

The Coming Shakeout in European Airlines

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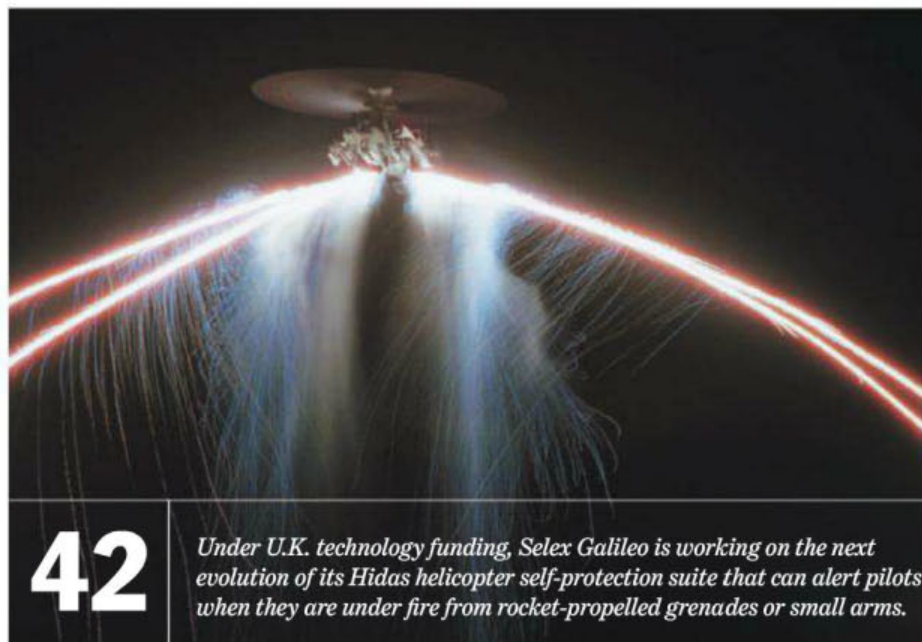
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Under U.K. technology funding, Selex Galileo is working on the next evolution of its Hidas helicopter self-protection suite that can alert pilots when they are under fire from rocket-propelled grenades or small arms.

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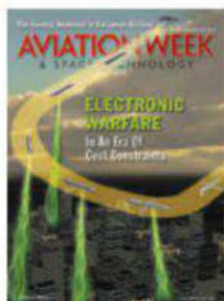
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COVER STORIES

38 *A Boeing artist's concept show how a new cruise missile-like vehicle—a product of the Air Force Research Laboratory's Champ program—has been designed and built to carry a directed-energy weapon into well-protected airspace. It can elude air defenses because of its small size, but it is smart enough to produce tailored pulses of energy to kill the electronics of key sites—or areas within those sites—without blanket power outages. In fact, there would be virtually no clue about where the attack came from. A link to videos of an electronic attack is on p. 44.*



18 *Some European airlines expected to remain struggling as a result of weak markets, slow restructuring and passenger taxes.*

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WHAT IS THE JSF WORTH?

💬 **The U.S. Marine Corps** has ferried its first two production F-35Bs, Stovl variants of the Joint Strike Fighter (JSF). The Bs join the small fleet of F-35As already at Florida's Eglin AFB. Senior Pentagon Editor Amy Butler posted photos of the aircraft in our **Ares** blog (tinyurl.com/7eb8yqy). One reader asks, "If you are in favor of the aircraft, is there a price at which you would change your mind and say—'no, it's too expensive?'" Naturally, that lightning rod of a rhetorical question kicked off a discussion of the JSF's value. To read more, go to AviationWeek.com/Ares

TRAINING TEAMMATES

💬 **BAE Systems** has announced that it is adding L-3 Link Simulation & Training to its existing partnership with Northrop Grumman to work on the Hawk Advanced Jet Training System. Our **Ares** blog predicted the announcement and handicapped the other teams (tinyurl.com/7qz9xy7). AviationWeek.com/Ares

AMY BUTLER/AW&ST



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HEATED AND PERSONAL

💬 **Houston correspondent** Mark Carreau blogs about the spat between NASA and Apollo astronauts James Lovell, Gene Cernan, Charles Duke and Rusty Schweickart over memorabilia the legendary space travelers are selling, like a checklist from the ill-fated Apollo 13 mission (AW&ST Dec. 5, 2011, p. 35).

The issue has become heated and personal, and has spurred NASA Administrator Charles Bolden's attention. Go to AviationWeek.com/OnSpace

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FROM THE WEB

Comments from readers
on AviationWeek.com

Frank Morring, Jr.'s "What's Next For Deep Space Crew Vehicle" drew varied reactions, most of them pessimistic.

Coastal Ron says:



I think the multi-purpose crew vehicle is destined to be a \$8 billion lifeboat, which is probably way overpriced. I know the original Orion was part of [then-NASA Administrator]

Michael Griffin's "Apollo on steroids" approach to returning to the Moon, and from that uninspired perspective, an upsized Apollo capsule made sense for the short Moon trips it was to do.

richardb writes:

The Space Transportation System is a political animal and will likely die off sometime in the Senate in the next couple of years as the economic mismanagement of both parties settles like concrete over our national finances.

Andy Nativi's Aerospace Daily And Defense Report article "F-35 Under Fire In Italy" elicited:

FMafia saying:

Don't be surprised if the cuts are more than the predicted one-third. The debt situation in Europe is getting worse.

Dare2 noting:

The article doesn't mention the escalating cost of the F-35 program. If it stayed at the level for which European customer nations signed, it wouldn't look this bad for countries with lower levels of debt.

RII opines:

Surely "B"s to retain a carrier capability are more important than "A"s to supplement an existing Typhoon force. Scrap the "A"s.



 Join the discussion at:
www.aviationweek.com/avweek

FEEDBACK

POY: A WORTHY RECIPIENT

Thank you for naming United Technologies Corp. Chairman/CEO Louis R. Chenevert your 2011 Person of the Year (AW&ST Jan. 2, p. 42). As a worker for an aerospace manufacturing operation in India, I must say that during Chenevert's shop tour of our facility in 2008 it was clear he was a hands-on leader who understood the nuances of operations and manufacturing. All workers in these tumultuous economic times must embrace the basics of competence and excellence. Chenevert personifies those qualities. For a long time, manufacturing/operations have taken a backseat to other functions in the corporate realm.

We also have had positive interactions with Goodrich, whose vision seems to be in line with that of UTC. Its pending acquisition by UTC would create a unique organization whose sum would be more than the total of the parts. I congratulate Aviation Week for its choice.

Raman Jeet Singh

LALRU, INDIA

POY: AN ILL-CONSIDERED CHOICE

Shame on Aviation Week for naming UTC Chairman Louis Chenevert "Person of the Year." You have American workers making a world-class product at a profit (building nacelles in California) and the first thing Chenevert wants to do is to send these jobs overseas? This type of action is the reason middle-class workers in this country are unemployed and unable to find jobs.

David Thomas

CORONA, CALIF.

(Chenevert said he did not plan to immediately close down a Goodrich nacelle plant in Southern California—Ed.)

HURDLE CLEARED FOR GOOD OR ILL

How soon the A&D community forgets. True, 2011 was packed with accomplishments and newsworthy events. However, I believe your Cheers and Jeers editorial (AW&ST Dec. 19/26, 2011, p. 74) overlooked a huge milestone for the U.S. Air Force. Last February, the long battle over whether USAF would get a replacement for the aging KC-135 aerial refueling tanker fleet was finally decided. One can jeer about who won, why it took so long to get there, or the length of the road ahead. Still, that hurdle is finally behind us. USAF deserves a cheer for finally "getting it done!"

Clarence Kohring

BEAVERCREEK, OHIO

Aviation Week & Space Technology welcomes the opinions of its readers on issues raised in the magazine. Address letters to the Managing 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.

REGULATION STRANGULATION?

"Time to Regroup" chronicles AMR's (one of the last remnants of the old-line carriers) descent into bankruptcy (AW&ST Dec. 5, 2011, p. 24).

What have we learned throughout this sad saga of closures? Early on, the U.S. Congress found airlines to be such an important national asset they needed to regulate them. When an airline got too large, laws were written to break it up. As their employees grew stronger, acts were passed that struck down the workers' negotiating capabilities. Then came open skies for all. Of late, a passengers' bill of rights was enacted that allows travelers the ability to control airline operations. Could it be that over-governance is a factor in the 100% failure of all founding airline companies?

Roy Steele

GEORGETOWN, TEXAS

STRAY BEAMS

The letter from Bill Ketchum advocating space-based solar-power generation (AW&ST Jan. 2, p. 10) sounded disturbingly familiar. I responded to a very similar proposal that appeared in AW&ST with a previous letter to the editor a few years ago.

As an engineer who deals with radio all the time, I'm appalled that anyone would suggest a space-based power-generation option. The idea of a massive beam of RF energy in a small footprint pointed at the ground is truly frightening. My question now is the same as it was then: What happens when a "minor glitch" causes the beam to wander from its designated receiver point? As I said years ago, it would give new meaning to the term "scorched earth." Given that space systems are generally fragile, I'm not willing to trust a satellite onboard computer to keep me from being instantaneously fried by an errant beam of microwave energy. In this situation, "well-done" becomes the ultimate oxymoron.

Jim Hendershot

GRANTS PASS, ORE.

WHO'S WHERE

Sean O'Keefe, CEO of Herndon, Va.-based *EADS North America*, is now also chairman, succeeding **Ralph D. Crosby, Jr.**, who has retired.

Bart LaGrone (see photo) has been appointed VP-airborne early warning and battle management command control programs at the Bethpage, N.Y., facility of *Northrop Grumman*. He was deputy integrated project team leader for the Broad Area Maritime Surveillance program.

Jeff Lockridge has been promoted to group VP-supply chain management from director of procurement at *Superior Air Parts*, Coppell, Texas.

Hal Heule has been named CEO of *Evergreen Maintenance Center*, Marana, Ariz. He was senior VP-technical operations at US Airways.

Christopher Ellender (see photo) has been appointed senior regional sales manager for product support sales at *Gulfstream Aerospace's* facility in Luton, England. He headed global aircraft sales and acquisitions for FirstFlight.

USMC Lt. Col. (ret.) **Paul E. Damphousse** has been named executive director of the Washington-based *National Space Society*. He was chief of advanced concepts for the National Security Space Office and the Defense Department executive agent for space.

Chen Siqing (see photo) has become chairman of *BOC Aviation* of Singapore, succeeding **Zhang Yanling**, who has retired. Chen is a member of the senior management of Bank of China and has served as VP and president of its Corporate Banking Committee since June 2008.

Jerry Hogge has been appointed senior VP-business development for McLean, Va.-based *Qinetiq North America*. He was VP-strategy and business development for Science Applications International Corp.

Peter Mastroianni has joined *Million Air* as general manager of its Fayetteville, Ark., facility. Mastroianni recently retired from the U.S. Air Force, where he was chief of standardization and evaluation for the 621st Contingency Response Wing at Joint Base-McGuire/Dix/Lakehurst, N.J.

Albert J. Givray (see photo) has been named general counsel of Tulsa, Okla.-based *Nordam*, succeeding **Russell E. Wienecke**, who has retired. Givray, a partner at Denver-based law firm Davis Graham & Stubbs, has been Nordam's outside counsel for more than 30 years.

Olivier Mazzuchelli has been appointed CEO managing director of Hamburg-based *Spairliners*. He was sales director-regional fleets at Air France-KLM's engineering and maintenance operation.

Daljinder Kaur has become sales and marketing manager of *Chromalloy's* U.K. operation in Nottingham, England. She was European business development manager at Trans World Alloys.

Hugh Dunleavy (see photo) has joined Kuala Lumpur-based *Malaysia Airlines* as the leader of network, alliance, strategy and planning, and **Shihaj Kutty** as head of revenue management. Dunleavy was executive VP-strategy and planning at WestJet, and Kutty head of pricing at Etihad Airways.

Olivier Gillot has been named senior VP-strategy, marketing and sales of the MRO unit of *Industria de Turbo Propulsores*, Zamudio, Spain. He held sales and business development positions within the Safran and Thales groups.

Stephen Myall has joined *Baines Simmons*, Camberley, England, as a consultant on its Isle of Man registry team. He was an airworthiness surveyor with the U.K. Civil Aviation Authority.

Carlos Graziani (see photo) has been named general manager of Houston-based *Landmark Aviation's* Kendall-Tamiami Executive Airport location in Florida. He was operations manager for Atlantic Aviation in Tucson, Ariz.

Richard Ziskind has been appointed VP-sales and marketing



Bart LaGrone



Christopher Ellender



Chen Siqing



Albert J. Givray



Hugh Dunleavy



Carlos Graziani



Antoine Ajarrista

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for Greensboro, N.C.-based *Dynamic Airways*. He was director of marketing at Omni International.

Antoine Ajarrista (see photo) has been promoted to senior VP and general manager from senior VP-operational control at *Dassault Falcon Jet*, Teterboro, N.J. He succeeds **Frederic Lherm**, who is now senior VP-industrial operations for Dassault Aviation in St. Cloud, France.

Guiseppe Coccon is the new senior VP-communications at *Avio Group*, Turin, Italy. He was communications and media relations director at the Barilla Group.

Ivy Chee has joined the *Pacific Asia Travel Association* in Bangkok as director for Asia. She was regional business development manager at Wego Pte in Singapore.

HONORS AND ELECTIONS

William Johnson, chief scientific and technical adviser for human factors in aviation maintenance for the FAA, has received the Whittle Safety Award from the *International Federation of Airworthiness*.

Richard Ennis, director of Melbourne (Fla.) International Airport, has been selected to receive the *United Safety Council's* Safety Leadership Award for his outstanding safety leadership efforts regarding a new management and training program for aircraft rescue and fire-fighting services.

