacerbating the stall.

There is no simple reason why this occurs, but there are some possibilities: previous training emphasizing “minimum altitude loss” following a stall; the lack of scenario-based stall recovery training programs within airline curricula; and the lack of proper simulation models that reasonably represent the characteristics of stalls in swept-wing aircraft. Limited practice of even approach-to-stall recoveries during the already tight training sessions also may be a factor. Regardless, we have a sky filled with pilots who should sharpen these skills and understand startle management.

We need to improve both stall prevention and recovery training. Stalls should not catch a pilot off guard, and attention must focus on recovery that includes sacrificing altitude for kinetic energy. We need to continue to improve our simulator models, understand simulator limitations and create that critical element of surprise in the simulator. Presenting startling conditions with proper instruction in high-performance light airplanes also appears to enhance awareness by pilots. Finally, proper instruction ties it all together.

Most of all, we need to generate awareness of the problem. Stalls don't just happen. Basic airmanship, manual handling skills and thorough academic knowledge are the foundations of aviation safety. And when the threat prevails, we must maintain the three most important tenets: fly the plane, fly the plane and fly the plane. ☛

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