John Manning has been elected chairman of the *Lee County Airport Board of Commissioners*, Fort Myers, Fla. **Brian Bigelow** was appointed vice chairman. ☐



Business Editor
Madhu Unnikrishnan blogs at:

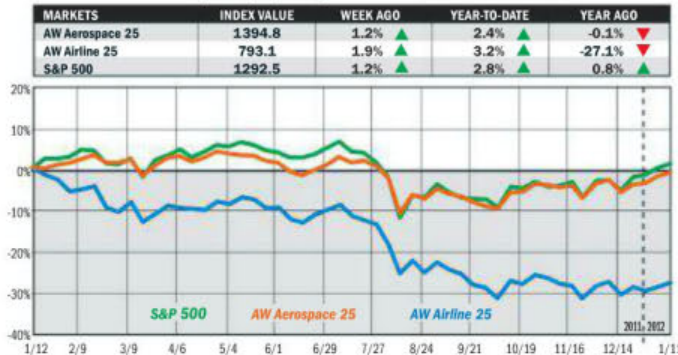
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AW&ST/S&P Market Indices

(as of 1/11/2012)

PERCENT CHANGE



Weekly Market Performance

Closing Prices as of Jan. 11, 2012

Company Name	Current Week	Previous Week	Fwd. P/E	Tot. Ret. % 3 Yr.	Tot. Ret. % 1 Yr.
AIR TRANSPORT					
AAR Corp.	20.50	19.68	9.7	19.5	-25.9 ▼
ACE Aviation Holdings	10.19	10.15	-16.5	30.0	-19.2 ▼
AerCap Holdings N.V.	11.89	11.48	6.1	178.5	-15.6 ▼
Air Berlin	3.07	3.22	-2.0	-45.0	-41.7 ▼
Air Canada	1.08	1.02	-2.5	-54.7	-68.8 ▼
Air France - KLM	5.06	5.19		-59.9	-73.3 ▼
Alaska Air Group	72.85	74.43	8.3	146.4	15.4 ▲
All Nippon Airways Co Ltd.	2.81	2.87	21.6	-35.7	-28.7 ▼
Allegiant Travel Co.	53.50	53.96	15.0	39.8	11.6 ▲
Asiana Airlines Inc.	5.71	5.59	4.7	77.3	-36.3 ▼
Atlas Air Worldwide Holdings	41.55	39.28	8.0	93.6	-20.3 ▼
BBA Aviation plc	2.77	2.79	10.1	145.2	-16.6 ▼
B/E Aerospace Inc.	41.25	38.93	16.1	347.9	5.2 ▲
CAE Inc.	9.91	10.18	13.8	38.5	-16.5 ▼
Cathay Pacific Airways	1.78	1.70	9.0	71.7	-34.8 ▼
China Southern Airlines	29.29	26.32		272.2	-5.3 ▼
Copa Holdings SA	64.00	61.26	8.6	132.6	10.9 ▲
Delta Air Lines Inc.	8.61	8.01	3.7	-23.8	-31.2 ▼
Deutsche Lufthansa AG	11.67	12.25	11.0	-5.3	-44.7 ▼
easyJet plc	6.12	6.13	11.0	33.8	-13.2 ▼
FedEx Corp.	89.76	84.96	13.0	51.8	-4.9 ▼
GOL SA	6.95	6.89		46.8	-56.9 ▼
Hawaiian Holdings Inc.	6.00	5.59	4.5	7.1	-23.6 ▼
Heico Corp.	56.49	56.64	28.9	125.6	30.4 ▲
Jet Airways (India) Ltd.	3.92	3.31	-3.4	29.3	-71.5 ▼
JetBlue Airways	5.68	5.23	12.7	-19.4	-18.4 ▼
Korean Air Lines Co. Ltd.	36.55	38.56	7.7	17.2	-42.1 ▼
Lan Airlines SA	23.90	24.03	19.5	178.1	-20.9 ▼
Qantas Airways Ltd.	1.56	1.60	10.2	-38.6	-40.0 ▼
Republic Airways Holdings Inc.	3.73	3.48	4.8	-63.7	-47.1 ▼
Ryanair Holdings ADS	29.37	28.67	64.4	7.3	-7.9 ▼
Singapore Airlines Ltd.	8.16	8.07	19.2	60.5	-17.4 ▼
Skywest Inc.	13.34	12.98	22.0	-21.8	-18.4 ▼
Spirit Airlines, Inc.	15.49	14.62	9.1		
Southwest Airlines	8.88	8.60	11.9	3.6	-32.4 ▼
TAM SA	20.08	20.22		159.8	-16.0 ▼
United Continental Holdings, Inc.	18.01	18.52	3.5	54.6	-30.5 ▼
United Parcel Service Inc.	74.61	73.84	16.0	61.8	6.8 ▲
US Airways Group	5.91	5.03	4.0	-30.8	-45.7 ▼
WestJet Airlines Ltd.	11.28	11.64	10.4	-14.4	-17.5 ▼
Zodiac Aerospace SA	88.26	85.94	13.7	161.8	27.6 ▲

COMMENTARY

Airlines Looking Good To Wall Street

You may recall the airline industry's promising start a year ago, building on the recovery in 2010 from the global financial crisis in 2008. But the favorable operating climate didn't last. A surge in oil prices, an epic natural disaster in Japan and the European sovereign debt crisis created yet another round of major problems for carriers. So is it any wonder that airline stocks over the last 12 months lost 27% of their value? Here's the real surprise: Wall Street is bullish for the industry's prospects in 2012, despite the fact that it has been a textbook study in destroying shareholder value for the last 10 years.

Whether the financial analysts' upbeat outlook will actually pan out, of course, is highly questionable. Of the last round of challenges to shake up the industry, only one—the effects of the natural disaster in Japan on air travel—has resolved itself. Fuel prices remain stubbornly high, the economic recovery is no less fragile than it was a year ago, and Europe is teetering on falling into a recession, if it hasn't already. And let's not forget the specter of Iran threatening to disrupt the flow of oil from the Persian Gulf.

A close review of the U.S. airline industry's stock performance would support the premise that the sector is spiraling down fast. Setting aside **American Airlines**, whose parent, **AMR Corp.**, filed for bankruptcy on Nov. 29, share prices of U.S. carriers started 2012 on a dismal note, down by double digits across the industry.

Nonetheless, some analysts believe better days are ahead. "The sector is undervalued," insists Ray Neidl at Maxim Group. He is forecasting the U.S. industry, excluding American, to report a \$3.5 billion profit for 2011—and earn nearly double that amount of profits this year. He reasons that the industry is continuing to reap the benefits of consolidation.

For example, **Delta Air Lines'** acquisition of **Northwest Airlines** allowed it to de-emphasize underperforming hubs in Memphis and Cincinnati, just as **Continental Airlines** is scaling back at Cleveland. And Standard and Poor's analyst Phil Baggaley notes that **Southwest Airlines** is digesting and realigning **AirTran Airways** and rethinking its Atlanta strategy. (Like *Aviation Week & Space Technology*, S&P is a unit of The McGraw-Hill Companies.) On the demand side, consumer confidence is building, and desire for both business and leisure travel is rising. Moreover, if the euro falls relative to the dollar, Europe could become a more attractive vacation destination for Americans, Baggaley says.

Of course, it's possible the global economy could go from bad to worse; the current forecast is for growth of between 1.5-2%. In addition, taxes and regulations—including more stringent flight and duty time rules in the U.S., not to mention the European Union's emissions trading system—threaten to take a bite out of the industry's revenues. For now, though, optimism prevails. "As long as Greece doesn't fall into the Mediterranean and the Strait of Hormuz remains open, we could see a major rally in one to three months," says Neidl. ☺

Source of financial data: Standard & Poor's and Capital IQ Inc. (a Division of Standard & Poor's) U.S. dollars and cents. Forward P/E ratio uses S&P and Capital IQ forecasts of current fiscal year.

AIR TRANSPORT

Airport Revenues Up 7%

Although financial markets are uncertain about Europe's sovereign debt crisis, consumers seem unfazed, says Airports Council International, which expects overall passenger traffic growth to remain above 4% and international traffic to grow by 6% this year. The increase may be smaller in the first half "but overall airports should be in a good spot to grow revenues further," ACI says. Growth in China and Brazil is expected to cool, and political uncertainty in North Africa is expected to slow activity there. Traffic in the rest of the Asia-Pacific region is expected to continue expanding, as it will in Latin America. Growth in Europe and North America is expected to be "rather muted." ACI reports 2010 airport revenues were in line with global industrial growth and reached \$101.8 billion, up 7% year-on-year. Responses to its annual survey came from 604 airports that handled 3.12 billion passengers last year. They reported \$26 billion in capital expenditures, nearly a third lower than expected.

Split Performance

Embraer is starting 2012 with a slight year-on-year drop in the value of its backlog, after a year in which commercial aircraft deliveries increased slightly but executive aviation saw another decrease. The Brazilian aircraft maker ended 2011 with 99 executive aviation deliveries, down from 144 the year before. Phenom, Legacy and Lineage deliveries suffered declines. On the regional jet front, deliveries were up to 105 units from 100. The company closed out the year with 249 E-Jets in its backlog, roughly equal to the 250 at the start of 2011. The value of the backlog has declined to \$15.4 billion from \$15.6 billion.

NEO Numbers Grow

Airbus has added to its A320NEO firm order backlog, with Mexico's Volaris signing for 30 of the aircraft (in addition to 14 classic A320s). Additionally, Spirit Airlines has confirmed its deal for 45 of the reengined A320s is now also firm, boosting the backlog for the aircraft family to more than 1,270 aircraft.

Outsourcing

An Airbus decision to shift A320 wing

work to Korea Aerospace Industries is drawing fire from the U.K.'s Unite labor union representing workers at the Broughton facility where the work has been done. Unite, in a statement, says workers were told on Jan. 10 that the bottom wing skin production work would shift to KAI. No job cuts loom as a result, with Airbus committing to shifting the affected personnel to other work. In a statement, the company says "production rates in Airbus are currently increasing and many of the resources made available by this decision will be utilized in supporting the impact of this at Broughton." Still, the

union argues "the decision undermines the world-beating skills of U.K. workers and will weaken the Britain's position in the global aerospace industry." Airbus says "the decision will help strengthen Airbus in the U.K. as a business long-term, allowing its Broughton facility to focus resources on key high-value production areas—core competencies of wing assembly and equipping."

Socata Sales

Daher-Socata delivered 36 TBM850s last year, equaling the total the year before. Deliveries to buyers in the U.S. continued to dominate, with 84% of

Renton Shifts Into Higher 737 Production Rate

Boeing's progress toward producing two aircraft per day from its Renton, Wash., 737 factory has reached another milestone with the rollout of the first aircraft on a 35-per-month cycle.

Renton's parallel final-assembly lines are scheduled to reach a combined rate of 42 aircraft/month in the first half of 2014. With 21-22 production days per month, that rate equals about one aircraft per day from each of the two lines. The last time Boeing increased its rates was in 2009.

The buildup is occurring without noticeable strain to the supply chain. The first aircraft produced at the higher rate, a 737-800 for AWAS Aviation Services, left the line with only eight jobs to be completed outside the normal production sequence, says Boeing Vice President Beverly Wyse, the 737 program general manager. The AWAS aircraft will be leased to Norwegian Air Shuttle.

Out-of-sequence work is not unusual if parts arrive too late for inclusion in the normal final-assembly process. Often, these parts "travel" to Boeing because they were not available to subcontractors. Boeing's rate buildup is not happening in a vacuum; Airbus also is boosting rates and shares many suppliers with Boeing. So supply chain shortages, a major reason why Boeing's 787 development effort fell behind, are watched closely as the company boosts rates. Wyse says they are not a problem for the 737. "We only experienced three parts shortages during production," she reports.

Renton employees will now assure the 35/month rate is stable before stepping up production again in the second quarter of 2013 to 38/month. The last step change was to 31.5/month in the third quarter of 2009.

In the meantime, Wyse and her production team must plan for the introduction of the 737 MAX into the Renton factory flow. MAX is the more fuel-efficient, reengined 737 Next-Generation series that Boeing is offering airlines as an alternative to the NG series. It is to enter service in 2017.

Separately, a Jet Airways order for 17 737 NG aircraft and an unidentified customer order for 10 787s are leading Boeing's early 2012 sales activity. The company recorded 26 net orders as of Jan. 12, including one for a 737 from Virgin Australia. There were also two canceled 777 orders by unidentified customers.



deliveries topping even the 76% of 2010. Latin America was the second largest market, with Asia-Pacific and Europe following. Europe was the second largest market in 2010. Daher-Socata says it was the fourth best sales year for the TBM.

AirLiance Acquisition

Lufthansa Technik has increased its stake in AirLiance Materials to 100% from 50.2% after purchasing its partners' shares of the Chicago-based company that provides surplus parts services. United Airlines and Air Canada previously held 49.8% of the joint venture the three companies formed in 1998. The companies did not disclose the acquisition price. AirLiance fits much better with Lufthansa Technik's core business than it did with its former partners, and sees growth in the parts business—especially through global sales.

ROTORCRAFT

Raider Team Unveiled

Sikorsky is hoping to set a procurement precedent by assembling an industry team to fund the construction of prototypes that would support a Pentagon decision to launch full-scale development of a new armed scout helicopter. The team of 35 suppliers is providing 25% of the unspecified cost of building two prototypes of the high-speed, coaxial-rotor S-97 Raider. Sikorsky is providing the remaining 75% from its research and development funds. General Electric is supplying the 2,600-shp YT706-700 engine; Aurora Flight Sciences is building the composite fuselage; and companies including BAE Systems, Esterline, Hamilton Sundstrand, Honeywell and Parker are supplying avionics for the fly-by-wire S-97. Flights are planned to begin in 2014.

Helicopter Prowl

The South Korean defense procurement agency is kicking off a major competition for up to 36 AH-X attack helicopters, with bids due May 10.

SPACE

Shuttle Engines to Stennis

The 15 remaining RD-25D space shuttle main engines are on the way from Kennedy Space Center in Florida to the Stennis Space Center in Mississippi,

Breakup of Doomed Russian Spacecraft About To Happen

The uncontrolled reentry of Russia's stranded Phobos-Grunt spacecraft presented a moving target to satellite trackers just days before pieces of the botched Mars mission were expected to fall to Earth.

The Russian space agency Roscosmos said Jan. 12 that while much of the 13,200-kg (6,000-lb.) spacecraft was likely to burn up during a fiery atmospheric reentry Jan. 15, as many as 30 chunks of the unmanned probe were expected to reenter Earth's atmosphere over a patch of the Indian Ocean off the east coast of Africa. However, the prediction came less than 24 hr. after Russia forecast the spacecraft's reentry over the opposite side of the ocean, just west of Indonesia.

Cautioning that it is too soon to predict the precise time and place of impact, Roscosmos said on Jan. 6 that the dynamics of spacecraft deceleration in the Earth's atmosphere depends on a variety of factors. Chief among these, Roscosmos said, is the variability of the behavior of the atmosphere, which expands and contracts relative to the Earth's solar cycle. "The exact spot, the date and time of their fall is possible to predict, but not earlier than one day beforehand," the agency said.

Brian Weeden of the Secure World Foundation, a non-profit group based in Washington, says an accurate prediction is unlikely until the end is near.

Launched Nov. 8 from the Baikonur Cosmodrome in Kazakhstan, Phobos-Grunt was left stranded in low Earth orbit after separating from its Zenit 2-SB rocket when the spacecraft failed to boost itself into an interplanetary trajectory. Subsequent efforts to salvage the mission failed, and the satellite's orbit has been gradually decaying ever since. As of Jan. 12, Phobos-Grunt was traveling in a near-circular orbit between 157 and 186 km above the Earth at an inclination of 51 deg.

where they will be stored until needed to power the core stage of NASA's planned heavy-lift Space Launch System (SLS). As many as five of the reusable liquid oxygen/liquid hydrogen engines will be used on the SLS, now scheduled to make its first flight test late in 2017 (see p. 24). Moving them to Stennis, where they were ground-tested during the 30-year shuttle era, will make it more efficient to prepare them for the SLS application, NASA says.

China Launches Ziyuan 3

Development of new Chinese Earth-observation satellites is in the planning stage, national space contractor CASC says, announcing the launch of the latest such spacecraft. A Long March 4B rocket lofted the new satellite, Ziyuan 3, to a 500 km Sun-synchronous orbit inclined at 97.5 deg. at 03:17 GMT on Jan. 9. The Xian launch control center reported separation of the payload and injection into orbit 12 min. after launch. The 2.65-metric-ton Ziyuan 3 is China's first civil satellite built for precision, three-dimensional mapping, says CASC, whose spacecraft-manufacturing subsidiary CAST built it. The satellite will provide multi-spectral as well as 3-D imaging, with a design life of five years. The launch was late; it was originally scheduled for 2011. The Yaogan series of remote-sensing satellites already has units with synthetic aperture radar for

military use. Use of Ziyuan 3 is officially assigned to the National Administration of Surveying, Mapping and Geo-information, with such functions as soil monitoring and disaster mitigation.

Landing Systems Pass

Testing has proved the effectiveness of crucial landing technology for China's third lunar exploration mission, says CAST. The mission, to be called Chang'e 3, is aimed at making advances in a wide range of technologies, says CAST, listing them as soft landing, surveying the surface by rover, "survival on the lunar surface," communications for long-distance monitoring and control, and direct injection into a lunar transfer orbit. The landing systems that have lately completed their tests have functions such as braking and obstacle avoidance, says the manufacturer. The Chang'e 2 spacecraft, built as a spare for the pioneering Chang'e 1 lunar orbiter but sent on its own mission to the Moon in 2010, is now conducting observations at the second Lagrangian point. Chang'e 3 is due to be launched around 2013.

Correction: In an item about F-15 sales, *Washington Outlook* in the Jan. 2 edition (p. 23) erroneously referred to the "Royal Singapore Air Force." Singapore is a republic and has no royalty.



BY MICHAEL MECHAM

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COMMENTARY

Going for A&D

States and regions need a big bag of tricks to lure top manufacturers

Boeing's decision to close its Wichita defense plant is a story of too much factory capacity and not enough work. The 2013 closure raises concerns about the future of the company's more than 2,100 employees as jobs shift to facilities in other states.

The Wichita story is mainly one of costs and efficiencies. With program funds drying up, Boeing felt its Wichita factory was no longer competitive. Boeing is not the only aerospace and defense (A&D) industrial leader with excess capacity. Commercial backlogs may be healthy, but not enough to take up all the slack for suppliers feeling the defense budget squeeze.

The pressure to boost production without adding workers is relentless. "The long-term trend is to replace labor with technology," says Deloitte LLP A&D analyst Tom Captain. "So labor is becoming less important as a cost factor." Instead, digital product definition and lean practices are keys to success.

Eager to attract skilled, good paying, middle-class jobs, many regions offer tax and regulatory sweeteners and frequently pick up the tab to train new hires, providing employers offer job guarantees. But applying these strategies is easier said than done. During a recent visit to Montreal, I was struck by how much prime and Tier 1 manufacturers in Quebec—Canada's largest A&D market—have layered their support programs to build the region's A&D industry.

Montreal offers government-backed programs that seed new aircraft development—providing jobs are guaranteed—and pursues foreign talent and manufacturing partners if they can boost the fortunes of the city's A&D sector. The region's universities and specialty schools, such as Ecole Nationale d'Aerotechnique with 900 students in a three-year program, feed the industry graduates and engage



in research on its behalf. Aero Montreal, the region's A&D think tank, has initiated a mentoring program to help small and medium-size enterprises (SMEs) learn how to move into design and manufacturing roles valued by global supply chains.

Similar efforts can be found in numerous states in the U.S. But Montreal's layered approach stands out.

In Montreal, CAE is an example of growing strong locally in order to compete globally. CAE counts itself as first or second in flight simulation and training across multiple segments, including commercial, business and military aircraft. The company has focused on emerging economies since the 1970s but counts U.S. military programs as its largest customer base for such programs as full-flight simulators for the U.S. Navy's P-8A maritime patrol aircraft (see photo).

Leading contractors say the drive to support local industry is very strong

even if it is not always satisfied. Pratt & Whitney Canada buys \$4.2 billion annually from Canadian suppliers but could go as high as \$16 billion if the right suppliers were available, says Senior Vice President Maria Della Posta.

Heroux Devtek, best known for its landing gear, works with 200-300 Canadian suppliers, says Vice President Martin Bressard, general manager of the company's Longueuil plant outside Montreal. "Lots of them are local machine shops, doing shot peening or specialized work," he says.

The company has learned to work closely with its own customers, such as with Alcoa on the design of a titanium/aluminum forging for the F-35 bulkhead. Heroux Devtek wants to develop the same relationship with its own suppliers.

Bell Helicopter Canada is one of the sponsoring mentors for Aero Montreal's SME development program. President Barry Kohler says mentoring is all part of the region's heavy emphasis on technical training and managerial cooperation. "There is a lot of cooperation between us and the research institutions," he says. "We really cooperate to an extent that you won't see in any other city."

Bell has more than 200 Canadian suppliers, 50-60% from within Quebec. "Do we cluster? Absolutely, but with the caveat that the SME equation has changed," he declares. His reference is to the rise in the value of the Canadian dollar, which deflates a longtime Canadian cost advantage. "The SMEs are going to have to take a step up, in my opinion. They're going to have to globally source to be competitive."

As much as Bell supports buying locally, it sources from everywhere. Recently it built a fuselage plant in Chihuahua to take advantage of lower Mexican wage rates for its Bell 429 program. Kohler smiles at some of the ways Bell has learned to function internationally. As he points out, Bell Helicopter is an English-speaking parent company with a French-speaking subsidiary in Montreal that is now relying on a Spanish-speaking fuselage factory. The trick? The Mexicans build the fuselage without written instructions. They use symbols—31 of them—for the entire process. ☛



BY WILLIAM GARVEY

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COMMENTARY

Swiss To Watch

As multifunctional as a certain army knife

There was nothing like it: A pressurized, single-pilot, single-engine turboprop with 1,500-nm range, capable of taking off and landing on short, grass strips, featuring a flat-floor, 6-9-passenger cabin as capacious as those in some medium jets, and with a fully enclosed, flushing lavatory. And in addition to its people door, it had a barn-sized one that could swallow cargo measuring 4 sq. ft.

Pilatus Aircraft Ltd. had always been known for building unique utility and training aircraft, but this one stretched the definition to the limits.

If it could sell 200 of the curiosities, the Swiss aircraft maker would consider the PC-12 (see photo) a success. At least, that was the thinking at the aircraft's debut in 1994. That thinking has since changed. The company has now delivered more than 1,100, making the PC-12 the most populous Pilatus ever, and five new ones roll off the wooden production floor in the Alpine burgh of Stans every month.

PC-12 buyers are as eclectic as the aircraft is unique. The Royal Canadian Mounted Police uses its fleet of 15 to transport personnel and prisoners and carry out searches. The two-dozen medevac versions operated by the Royal Flying Doctor Service are key to providing emergency care and transport for patients throughout Australia. PC-12s serve as regional airliners in South Africa, cargo-haulers in South America, executive short-haulers in the U.S.—PlaneSense, a fractional ownership program headquartered in Portsmouth, N.H., boasts a fleet of 30—and are a favorite among special ops forces alighting in places dark and dangerous.

Pilatus focuses on aircraft that serve niche markets and promise long production runs—the short-takeoff-and-landing PC-6 Porter has been in production, albeit at a very low 2-5 annual rate now, for over 50 years—and the PC-12 fits those criteria perfectly. The airplane was in production for 14 years before it underwent a major upgrade



PILATUS

in 2008, being fitted with Honeywell's Primus Apex integrated cockpit and a more powerful Pratt & Whitney Canada PT6A-67P engine flat-rated at 1,200 shp, creating the PC-12NG (as in "Next Generation"). That model, which is standard, sells for \$4.5 million.

Conventional wisdom holds that airframers must provide their customers with follow-on models, and, accordingly, Pilatus management is regularly asked, "What's next?" For years, the (non)response left reporters' notebooks blank.

Privately held, Pilatus eschews debt and instead funds new product development—alternating between military trainers and civilian programs—with profits from sales, but it exhibits the reserve of a Swiss banker in sharing any details. Still, Chairman and CEO Oscar J. Schwenk has acknowledged that design work is underway on a new civilian model, the PC-24, and one company executive recently hinted there might be "some news this year" regarding the new aircraft.

Details on the airplane are woefully absent—could it be a turbine twin? A larger single? Something altogether different? But certain characteristics seem certain: it will be built to last, it will be unique, and it will be around for a long, long time. ☺

'AMAZING' TOUCHDOWN

It was a straight-in nighttime approach to Hartsfield-Jackson Atlanta International Airport's Runway 9R. The Learjet was at 2,400 ft., 6 mi. out. That put the pilots below the glideslope, but with ceiling and visibility unrestricted, winds calm and all instruments in the green. Piece of cake. Unless, that is, you had never before been in a cockpit nor at the controls of any airplane. And the whole world was watching. Oh, and a million bucks were on the line.

That was the situation confronting three pairs of contestants in last season's final episode of "The Amazing Race," a television show in which couples hopscotch the globe trying to best unusual challenges and unravel clues in the least amount of time in pursuit of the grand cash prize.

The landing attempts occurred in a trio of simulators at FlightSafety International's Atlanta Learning Center and followed 15-min. briefings with instructors there. The results?

One couple, Ernie Halvorsen and Cindy Chiang, made it down safely on their first attempt (see photo). The second couple made it on their second try, after nearly stalling at 500 ft. on their first. But the third team, former NFL tight end Marcus Pollard and his wife/co-pilot, Amani, had to make 12 time-consuming attempts before getting the aircraft down and stopped safely.

Although he concedes that the broadcast was unlikely to deliver any new business beyond the show's cost payments from its producers, FlightSafety communications head Steve Phillips maintains that the exposure to a viewing audience of millions made the whole thing worthwhile: "It showed the value of well-trained professional pilots, and that's what we help produce." ☺



CBS BROADCASTING



BY ADRIAN SCHOFIELD

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COMMENTARY

Rebound Year

Australian airlines look for new momentum

While 2011 was a tumultuous year for Australian airlines, enough challenges remain to make 2012 another pivotal period.

Australian carriers certainly had a bumpy ride over the past 12 months—even by the volatile standards of the global airline industry. For some the upheaval was intentional, but for others the year was marked by unwelcome setbacks that are affecting their 2012 plans.



Tiger Airways Australia is gradually rebuilding after an enforced shutdown last year.

KEITH GASKELL

Qantas began 2011 still dealing with the engine problems that forced it to ground its flagship fleet of Airbus A380s. Another temporary grounding occurred in late October, this time of the carrier's entire mainline fleet. This was the result of a bitter labor battle, with contract disputes magnified by union concerns about Qantas's plans to restructure its international operation. After months of industrial action by its major unions, Qantas eventually responded by announcing a lockout and halting operations until the government intervened.

Qantas's union headaches have eased somewhat now that the nation's top labor relations authority has taken charge of negotiations and banned strikes. But even if the threat of disruption has waned, this probably remains the carrier's leading challenge for 2012.

While it has recently reached a deal with one of the three unions it was battling, the two remaining groups—baggage handlers and international pilots—will be tougher. The airline will need not only to resolve the contract

issues, but also to ensure that union deals do not constrain its ambitious offshore plans.

The transformation of its international operation will be the other major goal for Qantas in 2012. It has already outlined its intentions, and must now bring them to fruition.

The airline wants to set up a premium carrier in either Kuala Lumpur or Singapore, flying Airbus A320s on routes to Australia and elsewhere in the region. Qantas has been negotiating with governments and local interests, and is expected to decide soon where and when it will launch the carrier. International growth will also be channeled through Qantas's Jetstar subsidiary, which plans to launch a new joint-venture airline in Japan later this year.

Virgin Australia's focus, meanwhile, will be on consolidating the dramatic changes it underwent in 2011.

The carrier conducted a major rebranding exercise, bringing all of its various operations under the new Virgin Australia name. This also marked a

change in focus, as it broadens its scope from low-cost service by adding a premium product to compete with Qantas in the lucrative corporate market.

In 2011 the carrier put the last major pieces in place for a "virtual" international network, expanding its long-haul offering by building partnerships with overseas airlines.

U.S. regulators last year approved Virgin Australia's alliance with Delta Air Lines, after taking the almost unheard-of step of overturning a preliminary rejection of the deal. The carrier also unveiled a partnership with Singapore Airlines to open up more Asian markets. These moves followed the approvals of similar agreements with Etihad and Air New Zealand.

Having created the framework for its new strategy, Virgin Australia's challenge now is to execute it. A major aim will be returning to profitability, reversing the net loss from its 2011 fiscal year.

Tiger Airways Australia probably had the most disastrous 2011 of any of the Australian carriers, and also has the most to prove in 2012. The airline was shut down by Australian regulators in July for five weeks owing to concerns about its safety practices, and when it resumed flying it was limited to only a handful of routes.

The carrier was a financial drain on its Singapore-based parent even before the grounding, and many analysts were skeptical about its long-term survival. However, Tiger appears to be bouncing back by focusing on core routes. Australia's Civil Aviation Safety Authority approved the carrier's request to have its flight limit raised to 32 sectors daily, and it seeks further loosening of the restrictions. Tiger is operating a much smaller network, but it intends to add back more routes this year.

On top of all their individual issues in 2011, carriers had to contend with external challenges ranging from record flooding in parts of the country to volcanic ash clouds that disrupted flights for weeks.

Airlines will undoubtedly face more headaches this year, from either the forces of nature or the global economy. The main Australian players will be hoping that the changes forged in 2011—whether planned or not—will make them more resilient. ☛



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COMMENTARY

Climate Science

Larger climate role envisioned for satellites

Operational satellite networks that routinely monitor Earth's climate in the same way meteorological satellites watch the weather today will be extremely useful as the links between human activity and long-term environmental conditions become better understood, and perhaps more dangerous. It is an opportunity the aerospace industry cannot afford to pass up, given its unique ability to address climate-change issues.

This shot (above) of the Deepwater Horizon oil spill in the Gulf of Mexico by a member of ISS Expedition 23 illustrates how obvious mankind's impact on the planet is from space. Oil from the leak continues to impact the Gulf coast, according to a Dec. 30 report by the Natural Resources Defense Council. But there is no way to monitor the environment and its effects on society systematically, and an expert panel of the U.S. National Research Council (NRC) warns that tight budgets and other factors have left the U.S. facing "serious gaps" in its ability to track changes on Earth from space.

A draft NRC review of the 10-year strategic plan prepared by the U.S. Global Change Research Program (USGCRP), which drives U.S.-government efforts to understand and mitigate climate change, finds the plan would fall short even if it were better suited to the seriousness of the issue.

"The proposed broadening of the program's scope from climate change only to climate change and 'climate-related global changes' is an important step in the right direction," the NRC panel says, while noting "that such an expansion may be constrained by budget realities."

"As the program moves in this direction, a high priority is to assure that observing systems are designed to monitor a broad array of global changes, given that valuable information is being lost every year that such efforts are delayed," the NRC reviewers say.

The USGCRP plan acknowledges the importance of satellites for climate-change monitoring, and calls

"for agencies to continue working collaboratively through USGCRP to leverage resources and set priorities," according to the NRC draft. However, the NRC notes that the cost of some Earth-observation missions has grown "dramatically," while the U.S. program has suffered setbacks with the launch failures of the Orbiting Carbon Observatory and Glory missions in 2009. At the same time, budgets for Earth-observation work "have not been sustained at the expected level."

Under those circumstances, the collaboration approach does not go far enough, says the NRC panel, which was headed by Warren M. Washington, a senior scientist at the National Center for Atmospheric Research in Boulder, Colo.

"The USGCRP needs an appropriate governance structure and clear mechanisms for assuring that long-term satellite-based observing systems are developed and sustained in a manner suitable for meeting the program's key science objectives," the NRC report states.

Reviewers also found a growing need to continue integrating climate data from abroad with data collected by non-U.S. systems, including remote sensing and in-situ monitoring systems such as the 31-nation Argo network of instrumented ocean buoys. And they suggested greater use of "citizen science" data, some of it based on agronomy like an 800-year cherry blossom database collected in Japan and a 500-year grape harvest record.

Other "emerging" data sources may be useful in climate modeling

with more research, the NRC found, including atmospheric pressure data from automobile fuel-injection systems, seismic data from smart phone accelerometers, and a range of blogs, Google-Earth type mapping and other Internet-based inputs that could help the USGCRP advance its goal of better integrating social and climate sciences to guide political leaders trying to cope with the changing climate.

"An observational system that integrates relevant social, ecological and physical data (and that can cope with the rapidly evolving needs and capabilities in satellite and in-situ observations) is an indispensable foundation for understanding and informing societal responses to global change," the NRC says.

Developing such a system will not be easy or cheap. According to a position paper prepared for the World Climate Research Program (WCRP)—a 30-year-old international body cited in the NRC review—an operational system for climate science alone would need to track at least 50 "essential climate variables"—16 each for atmospheric and terrestrial conditions and 18 for the oceans.

"Space and time scales are more extreme, ranging from aerosol and cloud physics occurring at seconds and micrometers, to global decadal change at 100 years and 40,000 km," the WCRP paper states.

But far from meeting the needs of an operational climate-monitoring system, the NRC panel found today's ad-hoc network of weather and scientific satellites at risk of losing even more environmental data than is already being lost through inaction.

"[T]he nation is currently at risk of having serious gaps in observational capability, for both operational forecasting missions and for key climate records (e.g., sea-level observations)," the NRC draft states. "For instance, delays in advancing [the National Oceanic and Atmospheric Administration's] Joint Polar Satellite System have led to the possibility of a gap in some key observations that have been collected over the past decade by the Earth Observing System satellites (which are well past their expected operational lifespan)." ☛



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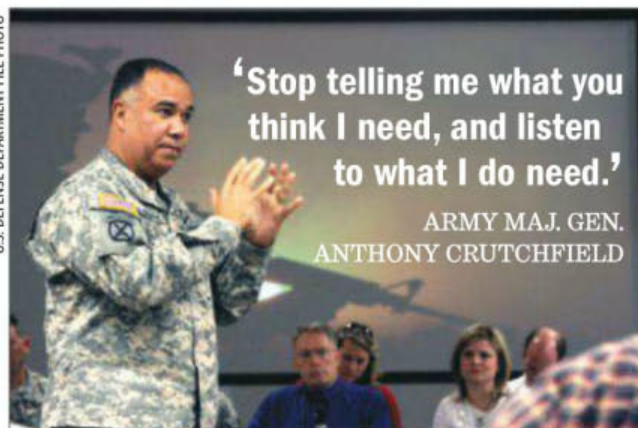
COMMENTARY

Rotor Revolution

Army looks beyond its current crop of helos

Although it seems that old military helicopters never die, a top Army aviation official thinks the Black Hawk, Chinook, Apache and Kiowa Warrior will all be put out to pasture by 2040. As the Army considers its vision for aviation in 2030, upgrades are not a part of the picture. "We should not plan for the Apache Block 40," says Maj. Gen. Anthony Crutchfield, head of the Army's Aviation Center of Excellence. "I'm thinking beyond that now." That will probably be welcome news to an industry that has been begging the Pentagon to get real about pursuing next-generation rotorcraft—but it could also be a case of "be careful what you ask for," since MRO and upgrade efforts have kept the industry alive to date. "Service priorities, inadequate science and tech-

U.S. DEFENSE DEPARTMENT FILE PHOTO



nology and development funding, execution issues and 'requirements creep' have all led to an industry that is surviving to a large extent on modification programs," the industry-led Vertical Lift Consortium says.

Moreover, Crutchfield's comments come in the thick of a budget season that marks the beginning of major reductions in military spending. Crutchfield is encouraging industry to stay focused on designing far-reaching advances in rotorcraft while working alongside the military. "I know you are in business, but I [think] that the reduction in resources is going to cause us to move even closer than we are for both of us to succeed," he said in a speech opening an aviation symposium hosted by the Association of the U.S. Army conference Jan. 12. "Stop telling me what you think I need, and listen to what I do need." ☐

LABORED RELATIONS

When Congress returns from its holiday recess, the world's largest business association would like to see House Republican leadership yield on a labor issue that is preventing passage of the FAA reauthorization bill. U.S. Chamber of Commerce President Thomas Donohue, a proponent of the NextGen air traffic management system, last week said Congress needs to pass the FAA bill that has been stalled for more than four years. The FAA's current operating authority expires Jan. 31, but lawmakers have just a handful of legislative days to pass the 23rd extension or reach an agreement. Republican leaders have held out for a change to rules on how unions are created, but top chamber officials say they would prefer if Republicans dropped the fight and allowed the bill to proceed. "I think we'd be happy if we went back to the way things were on

the labor front," says Bruce Josten, the chamber's executive vice president of government relations. ☐

VENUE VICISSITUDES

NASA bigwigs want to be in Cape Canaveral to watch Space Exploration Technologies launch its first Dragon capsule to the International Space Station (ISS) on Feb. 7. The problem is, the Obama administration expects to present its budget request Feb. 6, so officials are undecided about whether to spell out NASA spending details in Washington or from Florida. As is often the case, the Falcon 9 rocket launch may slip. To allay NASA safety concerns and meet the Feb. 7 date, SpaceX has dropped plans to piggyback two Orbcomm satellites with the Dragon, lest they return to hit the ISS on a later orbit. NASA still has not officially cleared the mission, which will send the Dragon close enough to the ISS for it to be grappled by the station's main robotic arm and berthed to a hatch. A formal flight readiness review is scheduled early in February, and final approval from NASA managers for Dragon to approach the station will not come until at least three days after launch. By then, it should be clear whether SpaceX has control over the 20-ton vehicle as it orbits. ☐

LONESTAR LONG SHOT

Ron Paul, the Republican presidential candidate most likely to support reductions in defense spending, ranks third in terms of donations from defense industry employees. Paul might want to end the war in Afghanistan, scrap all aid to foreign governments and see Pentagon spending tumble by \$1 trillion, but the Texan with Libertarian tendencies strikes a chord with the defense industry's techno-geek workforce. He has brought in \$49,833—primarily in donations of less than \$1,000 from defense programmers and engineers, according to the independent Center for Responsive Politics. President Barack Obama has received \$111,745 in defense industry contributions, more than any other candidate in the 2012 campaign. Mitt Romney, who won the Jan. 10 New Hampshire Republican primary and is solidifying his place as the party's front-runner, has received \$56,050. ☐

ON THE BR

JENS FLOTTAU/**FRANKFURT** and ROBERT WALL/**LONDON**

The days of getting by for struggling European airlines are coming to an end. Malev Hungarian Airlines may become the first financially troubled airline unable to ride out the region's economic turbulence, but it will almost certainly not be the last.

The suffering of Europe's airlines has three main causes. Markets are weak, and they are forecast to remain so at least for this year. Some governments have added passenger taxes—such as the U.K. Air Passenger Duty or the German departure tax—that airlines have not been able to pass on to customers and have had to add to their cost bases. More importantly, however, many airlines are learning the hard way that they did not do their homework when times were good. Central European carriers like Malev, CSA Czech Airlines, LOT Polish Airlines and Air Baltic have been kept afloat by their respective governments, but structural reform has been slow.

The weak financial situation of Europe's airlines raises the question of whether there will be more foreign investment along the lines of Etihad's entry as the largest shareholder of Air Berlin. Aer Lingus and the Irish government denied they were in talks with Qatar Airways over a similar deal. Qatar is rumored to be interested in Spanair, too. But there are many more shares of carriers up for sale, including a significant stake in Virgin Atlantic.

Even the most successful legacy carriers, Air France-KLM and Lufthansa, are still struggling to overcome their structural weakness in short-haul markets. Both are in the process of launching new rounds of cost-cutting measures. Without changes to legacy procedures, work rules and networks, there are tight limits to what can be achieved.



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For the time being, no major aircraft order cancellations are expected, but airlines are retiring existing fleets earlier than planned and deferring some deliveries. For the most part, weaker carriers have not placed major aircraft orders at this stage, though LOT signed a commitment for eight and Air Berlin for 15 Boeing 787s.

The International Air Transport Association (IATA) expects European carriers to post a combined loss of \$600 million in 2012. Based on estimates, they made a profit of \$1 billion in 2011, a 1.2% margin.

The situation is most dramatic in Hungary, where national airline Malev appears to be on the brink of collapse yet again. The country's government says it has accepted a European Commission ruling that financing granted to Malev in 2007-10 "constitutes illegal state aid." The commission asserts that "Malev would not have been able to obtain similar financing from the market on the terms conceded by the Hungarian authorities." It also makes clear that "Hungary now needs to recover

the unlawful aid from the beneficiary."

The EC found that several transactions that took place in the past five years do not comply with European Union regulations stipulating that governments must behave like private investors in supporting airlines or other state-owned companies, following the "market economy investor principle." The illegal state financing under investigation is estimated at \$350 million at current conversion rates.

Malev has no way to pay back anything near that amount, given its huge debt burden and dearth of cash reserves. The airline depends on state aid to keep operating and was granted another \$21 million loan at the end of December, which has not been part of the investigation. Malev is trying to quell worries of suppliers and customers by insisting in public statements that normal operations will continue.

Hungary's government says it will discuss the Malev situation and make a decision about it at a cabinet meeting on Jan. 16. The development ministry says

RINK

European airlines are realizing they have restructured too little, too late



it is in the country's interest to have a national airline based in Budapest. However, even if state aid is allowed to continue, the government can no longer afford to prop up Malev.

The EC warns that Hungary's insufficient progress in cutting its deficit will limit Budapest's ability to inject further money into the carrier. The commission proposes going on to the next stage, the Excessive Deficit Procedure (EDP), which forces European countries to comply with public deficit limits. It says it could make new recommendations to Hungary "with a view to bringing to an end its excessive government deficit."

Hungary may be forced by the EC not only to stop supporting Malev, but also to try to sell the airline, as was the case for Portugal, which must privatize TAP Portugal. Hungary has tried to sell the national carrier several times in the past few years but could not find a buyer.

Air France-KLM, Europe's biggest airline, is also in trouble and launched a restructuring program with the goal of reducing annual costs by €1 billion (\$1.28

Malev Hungarian Airlines has been ordered by the European Commission to pay back illegal state aid but has no money to do so. Nonetheless, the airline insists it will continue normal operations in an effort to assuage concerns of passengers and suppliers.

billion). Measures include a pay and hiring freeze, slower than planned capacity growth and some aircraft deferrals.

The airline made clear in a statement that over the next three years it will only grow by 5% cumulatively, a move that analysts and observers have pushed for.

Fleet investment will be down to €5 billion over the next three years, compared to €6 billion in 2009-11. Air France-KLM plans to defer delivery of one Airbus A380 to 2016 from 2014, and two Airbus A320s that were to be delivered this year will arrive in 2013 and 2014, respectively. It will take one Boeing 777-300ER in 2016 instead of 2015 and cancel two options. The airline is sticking to its plans to acquire 25 Boeing 787s and 25 A350s. While the 787 order has been finalized, Air France CEO Alexandre de Juniac says the A350 deal is likely to be signed "in the next few weeks."

Air France-KLM's net debt is to be re-

duced by some €2 billion to €4.5 billion by the end of 2014.

Wages will be frozen at Air France for two years; KLM will have a policy of "wage moderation," meaning only small increases will be made. The group plans to reduce overhead costs, improve efficiency and cut the network where needed, but no layoffs are planned for the time being. The airline says negotiations with unions over the measures are to "begin rapidly." While the focus will be on the passenger business, "cargo and maintenance will also have to redefine their conditions for profitability," Air France-KLM says.

The company admits that "the structural decline in unit revenues has led to deepening losses" in the short- and medium-haul business. It estimates those losses totaled €700 million in 2011. "Long-haul operations, also subject to increasing competition, cannot alone

Air France-KLM is losing €700 million in its short- and medium-haul business and now aims to reach break-even in the segment within three years.



offset these losses," Air France-KLM says, and so it is striving for "better utilization of aircraft and assets." The company says it is not ruling out "more extensive outsourcing in some areas," though it offered no details. It aims to break even in the short- and medium-haul segments by 2014.

Air France-KLM plans to issue a progress report in March and present all details of the transformation plan in the summer.

Lufthansa is in far better shape than Air France-KLM and most of its other competitors, but even it sees a need for further restructuring. Another cost-cutting program will be announced in the coming weeks, but no details are yet available. Its restructuring program, dubbed Climb 2011, targeted—and achieved—€1 billion (\$1.28 billion) in annual savings. The group also disposed of the unprofitable BMI British Midland, which is being taken over by the International Airlines Group.

Austrian Airlines, fully owned by Lufthansa, is reinforcing its efforts to finally reach profitability in 2012. New CEO Jaan Albrecht admits the original goal of breaking even in 2011 was unachievable; the airline posted an operating loss of close to €66 million.

Austrian plans to phase out its 11 Boeing 737 NGs as soon as possible, replacing them with seven Airbus A319s and A320s. Albrecht concedes that Austrian itself does not have the money to finance the replacement, though it has secured

financial support from the Lufthansa group, contingent on significant improvements to its cost structure.

Albrecht says Austrian is battling serious structural disadvantages. According to the airline, air fares have dropped 50% since 2006, with the opposite trend in fuel prices. Also, the airline's staff costs have risen steeply. In the 2012 budget, they are where they were in 2009, but that is with 1,500 fewer employees after the huge layoffs of the past two years. Austrian says the increase in

Lufthansa is in far better shape than most of its competitors, but even it sees a need for further restructuring.

staff costs are mainly due to regular pay raises and adjustments for inflation.

"We have to eliminate our structural deficiencies and problems," Albrecht asserts. His target is to reduce personnel costs without layoffs. Two-thirds of the needed improvements are to be achieved through further cost cuts and one third through revenue growth. Austrian plans a more aggressive sales initiative for local small and medium-sized businesses.

Albrecht is launching another effort to reduce airport and air traffic control costs and wants to open new negotia-

tions with Vienna International Airport in particular. He is also pushing for the abolition of Austria's newly introduced air passenger tax that he considers to be another serious cost burden.

On the other hand, the former Star Alliance CEO sees growth on long-haul routes as the key to returning the carrier to profitability. Austrian plans to add two aircraft to its long-haul fleet in 2013. However, it faces the daunting task of replacing its six aging Boeing 767-300ERs, at least in the medium term.

It is not just flag carriers with deep structural problems that are suffering. Poor sales in December have added to the financial woes of U.K.-based regional carrier Flybe, which is warning that revenue will fall short of expectations and is not expected to improve notably for the remainder of the carrier's financial year, which ends on Mar. 31. The shortfall in revenue is "significant," the airline acknowledges. Year-on-year, Flybe saw an 8% drop in revenue in the third quarter for its U.K. operation, which represents 70% of its total annual revenues. The airline notes that yields have held steady, while conceding that it did not achieve the planned growth in that area.

However, Flybe is not deferring its expansion plans. "Management believes current market conditions will force further rationalization of the European regional and short-haul airline market, from which Flybe is well-positioned to benefit," the company says. ☐

New ERA

NASA considers next steps in green airliner concept study as budget squeeze looms

GUY NORRIS/NASHVILLE, TENN.

When NASA asked the three largest U.S. airframe makers to study advanced concepts for next-generation ultra-efficient airliners so quiet they could barely be heard beyond the airport boundary, it did not count on so many surprises.

But surprises there were when Boeing, Lockheed Martin and Northrop Grumman presented their final reports to NASA's Environmentally Responsible Aviation (ERA) program last week. All submitted preferred system concepts which either met, or closely matched, NASA's stringent noise, emissions and fuel-burn targets for airliners entering service in the late 2020s. Although the fact that each concept scored high marks was not unexpected, it was the array of unanticipated technologies, innovations and system attributes used by the teams that surprised the agency.

In addition to an unconventional flying-wing design from Northrop Grumman, and an innovative Rolls-Royce engine

with an extremely large fan powering Lockheed Martin's box-wing concept, the studies unexpectedly underlined the significant benefits that would accrue from flying advanced airliners within the FAA's NextGen airspace system, NASA says.

All too expected, however, is the looming budget squeeze that is forcing the agency to reconsider its ambitions for a flying demonstrator, or scaled test-bed vehicle (STV). Planned as a roughly half-sized test version to provide realistic aero-acoustic data, the STV was to have been based on one of the three preferred concepts, and was penciled in for first flight in 2018. The test program, based at Edwards AFB, Calif., would have helped raise relevant technologies to a development-ready level by 2019 in time for service entry by 2025.

To maximize the value of STV, NASA asked companies for designs with a 10,000-hr., 20-year research life. Initially aimed at flying for the ERA program up until 2020, the Boeing 737-sized

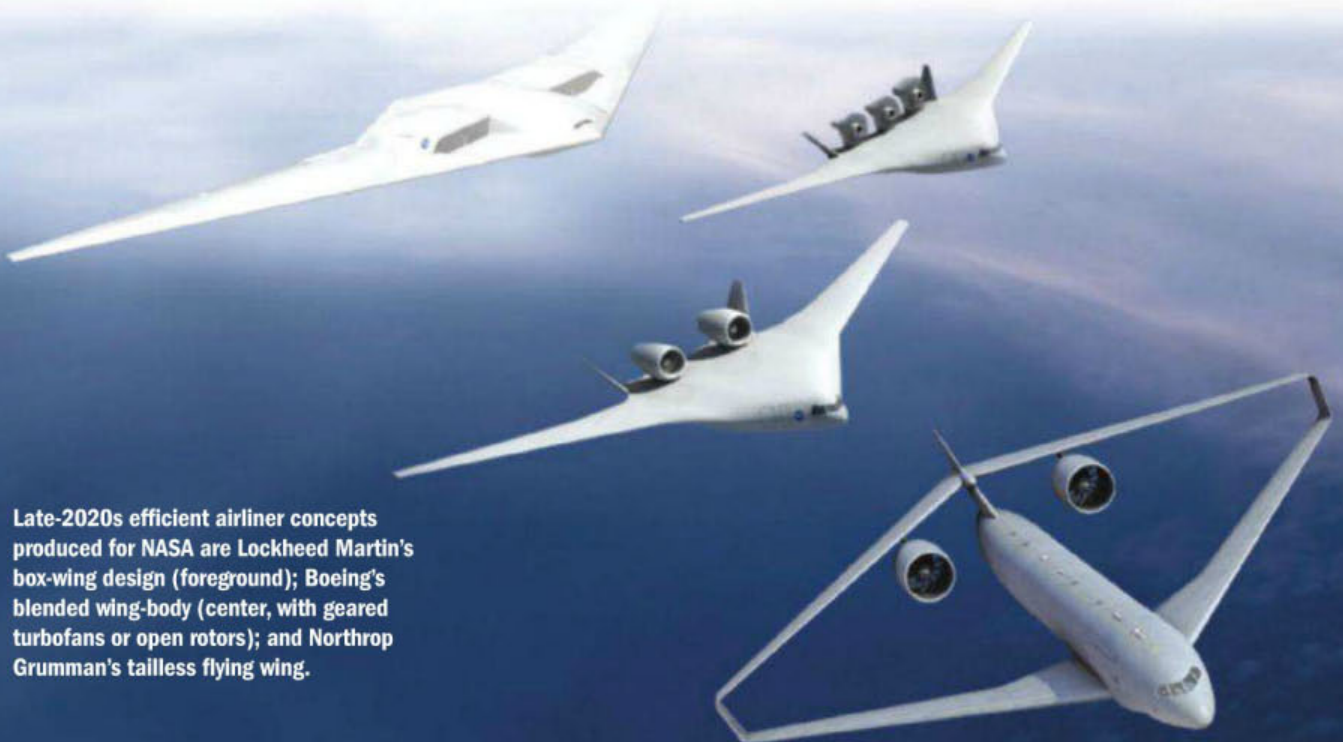
STV was also to be provisioned to fly autonomously as part of plans to test unmanned aircraft systems in national airspace in 2020-25. Following this, a third career was envisioned for the STV as a testbed for ERA's sister effort, the subsonic fixed-wing (SFW) fundamental research program, from 2025-30.

Although details are scant, the ERA program is looking at fresh options to enable some form of STV to proceed. The revised vehicle would likely be less ambitious in both scale and technology to reduce costs, and would potentially involve partnerships with the U.S. Air Force and industry. Unlike the original STV—planned purely as a commercial demonstrator—the revised vehicle could also be a multirole transport technology testbed with military-airlift potential. ERA insiders say the viability of this depends on gaining high-level advocacy within NASA and possibly other government agencies.

Begun in fiscal 2010, the ERA program is at the midway point as plans are completed for a second phase, which will take it through fiscal 2015. Program manager Fayette Collier says progress on the broader aspects of Phase 1 has been substantial and adds that technology road maps and priority targets for Phase 2 will be shaped partly by the results of the vehicle concept studies. NASA has "kicked off a tiger team for planning Phase 2," he

NASA

Late-2020s efficient airliner concepts produced for NASA are Lockheed Martin's box-wing design (foreground); Boeing's blended wing-body (center, with geared turbofans or open rotors); and Northrop Grumman's tailless flying wing.



says, adding that the agency “hopes to get authority to proceed in August.”

Key targets for the program include reducing noise by a cumulative 42 db compared to current Stage 4 levels, cutting emissions of nitrous oxides by 75% on takeoff and landing and 70% in cruise, and slashing fuel consumption by 50% relative to a 1998 technology baseline. Phase I research includes efforts to lower carbon emissions via drag, weight and fuel-burn reductions, and to make airport operations quieter by tackling sources of airframe and propulsion noise. Combustor and fuel-system work is focused on reducing emissions.

Details of the aircraft concepts, and the proposed demonstrators, were revealed at the American Institute of Aeronautics and Astronautics Aerosciences conference in Nashville, Tenn., last week. Each company also was asked to study how their design could best fit into the FAA's NextGen airspace system as well as meet specific performance requirements. For the passenger model, 224 seats, a 50,000-lb. payload and an 8,000-nm range at Mach 0.85 were called for, while the freighter was required to carry a 100,000-lb. payload over a range of 6,500 nm. Each team was also asked to sketch out a 15-year technology maturation road map and propose critical technology demonstrations for the second half of the ERA program.

A Boeing-led team including Pratt & Whitney, Rolls-Royce, the Massachusetts Institute of Technology and Cranfield Aerospace, developed a preferred concept based on a blended wing body (BWB) with twin geared turbofans (GTF). Although a parallel version with triple open-rotor engines showed better fuel burn, it was 8 db noisier than the GTF-powered version. The geared-turbofan design achieved a 52% fuel-burn reduction, beating the target, but it still fell short of NASA's noise goal by realizing only a 34-db reduction.

Boeing ERA program manager John Bonet says: “With an advanced landing gear and slat-noise reduction technology we can meet the goal of -42 db. We noticed that jet noise is so low on the BWB that other sources become dominant. Airframe noise reductions are the only ones that will allow us to meet the noise goals.” In addition, Boeing assumed a 14% fuel-burn benefit from detailed analysis of operating in the NextGen airspace.

Collier says: “There were a number of things I hadn't anticipated, and one was the benefit of [NextGen improve-

ments to the] national airspace system. That's a low-hanging fruit maybe, and confirms a number that came out of our colleagues in the SWF program.”

Boeing's demonstrator, originally planned for assembly in 2017, is a 65%-scale version of the preferred concept. The 149-ft.-span, 83-ft.-long, 21-ft.-high vehicle is configured with twin 24,000-lb.-thrust Pratt & Whitney PW-1000Gs. With a modular, stitched resin-infused composite structure, it would have commercial-off-the-shelf landing gear and a modified business-jet flight-deck with modular electronics. The wing would not be initially be equipped for drag-reducing laminar flow, but “would support spiral development,” says Bonet.

Lockheed Martin's team, which included Rolls-Royce and the Georgia Institute of Technology, proposed an unconventional box-wing concept with two ultra-high-bypass engines suspended from the aft

“I hadn't anticipated the benefit of [NextGen improvements to the] national airspace system”

wing. The 181-ft.-long, 171-ft.-span design is optimized for low drag and reduced fuel burn, says program manager Kenneth Martin. With potential military roles in mind, Lockheed says the design also offers “scalability from tactical to strategic, as well as reduced span for compatibility with the existing infrastructure.”

With an advanced composite structure, the lightweight airframe has a maximum takeoff weight of 365,900 lb. versus the 550,400 lb. of an equivalent 1998 technology-standard aircraft. Fuel weight is similarly reduced, being less than half that of the 250,000 lb. required by the baseline design.

The high-aspect-ratio wing design, the feasibility of which Lockheed acknowledges is wholly dependent on advances in composite structures, provides the capability of making steep, 6-deg. approaches to help contain noise within the airport boundary. Partially because of this, the design achieves -35 db, while engine emissions beat the target by coming in at -89% relative to current Committee on Aviation Environmental Protection (CAEP)/6 standards.

A major surprise of Lockheed Martin's concept is the Rolls-designed UltraFan engine. Conceived as a simple shrouded

fan, the engine has developed into a hybrid between current advanced turbofans and open rotors, says Rolls. With an extremely large 138-144-in.-dia. fan, the engine will be geared and possibly configured with three shafts. Rated at 63,600-lb. takeoff thrust, the UltraFan is encased in a slimline, natural laminar-flow, nacelle without a thrust reverser. Collier says: “We thought we knew where things were going with the engine companies, but the UltraFan concept came out of the blue. That Lockheed had a concept that could handle this was also surprising.”

Further optimizations will include airframe noise-reduction technology including continuous-moldline flaps, landing-gear fairings, slat fillers and shape-memory alloy serrations on the engine bypass-duct exit.

Lockheed's proposed demonstrator is a 50%-scale vehicle, measuring 125 ft. in length and 99 ft. in span with a maximum takeoff weight of 162,500 lb. Powered by unspecified 45,000-lb.-thrust engines, the aircraft would have a C-130J-based cockpit with open-architecture mission systems to support avionics and autonomous system upgrades.

Northrop Grumman's flying-wing concept, proposed by a team including Rolls-Royce, Wyle Laboratories and Iowa State University, is based directly on Northrop's B-2A bomber heritage. The passenger version has a 260-ft. span and a wide centerbody cabin, while the freighter variant has a 230-ft. span. Both are 119 ft. long.

With a flying wing, the cabin layout “drives the centerbody, and the propulsion system is integrated with the flow path and side clearances,” says Northrop Grumman ERA program manager Aaron Drake.

“Where we really get the big benefits is in noise, which is substantially better than the baseline,” says Drake. Noise reduction is predicted to be around -74.7 db, emissions 88% below current levels and fuel burn 41.5% below 1998 levels. “The biggest benefit is in the advanced propulsion, which provides 20% of overall improvement; second is swept-wing laminar flow, which contributes around 8.3%,” he adds. Key design concepts include composite wing, embedded high-bypass engines, advanced inlets as well as maneuver load alleviation and carbon-nanotube data cables.

Northrop's 55%-scale STV design is 143 ft. in span, 65.7 ft. in length, and powered by four General Electric Tech X future regional-jet engines. ☼

Fiscal Flare-Up

ESA braces for difficult negotiations with members, partners as budget talks loom



ESA

AMY SVITAK/PARIS

The most daunting challenges the European Space Agency will face in 2012 could come from the organization's closest partners, and even from within its own ranks.

In November, ministers from ESA's 19 member nations will meet to set priorities for the agency's next multi-year spending plan, tackling tough decisions on major programs that hinge on support from NASA and the European Union while debating projects of special interest to individual ESA member states, many of which are grappling with their own funding woes.

ESA's annual budget—the bulk of which comes from member states and Canada, with 20% derived from the EU—has remained relatively stable during the past few years despite Europe's economic turmoil. But in an increasingly constrained financial environment, ESA is relying more on international partnerships to fund large missions.

With the release of President Barack Obama's fiscal 2013 budget request next month, ESA Director General Jean-Jacques Dordain expects to learn whether NASA can commit funding to ESA's ExoMars program, a flagship mis-

sion that would send robotic probes to the red planet in 2016 and 2018. The U.S. space agency signed on to the campaign as an equal partner in mid-2009, offering more than \$2 billion to ExoMars, including U.S. launch vehicles for both legs of the mission. But that commitment wavered last year with the release of Obama's 2012 spending plan, which pared back budgets for most discretionary agencies, including NASA.

Since then ESA has kept an industrial team in place to continue low-level work through February on the 2016 leg of the mission, which would send a methane-sniffing orbiter equipped with data relay capability and an entry, descent and landing demonstrator to Mars. At the same time, the industrial team is in the process of descope the 2018 campaign in line with NASA's reduced participation, combining designs for a pair of rovers into a single vehicle capable of drilling for and caching soil samples from the Martian surface.

But in the absence of a firm U.S. commitment to launch ExoMars, ESA is now exploring a promising partnership with the Russian space agency Roscosmos. Dordain says such a cooperative en-

deavor could offer science and technology opportunities to Russia in exchange for a launch vehicle in 2016, and could potentially feed into a broader partnership in the area of space exploration.

Also on ESA's plate this year is the agency's financial obligation to NASA to cover common operating costs associated with the International Space Station (ISS). For now, ESA pays these costs through an in-kind contribution

ESA could refuse to launch the first Sentinel satellites for Europe's GMES program without an EU commitment to fund operations beyond mid-2014.

involving Europe's Automated Transfer Vehicle (ATV), a cargo vessel that carries food, water, supplies and fuel to the orbiting outpost. This arrangement expires in 2016, however, potentially leaving ESA on the hook for €150 million (\$192 million) in annual cash payments to NASA through 2020 if the space agencies are unable to cobble together a follow-on arrangement in the interim.

ESA plans to loft the third of five ATV missions in March, though construction of the remaining two ATVs is nearing completion and production has all but stopped. In the meantime, ESA and NASA are discussing possible barter arrangements, including one that would incorporate elements of ATV hardware and systems with the U.S. agency's deep-space Orion crew capsule, currently in development in the U.S. (AW&ST Jan. 9, p. 42). If the project is realized, it could satisfy ESA's operating-cost commitment to NASA while freeing up money for other exploration projects in the near term, says Dordain.

Meanwhile, ESA faces a budgetary stalemate with the EU, an important contributor that committed nearly a quarter of the agency's €4 billion budget this year. An increase of almost €100 million over the EU's 2011 contribution, the funding boost comes on the heels of a decision announced last June by the European Commission (EC) to eliminate funding for a showcase Earth observation program from the EU's multiyear budget.

Since then the EC has been casting about for alternative means to finance nearly €1 billion in annual operations and maintenance costs for Europe's Global Monitoring for Environment and Security (GMES) program outside the multiyear framework. But Dordain, with backing from the ESA Council, is pressuring the EC to guarantee this year that funding for

operations and maintenance of the GMES Sentinel satellites will be available beyond mid-2014. Otherwise, he says, ESA might not launch them.

"Launching the Sentinels into orbit without any money to operate them would be really a crime," he declares. "It would be completely unreasonable to place satellites into orbit and then to switch them off simply because you do not have the money to exploit them. Because today it's true, we do not yet have the money to exploit them. So we ask for a guarantee that there will be someone financing the exploitation of these satellites."

Finally, among its own members, which Dordain says will grow to 20 with the addition of Poland in 2012, ESA will spend the coming months mitigating frictions between competing national

priorities. One looming battle involves a decision to continue funding for the mid-life upgrade of Europe's Ariane 5. Although the upgrade is favored by Germany, which this year surpassed France as ESA's largest contributor, France is pressing for development of a successor rocket, and has anted-up close to €250 million in public bond money for early definition and design studies of a next-generation launch vehicle.

In December, ESA members agreed to maintain a low level of industrial activity for the Ariane 5 Mid-life Evolution (ME), "so that we can be absolutely sure there will be nothing irreversible up until the ministerial at the end of this year," Dordain says. "That said, it is true that for the ministerial this year we are thinking about what might be

best for the next decade when it comes to launchers, and we have begun discussions on that subject."

To this end ESA is consulting the core customer base that will rely on the next generation of European rockets to launch commercial communications satellites in the coming decade.

"They will tell me what they need and then I'll consult the launcher industry to find out how and under what conditions we can meet the needs of European customers," Dordain says. "But I don't want to stop Ariane 5-ME until I know what the results are going to be."

Franco-German tension is also expected as ESA members decide whether to continue subsidies for Arianespace, the European consortium that manages Ariane 5 missions. The Evry, France-

Kick Stage

NASA seeks existing upper stage for first two heavy-lift SLS tests

FRANK MORRING, JR./WASHINGTON

Tight budgets and a tight schedule mean NASA will use an existing upper stage for the first two tests of its Space Launch System (SLS) human-exploration rocket, instead of flying the Orion multi-purpose crew vehicle (MPCV) with the human-rated J-2X engine already in full-scale ground test.

Engineers developing the heavy-lift SLS are polling the worldwide launch industry in search of an upper stage they can use to kick the Orion MPCV on two test flights around the Moon. Under pressure from Congress to build and fly the big new rocket quickly, the U.S. space agency has scheduled an unmanned lunar flyby late in 2017, followed by a lunar-orbital mission with a four-person crew in 2021.

Because of the relatively low performance requirements for those missions, an upper stage already in use probably can fulfill them, says Garry Lyles, NASA's SLS chief engineer.

"We're on what we're calling a capabilities-driven exploration," he says. "So with the budget we have, we've laid out an evolution plan for the launch vehicle that's consistent with the need, and so that budget allows us basically to develop a capability that, with a small stage, a small delta-V with the launch vehicle, we can actually go beyond low Earth orbit with our initial launch vehicle capability."

That 70-metric-ton initial SLS lift capability is to be provided with a core stage powered by surplus RD-25D space shuttle main engines and two copies of the five-segment version of the four-segment shuttle solid-fuel booster originally developed as the first stage for the Ares I crew launch vehicle (AW&ST Nov. 14, 2011, p. 39).

Specifications for an "Interim Cryogenic Propulsion Stage"

(ICPS) published in a Jan. 9 solicitation via the NASA Acquisition Internet Service call for "three engine ignitions to achieve greater than 3,050 [meters per second] delta-V." By comparison, Lyles says, the SLS upper stage to be developed by Boeing will be able to deliver at least twice that velocity change, even after an ascent burn to help get a full-up Orion to low Earth orbit on missions destined to go beyond the Moon.

"This really is just an interim solution that allows us to actually go beyond low Earth orbit with what I would call a minimum launch vehicle capability," says Lyles. "What we actually derived is a set of test flights to demonstrate the spacecraft, the Orion MPCV capability, and we needed a rather small delta-V to do that test-flight demonstration."

For the first two flight tests, NASA wants an upper stage that can push an Orion weighing 24,224 kg (53,404 lb.) to an initial elliptical orbit with an apogee of 900-1,000 nm. It must be able to fire again to circularize that initial orbit, and then send the capsule on its way to the Moon with a "big burn" for trans-lunar injection, according to Lyles.

The payload requirement includes the Orion service module and, on the second mission only, a four-person crew. The first mission would simply swing the unoccupied vehicle around the Moon and return it to Earth for an 11-km/sec. (6.8-mi./sec.) re-entry velocity to test its heat shield. The second would use the service module propulsion system to place the Orion in a high lunar orbit while its systems are checked out, and then use service module propulsion for the return to Earth. That propulsion will be supplied by a modified version of the shuttle's Orbital Maneuvering System engine (AW&ST Jan. 9, p. 40).

While the solicitation is open officially to any upper stage operating today, including solid-fuel and storable-propellant systems, Lyles says it is possible that only cryogenic stages would meet the requirement. That could include an upper stage using hydrocarbon fuel instead of liquid hydrogen, as on the SpaceX Falcon 9.

"Even the kerosene stages use LOX [liquid oxygen], so you can say that's a cryo stage," says Lyles. "We'll take a look at it. It doesn't necessarily have to be a hydrogen stage."

Possible candidates include the upper stages for the Delta

based company has struggled to break even in recent years. The addition of new product offerings, including Europeanized Soyuz rockets and the new Italian Vega launcher, is expected to offset the company's high fixed costs. Despite the uptick in launch tempo, however, Arianespace will probably remain dependent on ESA for €120 million in annual price supports.

Notably, Germany is likely to oppose continued payments to Arianespace, particularly if France refuses to fund Europe's commitment to the ISS through 2020. During ESA's last round of ministerial-level budget negotiations, France begrudgingly agreed to extend space station operations for two years while Germany agreed to continue Ariane subsidies over that same period.

Despite the challenges ahead, ESA's budget is stable, Dordain asserts, and his agency has no complaints.

"We did not suffer too much," he said of Europe's recent economic turmoil, adding that 2011 saw an additional €1 billion in new commitments for a handful of large programs, including the ISS, Ariane 5 and the European Data Relay System. "Economic difficulties did not have any impact on the commitments taken by the member states."

However, Dordain says ESA renegotiated payment plans for some member states struggling to rein in deficits.

"I don't think the space agency is a major cause of the deficits behind the member states, but I also don't want to feed the deficits," he says, adding that some ESA members are having more

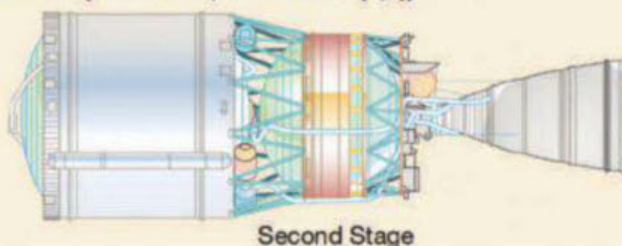
difficulty than others in maintaining their commitments.

"I don't particularly want to name names," he adds. "But it's true that we have, in certain cases, taken specific measures for those member states."

In addition, ESA is trying to lower internal costs and reduce spending. Dordain says ESA is becoming more prudent when budgeting cash reserves for programs, and austerity measures already in effect are expected to lower the annual €685 million operations budget by €175 million by 2015.

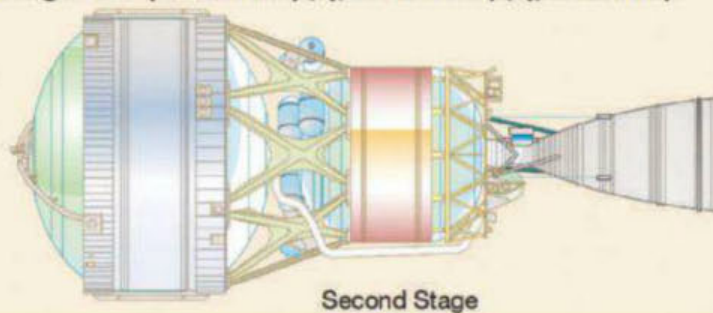
Looking ahead, Dordain says one potential outcome of the November ministerial meeting is a more streamlined organization. "There will be changes as far as how ESA is organized, so that we're a lighter structure," he notes. ☐

4-m Configuration (Delta IV M, Delta IV M+(4,2))



- Modified Delta III second stage
- 4-m-dia LO₂ tank
- Pratt & Whitney RL10B-2 engine

5-m Configuration (Delta IV M+(5,2), Delta IV M+(5,4), Delta IV H)



- 4-m-dia stretched LO₂ tank
- 5-m-dia LH₂ tank
- Pratt & Whitney RL10B-2 engine

IV and Atlas V, Europe's Ariane V, Russian Proton and Zenit vehicles, and perhaps others. Non-U.S. providers might need to team with a U.S. company to meet "Buy American" and other congressional restrictions.

"For this response, I would expect that we have the potential to have some international responses, and we would have to look at how those responses fit in, not only to our acquisition strategy, but we have to talk to the legal folks to make sure we're dotting every *i* and crossing every *t*," says David Beaman, manager of spacecraft and payload integration for SLS at Marshall Space Flight Center.

Beaman says NASA will provide the interfaces between the ICPS, the SLS core stage below it and the Orion service module above. The agency wants to see 10-page responses from industry by Feb. 7 "solely for the purpose of determining whether or not hardware is currently available and if the

Among upper stages that might work on an early version of NASA's Space Launch System are these, developed for the Delta IV.

procurement may be conducted on a competitive or noncompetitive basis."

Other criteria that must be met include an overall stage weight less than

71,400 lb., the ability to be human-rated for the second flight, and the ability to maintain three-axis control in space before it is separated from the Orion.

Meanwhile, NASA plans to continue developing the J-2X that will power the final SLS upper stage. Ground testing of the engine, which is based on the Saturn V upper stage engines, is under way at Stennis Space Center. However, work on the SLS upper stage will await actual requirements for it owing to NASA's "metered" development schedule designed to stay within a flat budget.

"We haven't gotten to the point for laying out how the upper stage itself is going to track," says Lyles. "That will be going through as we go through the negotiations with Boeing." ☐

Coming Together



Final configuration details unveiled as first Lynx parts readied for assembly

GUY NORRIS/NASHVILLE, TENN.

A multibillion-dollar annual market for space tourism and launch services could emerge within the next five years, projects suborbital space-flight hopeful XCOR Aerospace, which aims to begin flight tests of its first Lynx reusable launch vehicle by year-end.

Mojave, Calif.-based XCOR plans to begin final assembly of the Lynx Mark I this month, setting it on course for rocket-powered flights up to altitudes of 200,000 ft. beginning in 2013. The initial vehicle is the development pathfinder for a Mark II production version designed to carry a passenger and experiments to 350,000 ft. from 2014 onward. A Lynx Mark III, aimed at service entry in 2015-16 and configured with an external dorsal payload pod, is also in final design.

The two-seat Lynx is a single-stage, reusable, liquid-rocket-powered vehicle that will take off and land horizontally. Designed to fly to altitudes of 106 km (66 mi.) up to four times per day, the 27.9-ft.-long, 24-ft.-span vehicle is being developed to tap into an "addressable" market for space tourism and launch services worth \$6 billion a year by 2016, according to Andrew Nelson, business development vice president.

Although XCOR is realistic enough to know it will capture only part of this potential business, Nelson says signs of burgeoning demand are increasingly

evident. "After 2017 a sizable part of the global space market will be addressed by new players. Our current estimate is that a \$5-6 billion annual market will be enabled by suborbital reusable launch vehicles. It will be the starting point for a future trillion-dollar market," he asserts.

Of the overall \$6 billion, XCOR estimates the launch services market for people as well as Earth observation, materials science, upper-atmosphere research and microgravity experiments could be worth \$3.3 billion. Passenger traffic alone is estimated at \$0.8 billion, with the bulk of this—\$700 million—coming from space tourism and the balance from government-funded research flights. Payloads are expected to generate \$1.1 billion, while the small-satellite launch business is estimated at \$1.4 billion—with U.S.-based customers buying up to \$500 million of capacity per year.

The first composite fuselage for the Lynx is set to arrive at Mojave from a supplier in South Carolina by the end of January. "This will be put on a mobile test trailer and integrated with the four-engine propulsion system," says Lynx program manager Khaki Rodway McKee. Bids for final assembly of the cockpit pressure vessel and other structures are due to "go out next week," with deliveries due in April or May, she says.

Updating progress at the American

Institute of Aeronautics and Astronautics' Aerospace Sciences meeting here, McKee and Nelson gave first details of design changes made to improve the stability and control of the final configuration. Modifications to the original sharp-nosed shape were made after subsonic wind-tunnel

Wind-tunnel tests led to changes in vertical tails, wing-body fairing and nose.

tests in 2009 at the U.S. Air Force Research Laboratory (AFRL) in Dayton, Ohio, revealed a stubborn post-stall pitch-up condition. Follow-on tests at Marshall Space Flight Center in Huntsville,

Ala., conducted jointly with AFRL, prompted further design refinements to improve stability.

As a result of the changes, which delayed the first flight by two years from a planned 2010, the nose section is now broader and the chine extended farther outboard. The wingtip-mounted vertical tails have also been redesigned with a longer chord and extended ventral fins for added stability. The aft-body housing beneath the engine cluster has also been extended with a deeper, squared-off tail replacing the original faired design.

Design of the liquid-oxygen tank is complete, components have been ordered and the first part—a slosh baffle—has been delivered. "We also selected a commercial-off-the-shelf [COTS] landing gear. It is all in hand, and is being tested with a drop test," says McKee.

Avionics are "mostly COTS" and will be integrated into the airframe around May-June. "We plan to complete full integration of the Lynx by the end of the summer and taxi tests will begin in October-November," she says.

Flight-ready XR-5K18 engines have been built, and test firings of a prototype engine are under way to characterize propellant efficiency. Fuel pumps have been tested to "full Lynx power" and are ready to be integrated, while flight-weight versions of the liquid-oxygen pumps are undergoing bench testing. To date, the pumps have accumulated around 60 min. of test time and are "working up to full-power tests," McKee says. ☐

Jammer Surprise

U.S. Navy aims to save key EW asset by simplifying its procurement plans

DAVID FULGHUM/NAS PATUXENT RIVER, MD.

Sensing continued financial pressure even in the well-protected electronic-warfare domain, the U.S. Navy is slicing through red tape to streamline acquisition of its prized Next Generation Jammer (NGJ).

Savings from a decision to select a single contractor earlier than planned are being estimated in the hundreds of millions of dollars. With help from the offices of the under secretary of defense for acquisition, technology and logistics and the chief of naval operations, the Navy wangled approval to pick a single contractor—instead of two—for the technology development phase of the program that is slated to begin in 2013. The downselect had been planned for the engineering and manufacturing development phase in 2015. The NGJ program is in a technology maturation phase that ends in April.

"The changes we had approved for NGJ will make it more affordable and help us get an early start on some of the integration," says Navy Capt. John Green, chief of the airborne electronic attack (AEA) and EA-6B Prowler program office. "It's huge to be able to avoid completely that kind of cost. With this decision, we are a fully funded program

to develop the NGJ system and integrate it on to the EA-18G Growler."

Streamlining aside, contractors worry about some aspects of the project. They do not think the NGJ will be added to the F-35 Joint Strike Fighter on time, or perhaps at all, because there have been so many delays in getting through the JSF program basics, according to a vice president in one of the competing companies. "There is a concept for making [the F-35] an electronic attack platform, but they can't even think about those sorts of things yet," the official says. That means NGJ production might stretch out considerably, unless the system is adapted to other designs, most likely unmanned platforms with both stealthy and non-stealthy designs, which could be a boon to industry, contractors agree.

"If there are going to be opportunities for conventional [non-stealth] aircraft applications, NGJ is going to present a franchise opportunity for the winner," the industry official says. "It will provide financial backing for [development of further] increased capability."

Meanwhile, operational use of the Growler is gaining some definition.

"There's a discussion of stand-in jam-

ming at closer ranges versus a modified escort [jamming] mission that would require a higher-power, standoff capability," says a second industry executive, also involved in the competition. "The Navy's primary motivation is that the Growlers provide the escort for the F/A-18E/Fs Super Hornets so that they can get close enough [to targets] to operate. But they can't do that without electronic attack support. I wouldn't be surprised if NGJ migrated to unmanned aircraft to keep aircrews safe."

Another concern for some is BAE Systems' place as the incumbent electronic warfare (EW) house.

"We have the F-22 with passive EW, JSF with passive capability initially, but with self-protection built into it, and the latest Saudi Arabian F-15s [with] the digital EW system," the second official says. All were awarded to BAE, so, "You would expect that BAE has a leg up in any competition that would call for inserting a digital EW capability," he says.

Others dismiss the notion, pointing out that BAE's approach on the JSF is quite different than that being considered for the NGJ. Four teams—BAE Systems, ITT/Boeing, Northrop Grumman and Raytheon—are vying for the NGJ contract.

An industry day is scheduled for the week of Jan. 24 to answer questions about the new strategy, and Navy officials hope the early selection of a single contractor will trigger a flurry of subcontracting and new teaming arrangements among the former competitors.

"Leadership from my level up would like to see a lot of teaming," Green says.

Last year, the U.S. Navy's airborne electronic attack fleet—including this EA-18G Growler—engaged simultaneously in operations in Iraq, Afghanistan and Libya, stretching assets to the point where some targets could not be covered.



"Teaming reduces our risk, so we're encouraging industry to team. Going to one vendor sooner encourages them to think that way. It's an additional forcing function that I think will lead industry to the conclusion that the Defense Department has already come to."

A sense of urgency has been added to the NGJ acquisition process as the result of lessons learned during last year's simultaneous electronic-attack operations in three theaters: Libya, Afghanistan and Iraq. The Navy's current AEA capability is dependent on the ag-

ing, out-of-production ALQ-99 jammer pods carried first by the EA-6B Prowler and now by the Growler.

"When we first jumped into [Operation] Odyssey Dawn [over Libya], we were still supporting aircraft in Afghanistan and Iraq—three fronts," Green says. "To spread those dwindling assets out was really a challenge to support, but it was also tough for the warfighter. They had to move assets around or do without in some areas. We just don't have enough ALQ-99 jammer pods and [electronic attack] aircraft, particularly in some

key mission areas, to do everything we needed to do. If ever there was a reason for the Next Generation Jammer, it was validated by the lessons learned from trying to support three fronts."

The decision to pick a single contractor was approved by Defense Department and Navy officials in late December and will be announced late this month at the Naval Air Warfare Center Weapons Division's 42nd annual EW symposium.

"We worked very closely with the assistant secretary of the Navy for research, development and acquisition and the

Strong Signals

Pentagon's massive GPS III program moves forward amid budget crunch

AMY BUTLER/WASHINGTON

Despite its programmatic progress and status as an acquisition reform program for the U.S. Air Force, GPS III—as with any other Pentagon project—is under the microscope and could be subject to funding cuts.

The budget environment at the Pentagon gives new meaning to the term "capture team," which is used to describe the group assigned by a company to win a program. Many contractors say they feel they are in a perpetual "capture team" mode, constantly fighting not only to win programs, but to keep them once they have won the contract.

Despite cohesion in the Pentagon in May 2008 when Lockheed Martin beat Boeing for the \$1.5 billion GPS III development contract, financial pressure on defense spending has prompted some to question the Air Force's plan for modernizing the satellite constellation.

Late last year, defense officials said some budget drills had examined if the project could be scaled back in scope or delayed. One reason, say some GPS experts, is that the satellites in orbit are lasting longer than projected, possibly allowing for a delay to the 2014 launch date for the first GPS III satellite without jeopardizing service. A final budget plan will be unveiled by the Pentagon Feb. 6.

Others question the architectural approach for GPS III. U.S. Marine Corps Gen. (ret.) James Cartwright, until last year the vice chairman of the Joint Chiefs of Staff, says that while precision navigation and timing (PNT) is a critical mission for the military and global economy, pursuing a constellation of large, expensive satellites is overkill. He notes that with the emergence of the L1C signal, which is to be included on the GPS III design, U.S. data will be compatible with that of foreign satellites conducting the same mission. There is an opportunity for the U.S. to build fewer spacecraft and share the burden of responsibility with other countries, such as those in Europe that are pursuing the Galileo system, he says.

Further, Cartwright notes that the threat of high-power jammers drowning out GPS signals is expected to grow far

sooner than the Air Force can field high-power spot beams capable of boosting the GPS signal in a small footprint; this capability was originally planned for a later increment of GPS III satellite. Cartwright says more focus should be put on crafting an integrated PNT architecture that does not solely rely on large satellites, which can be vulnerable to jamming or an anti-satellite attack.

Such a concept would include aircraft payloads that can provide a localized capability if a satellite goes awry or boost signals in a region if operations require it.

Late last year, Boeing also proposed a way for the Pentagon to pull away from its GPS III commitment: It offered an unsolicited proposal to sell more GPS IIF satellites at the current prices. The company hoped to gain more profit from the program, which had not produced the revenue anticipated because of production issues and an early guarantee of a low price. Boeing has since withdrawn the offer, but there is pressure, nonetheless, on Lockheed to make good on its GPS III promises.

Despite its detractors, GPS III may have escaped a major reduction. Lockheed Martin, which won a \$1.5 billion development contract (including the first two satellites) over Boeing nearly three years ago, last week was awarded a \$238 million contract for satellites 3-4, a sign that support for the effort is still strong in the Pentagon. The company is meanwhile pushing hard to find ways to reduce the cost of fielding a constellation. Air Force Space Command chief Gen. William Shelton said last week that the Air Force has opted to take the unusual step of launching two GPS III satellites per booster "where it makes sense."

Lockheed Martin and the United Launch Alliance had proposed "dual launch" for GPS III as a way to save money. In the past, Air Force officials have been reticent to put two critical payloads on one rocket for fear of a launch failure, but a flawless track record by the United Launch Alliance with its Atlas V and Delta IV families has boosted confidence.

The Air Force has looked at implementing the dual-launch concept with space vehicle (SV) 9, though Keoki Jackson, Lockheed Martin's GPS III program director, says the company is postured to do it as soon as SV-5 around 2017. Col. Bernard Gruber, GPS program manager for the Air Force, notes that while fewer launch vehicles must be purchased, the service will have to invest to conduct dual command and control and ensure the launch facilities can process two payloads simultaneously.

Furthermore, in accordance with an Air Force request to re-

chief of naval operations's staff to look at developmental risks and determine what could we do," Green says. "This new approach will save us hundreds of millions [of dollars] . . . for a couple of reasons. During [technology development], we're going to be prototyping and testing those systems. That's also when we do the preliminary design review and make sure all the technologies are mature enough to press into actual full-scale development of the system.

"This is a major change from our original acquisition strategy," Green

notes. "The Defense Department made a significant investment in [technology maturation] and burned down enough technology risk so that we are confident we can select a single team now to build NGJ. The request for proposals is being drafted and we're planning to release it in May."

The NGJ is being designed to provide improved airborne electronic-attack capabilities against a wide variety of radio-frequency targets. Also, the technology is to provide greater electronic agility and precision, both spectrally and spatially.

Roughly, the goal is better interoperability with other systems—such as the U.S. Marine Corps Intrepid Tiger II communications attack system and the U.S. Air Force's miniature air-launched decoy jammer—and an increased capability to deny, degrade and deceive enemy radar and other electronic systems.

Other improvements will be tied to major increases in effective radiated power. They include more powerful jamming as well as much greater standoff ranges from which to engage air defense radars, communications and data links. ☛

duce personnel costs, Lockheed has removed about 150 people from the program to lower expenses as it heads to a "production baseline" manning level, Jackson says.

The company is also trying save the Air Force hundreds of millions of dollars, Jackson says, by using as many common practices, processes and materials as possible for GPS III, which is based on the A2100 bus like the Advanced Extremely High Frequency (AEHF) and Space-Based Infrared System (Sbirs) satellites the Air Force is also buying. Lockheed was criticized for bloated costs in the AEHF and Sbirs programs.

An up-front investment in a GPS III pathfinder satellite, an

engineering and development unit that is being built using actual production processes and tooling but will not be used for operations, is also helping keep costs down, Jackson says. Using this unit, the company has identified "tens of millions of dollars in savings" for the production units to follow at the Denver assembly line. The pathfinder also helped the company identify a signal-timing issue and flight software changes that need to be made before building the first production unit. Eventually, Lockheed will ship the pathfinder to the Air Force to conduct a rehearsal for satellite processing prior to launch, a measure also designed to reduce risk.

Nearly all of the parts for the first production satellite have been delivered, and assembly in Denver will begin in the summer, with the first flight navigation panel expected in the fall. Launch is scheduled for May 2014.

Meanwhile, the Air Force and Office of the Secretary of Defense (OSD) are working out what capability improvements they should plan for future satellites. In 2008, the Air Force laid out a "back-to-basics" block upgrade plan for GPS III, including an A model (the baseline now being built) and B and C models, which would contain incremental upgrades.

They have since scrapped that plan and now refer to a yet-to-be-formed SV9+ plan. OSD is leading this analysis of alternatives. Such capabilities as a high-power spot beam capable of penetrating fierce jamming or multidirectional cross-links had been considered for the later increments, but the study is moving forward with an eye toward affordability.

Some satellites will include a new nuclear-detection system (placed on all GPS satellites to alert of a nuclear blast) and the Distress Alerting Satellite System, an improved emergency beacon locator system.

Meanwhile, Gruber says the program is exploring several ways to introduce additional new capabilities and remove them if a funding shortfall occurs.

The Air Force's GPS constellation now includes 31 operational satellites of varying age and configuration, says Col. Harold Martin, who heads up PNT efforts at Air Force Space Command. In many cases, these spacecraft are far exceeding design expectations. Though they all transmit a "standard signal," some have had failures over the years and are relying on redundant systems. Block IIAs have a design life of seven years, while the IIFs and IIRMs were built to last for at least 12 years. GPS III will be built for 15 years of operation.

Martin says that an analysis of alternatives of architectures to augment the GPS system if spacecraft malfunction or are subject to an attack should wrap up later this year. ☛



The GPS III pathfinder unit, designed not for operations but as a prototype for the production process, was sent in December to Lockheed's Denver facility, where the remainder of the GPS III satellites will be built.

LOCKHEED MARTIN

Bienvenido, Texan

Mexico's air force turns to the Hawker Beechcraft T-6 even as the U.S. Air Force turns away.



Hawker Beechcraft receives good news from south of the border

KERRY LYNCH and MICHAEL BRUNO/WASHINGTON

The U.S. Air Force might be turning away from Hawker Beechcraft's T-6 trainer, but Mexico is rolling out the red carpet and company representatives hope the move could lead to a long relationship for the embattled Wichita manufacturer south of the border.

The Mexican air force early this year will begin replacing its aging PC-7 training fleet with the first of six Hawker Beechcraft T-6C+ trainers. The initial contract, announced Jan. 9, comes as the company sues the U.S. Air Force over its handling of the Light Air Support (LAS) contract (*AW&ST* Jan. 2, p. 31).

Hawker Beechcraft had offered the AT-6—a more powerful version of its T-6 Texan II trainer—for the 20-aircraft, \$355 million LAS contract, but was shut out in favor of a Super Tucano variant proposed by a Sierra Nevada/Embraer team. Denied its bid protest, Hawker is now suing the service for unfair contracting practices; the U.S. Air Force on Jan. 4 issued a stop-work order to the Super Tucano team as the court fight plays out.

Terms of the Mexican air force contract were not disclosed, but Hawker Beechcraft believes the initial sale could lead to more Mexican business.

"We see this sale of six aircraft as just the beginning of a long and productive relationship with the [Mexican air force],"

Jim Maslowski, president of Hawker's defense unit, said in announcing the award.

The T-6C+, which is based on the Beech/Pilatus PC-9 Mk. II, will be fitted to carry external stores and practice weapons for training. The aircraft will incorporate a head-up display, up-front control panel and glass cockpit based on the Esterline CMC Cockpit 4000 avionics suite.

The T-6, first delivered for the U.S. Air Force and Navy for the Joint Primary Aircraft Training System (Jpats) program beginning in 2000, has since been selected for training, navigation and weapons systems use in nearly 20 countries.

While a smaller initial contract than the LAS, the Mexican air force order will provide a much-needed boost to the company, which has relied on its military business to help stem the mounting losses from its business and general aviation segment. Hawker Beechcraft has posted cumulative operating losses of nearly \$1 billion since 2009, and its core market of business jets is not expected to rebound significantly until at least 2013.

Despite the LAS stop-work, the Air Force is sticking by its controversial award. A temporary restraining order was likely to come that would have prevented the work, and USAF issued its

stop-work order in an effort to expedite the process of sorting out Hawker's claims.

"The competition and source-selection evaluation were fair, open and transparent," according to an Air Force spokesman, Lt. Col. Jack Miller. "The Air Force is confident in the merits of its contract award decision and anticipates that the litigation will be quickly resolved."

Another Air Force official says the service's paramount concern is fielding the first LAS aircraft next year, with the last of 20 to be delivered in 2014.

In addition to its lawsuit against the armed service, Hawker Beechcraft is hoping to build political pressure on lawmakers and the Pentagon to force USAF to revisit its LAS award to the Sierra Nevada Corp. team. A letter-writing campaign was launched that asked customers and other supporters to contact their local congressional representatives and the Pentagon. As a result,

more than 5,000 letters had been sent to Congress and the Defense Department by Jan. 6, according to the company.

While Hawker Beechcraft's trainer and attack aircraft sales are ongoing, the company's largest contract, the Jpats program, is nearly complete. The Navy is approaching the end of its initial procurement target set in 2000 for the company's T-6 Texan II single turboprop, with an estimated purchase of 36 units in 2012 and 24 in 2013. The Air Force had increased its delivery of the aircraft in fiscal 2004-07 and has not scheduled any future deliveries.

According to Forecast International, manufacturers of military fixed-wing trainers are forecast to produce 1,675 aircraft worth \$21 billion during the next decade. But of those, 984 will be jet-powered and will be worth \$15.3 billion, and the demand for turboprop trainers could be weaker than widely expected this decade.

Once the Jpats program ends, the Pentagon will be out of the turboprop market, and other nations cannot replace this demand, Forecast's analysts say. Annual production in the turboprop segment will drop "precipitously" in 2016, from an average of 100 deliveries per year in 2011-15 to only 35-40 trainers for the remainder of the decade. ☐

HAWKER BEECHCRAFT

Stalking Horse

South Korea's MUAV program could be a blind for the country's intent to opt for Global Hawks

BRADLEY PERRETT/BEIJING

With little publicity, South Korean engineers are working on the largest and most complicated aircraft their country has built independently, an unmanned surveillance aircraft called MUAV. From the scanty information available, they seem to have a technically successful program on their hands, one that augurs well for their ambitious national industry. The problem is that it might turn out to be a fiscal failure.

The first flight for the MUAV is now due in April, delayed from November because testing revealed a need to strengthen some structures. Following test flights, the design should be revised and then a production order issued for an undisclosed number of operational aircraft—except that the government has said that the MUAV will not be needed if, as planned, South Korea buys the Northrop Grumman RQ-4 Global Hawk. It appears that the MUAV is being kept alive only as a means of applying competitive pressure on Northrop Grumman.

And while development of the bare aircraft has gone smoothly, it is not clear that the program has made nearly as much progress in integrating the sensor suite planned for the MUAV. Under the leadership of the Agency for Defense Development, engineers mainly from Korean Air Aerospace have done the detailed design of the aircraft. The company has also built three prototypes.

The MUAV is the most ambitious of a range of unmanned surveillance aircraft South Korea is developing. The country is also working on a demonstrator for a combat drone to be fielded late in the next decade (AW&ST Oct. 24, 2011, p. 34).

The first MUAV prototype was completed in May 2011 at the Busan works of Korean Air Aerospace. No photographs have been released, although concept drawings show the engine mounted not only aft, as usual, but above the fuselage to keep the propeller clear of the ground, and with a stub ventral surface to protect the propeller against over-rotation. Like other pilotless surveillance aircraft the MUAV has a radome, shaped and po-

sitioned like a cockpit canopy, evidently covering a large satellite communications antenna.

An important program objective, apart from gaining developmental and operational experience with a large reconnaissance drone, was advancing South Korea's manufacturing technology. But the U.S. government declined to allow use of some technology that the South Korean developers had requested. This included structural technology, notably automatic



The MUAV design has changed greatly since this concept drawing was prepared early in the program. The design now has a radar in the bottom of the fuselage.

tape-laying for composites, says one person working on the program. The aircraft is mainly metal, but has a mostly composite wing. The structure around the V tail needed strengthening, testing revealed. Beefing up the structure is fairly straightforward and the problem is not expected to influence the program much.

The project survived possible cancellation by the defense ministry early in 2011 but the defense minister said in September that the country needed either the MUAV or a higher-flying aircraft, but not both. The competitor is the Global Hawk, the purchase of four of which is proposed, although the country is also formally assessing RQ-4 competitors that are still in development. In response, MUAV program officials have argued for canceling the proposed order for Global Hawks and pouring the money instead into the domestic aircraft.

If fielded, the MUAV will have electro-

optical and infrared cameras and a synthetic aperture radar, an official told local media in September. The radar range is stated as 200 km (124 mi.), though the aircraft may have a horizon of twice that distance. The radar is mounted below the body just ahead of the wing. More than a 200-km radar range would be needed to keep the MUAV safe from North Korea's S-200 (SA-5) surface-to-air missiles.

The design has had significant changes over the past year, including alterations in its electronics fit, materials and engine. The turboprop engine for the MUAV is not known, but it is likely to be at least in the class of the 670-kw (900-hp) Honeywell TPE331-10GD. A version of the Pratt & Whitney Canada PT6 should be a candidate. Although an early concept showed what appeared to be weapons, the aircraft has been designed with-

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY

out provision for them. Even if arming the aircraft later were considered, it would be a low priority.

The MUAV's span is about 27 meters (89 ft.), according to a person familiar with the design. Early in the program, the span was expected to be about 25 meters and the maximum takeoff weight 6.5 metric

tons (14,300 lb.). As large as the span may seem, it is much smaller than that of the Global Hawk, which in its 14.6-ton RQ-4B version spans 39.8 meters. The General Atomics MQ-9 Reaper has a span of 20.1 meters and a maximum takeoff weight of 4.8 tons.

Maximum altitude for the MUAV is officially given as 10,000 meters (33,000 ft.), but the designers are aiming at 14,000 meters. They appear to have lowered their target from an original ceiling of 15,000 meters, about the same as the MQ-9's. The RQ-4 flies as high as 18,300 meters, giving it greater surveillance range and steeper grazing angles for looking behind obstacles, such as hills.

Development of the MUAV follows South Korea's fielding of several small homegrown surveillance drones and is being done in parallel with work on several new models, including the KUS-15, which is of about the size of the 1-met-

ric-ton MQ-1B Predator. The Agency for Defense Development—home of much of South Korea's defense engineering expertise—has spent 200 billion won (\$170 million) on MUAV since 2006, according to a report to parliament. The agency paid the Korea Advanced Institute for Science and Technology to develop the

automatic takeoff and landing (ATOL) system, which is a particular challenge for an aircraft with such a long and slender wing. "Due to its high aspect ratio and long wing span, the ATOL system has to consider aerodynamic and structural characteristics such as aeroservoelasticity (ASE) and limits of

maneuverability in roll during the landing and take-off," the institute says.

According to a 2005 policy paper in which the program was proposed, development would account for most of 445 billion won of non-recurring costs. Service entry was then set for 2016-20, but by 2008 had been brought forward to 2013. ☛

Repeat Offender

Watchkeeper again fails to achieve Afghanistan delivery date

ROBERT WALL/LONDON

Tired of cost and schedule overruns, the U.K. Defense Ministry is applying top-level oversight on troubled programs to force companies to cure persistent ills. Unfortunately, in one of the first test cases—the Watchkeeper unmanned aircraft program—that strategy has not panned out.

The Thales-led Watchkeeper development, begun in 2005, is the ministry's flagship unmanned aircraft development program. Having acquired many off-the-shelf systems—such as the Desert Hawk small UAV or Reaper medium-altitude, long-endurance system—Watchkeeper was more ambitious; Thales would take the Elbit Hermes 450 and significantly change its systems and architecture to deliver a far more capable system for the British army.

The development has repeatedly logged schedule setbacks. Last year, as part of a wider push to reform defense acquisition management, the government

established the Major Projects Review Board (MPRB) to scrutinize its top acquisition efforts; Watchkeeper was among the first to be put under this microscope. The board, chaired by the defense secretary, was created to ensure that large acquisition programs receive proper attention and to detect development problems earlier in the process.

If problems are found and it is determined that no progress is being made to address those ills, the program would be listed as a "project of concern," a category created last year as part of the reform program. Then-Defense Secretary Liam Fox, who set up the process as part of a wider reform agenda, argued that naming and shaming companies would compel them to rectify adverse situations quickly because shareholders would be alerted to problems and presumably apply pressure.

Watchkeeper, during its review, managed to escape being put on the list, but

the ministry warned at the time that "given the importance of delivering this capability to Afghanistan and the residual risk, the MPRB will look at it again around the turn of the year."

The next major milestone for Watchkeeper after the review was to ship the first equipment to Afghanistan, which was slated for December. However, a ministry official notes that "Watchkeeper has not yet been delivered." No reason for the delay was given, nor was a precise date set on when the equipment will now make it into the hands of deployed forces. "Watchkeeper will deploy to theater later this year," the official notes.

The military was hoping to have sufficient numbers of Watchkeepers fielded to sustain three orbits in April, with the number of orbits to reach six in October. A total of 54 Watchkeepers are being bought under the current procurement agenda.

The in-service date for the program was initially planned for June 2010 and, according to the U.K. National Audit Office, it is one of the nation's most delayed development programs.

Fielding Watchkeeper would allow the ministry to start drawing down Hermes 450 unmanned aircraft being used on a fee-for-service basis in Afghanistan. The service contract has already been extended due to earlier delays.

The development is not just a setback for the government's reform drive. Thales CEO Luc Vigneron made elimination of program delays a priority when he took the helm three years ago. When the program suffered its most recent overrun, Thales had to absorb the extra costs.

The latest delay comes as the Defense Ministry is widening its review of programs beyond the small number that were scrutinized in 2011.

The Watchkeeper delay also comes as British military officials note that the need for intelligence, surveillance and reconnaissance assets in Afghanistan will actually increase soon in light of the diminution of troop levels due to the planned pullout of forces in 2014. ☛

The British army has been relying on Hermes 450s for surveillance in Afghanistan as it awaits the long-delayed Watchkeeper.



NextGen Network

Industry teams compete for FAA's major air-ground communications upgrade

ADRIAN SCHOFIELD

Almost since the beginning of air traffic control in the U.S., the interaction between pilots and controllers has been based on talking via radio. But voice communication, like radar, is about to be overtaken by new technology.

The FAA aims to establish a data communications network to shift most controller-pilot messages—more than 1.2 million a day—to a digital text-based system. This will be one of the key enablers of the NextGen modernization effort, which requires aircraft to fly satellite-based procedures that are too complex for current ATC communications technology.

The agency's Data Communications (Data Comm) program will make it quicker for controllers to send and revise clearances, as well as reducing frequency congestion and allowing the transmission of complex flight profiles. Departure clearances and other instructions will be uploaded directly to an aircraft's flight management system (FMS), which will further streamline the process and cut error rates associated with manual entry.

Departure clearance procedures at busy airports like Miami International will be streamlined under the FAA's Data Comm program.

Most of the major names in the aerospace industry are involved in bidding for the Data Communications Integrated Services (DCIS) contract, which will likely be one of the largest NextGen awards to date. The winning team will establish and operate the Data Comm network for up to 17 years, with the FAA paying a fee for the service. Contract award is expected in June.

Three teams have submitted bids to the agency for DCIS. The teams are led by Harris Corp., ITT Exelis and Lockheed Martin. None is revealing its bid amount yet.

Airlines have put their support behind the DCIS effort, says Ed Sayadian, vice president of air traffic management for ITT Exelis. "Nobody is arguing with the

benefits this program will provide when fully deployed," he says.

Peter Challan, vice president of government relations for Harris, says air carriers regard Data Comm as one of the NextGen initiatives that has the potential for significant user benefits, and it is backed by a strong business case. In addition, the FAA is including equipage funding in the contract to help deployment reach a "tipping point" in the airline fleet, he says.

Data Comm has been identified as one of the "foundational" NextGen programs, says Diane DeSua, Lockheed Martin's director of NextGen strategy. "This is the only way we can move to trajectory-based operations," DeSua stresses that this will be one of the most complex programs the FAA has undertaken, with a network linking to a wide range of ATC platforms, as well as cockpit avionics. "It's a really large systems integration job," she says.

The FAA, meanwhile, sees Data Comm as "necessary for the transition from a voice-based air traffic control communications system to data-centric NextGen, and [it will] serve as the primary enabler for many of the NextGen operational improvements," says an FAA spokesman. The agency expects Data Comm will improve controller productivity and reduce workload by automating the delivery of routine clearances.

Data communication links for ATC are already used extensively on oceanic routes in the U.S. and elsewhere, and Eurocontrol uses them in the upper airspace it controls in Western Europe. The U.S. had an earlier program called Controller-Pilot Data Link Communications, but it was shelved in 2003.

The DCIS acquisition effort has been underway for more than two years, and the FAA "has spent a lot of time with the contractor community coming up with a viable, executable program," says Challan.

The first stage of deployment, to be completed from 2015-18, will cover air-



ERIK SIMONSEN

port data communication services. This step will allow departure clearances to be streamlined. Five initial sites will be selected for testing, and the system will be deployed eventually to 73 airport towers.

Improving the departure clearance process will be one of the major benefits of the Data Comm program, says Sayadian. It will mean controllers can quickly revise multiple clearances to reroute aircraft during severe weather.

The Data Comm program will be expanded to en route centers from 2018-23, requiring a range of additional messages covering everything from altitude and route changes to tailored arrivals. Eventually the system will be

applications used by airlines for sending digital messages to pilots.

A second component of the program covers airline equipage. The FAA has earmarked \$80 million to be used to help carriers upgrade aircraft to use the service. The bidders must propose how that sum can provide incentives for at least 1,900 aircraft to be equipped for data communications.

While newer aircraft are capable of handling data communications, older fleets will need avionics upgrades. There will be no mandate for airlines to equip, although all are likely to participate, says DeSua.

The winning bidder will also have to

Baseline 2 is being developed, and this will allow the more complex messages to be uploaded to the FMS.

One question that the FAA must still answer is whether Data Comm will support ATN Baseline 1 in addition to Baseline 2. Baseline 1 is regarded as an interim solution, and is the standard being used in the Link 2000+ data link program in Europe. Boeing and Airbus are among those recommending that the FAA does not include Baseline 1, as it would divert resources from the development of Baseline 2.

Because of the huge scope of DCIS, ITT has brought in expertise from all facets of the industry in its bid team, Sayadian says. ITT is the prime contractor for the FAA's Automatic Dependent Surveillance-Broadcast (ADS-B) program, which also involves the establishment of a nationwide network.

Included in the ITT team are air carriers United Airlines, JetBlue Airways and UPS, which have provided perspective on equipage and operations. Rockwell Collins contributes avionics expertise. Among the other team mem-

Data Comm will allow advanced NextGen flight procedures, such as 4-D trajectories, to be transmitted to the cockpit.

bers are Airbus, Raytheon, General Dynamics, Aerospace Engineering, AT&T, Airtel, Northrop Grumman, CSC, Saab Sensis, Nav Canada and Nexa Capital Partners.

Harris Corp. has not yet released its full team list. However, the company says it includes Arinc, which is one of the prospective commercial network providers. Also in this team are GE Aviation, which will provide avionics expertise, and Thales. There is also a major airline partner, but Harris is not yet revealing which one.

The DCIS program "falls right in the wheelhouse" of Harris, says Chalan. This is due to the FAA activities in which the company is already involved, particularly the FAA Telecommunications Infrastructure program.

The Lockheed Martin team includes Boeing, Level 3 and Telcordia. Lockheed is also not yet naming its major airline partners. DeSua notes that Lockheed was the prime contractor for the FAA's oceanic ATC system, which is the only system in the U.S. that currently uses controller-pilot data links. Boeing has already used data communications in various demonstration programs. 



used to send the complex information required for the four-dimensional trajectories that are a key NextGen element. A schedule for data communications to be applied in terminal airspace has yet to be determined.

The FAA has stipulated that DCIS will use the air-ground communication networks of Arinc and SITA, to take advantage of existing infrastructure. The winning bidder must strike a separate deal with one or both of these two companies, and will work with them to add to their networks where necessary. An advantage of this approach is that it avoids the need for separate aircraft equipage for Data Comm and existing

supply integration and engineering support to the FAA as the system is rolled out. The agency will need to upgrade tower and en route ATC systems to align with Data Comm.

The service will initially use the Future Air Navigation System 1/A (FANS 1/A) standard via VHF Digital Link Mode 2, since FANS 1/A is already widely used for airline operations and for oceanic data communications. While FANS 1/A messages can be uploaded to the FMS, this standard cannot handle the more-complex messages needed for advanced procedures such as 4-D trajectories. A standard known as Aeronautical Telecommunication Network (ATN)

Joyful Progress

Avic Aircraft is forcing itself to learn about after-sales service

BRADLEY PERRETT/BEIJING

In early 2008, Avic I, as it was called then, announced it was setting up an airline that would buy its regional airliners, a move that had many industry watchers perplexed. To any trenchant doubter of China's future in civil aeronautics, it must have seemed that the product—the 50-60-seat MA60 turboprop—was so uncompetitive that Avic I could only sell it to itself.

But that was not the point of setting up Joy Airlines, as the carrier was called. Rather, Avic I had recognized that it had a lot to learn about customer service, and decided that it could learn faster if it owned a demanding customer—indeed, a customer that would be under orders to be demanding.

Almost four years later, the manufacturer and at least one of its independent customers believe it has made substantial improvements in keeping airlines satisfied. The importance lies not so much in the boost to MA60 sales as in the reputation and expertise that the company is building for future projects,

notably the MA700, a larger turboprop, new details of which are now available.

It is hard to judge how much more progress in customer service the manufacturer must make—and it would be surprising if a state supplier to a Communist military had thoroughly rid itself of bureaucratic inertia. But if China succeeds in its ambition to build a broad range of globally competitive civil aircraft, then the Joy Air experience will probably be seen as a turning point: the moment when Avic learned to answer the phone, listen earnestly, mobilize expertise, dispatch parts and get the customer's aircraft back in the air. Quickly.

Advice from Joy is also helping in the preliminary design of the MA60's proposed successor, the MA700, says an industry executive. Meanwhile, the latest version of the MA60, the MA600, is receiving 21 design changes, based on customers' input. Under the 2008-09 reorganization of the Chinese aeronautics industry, these entities are now products of Avic Aircraft, a large-airplane subsid-

iary of Avic whose core is Xian Aircraft.

The MA700 is now intended to go into service in 2016, unsurprisingly slipping by one year from the 2015 objective that the company was sticking to last year. The business case is being built on producing 800 units, says another industry executive.

The targeted cut in direct operating costs is 10%, but it is not clear whether that comparison is being made with the ATR 72 or the Bombardier Q400, whose performance and therefore economics are different. While achieving the cost saving will, as usual, depend crucially on new engines, the aircraft will probably also have a key price advantage, thanks to a combination of low labor and capital costs, subsidies and, potentially, a simple structural design.

Flight controls will be fly-by-wire, and the aircraft will feature automatic noise and vibration reduction, the company tells *International Aviation*, the Chinese partner magazine of *Aviation Week & Space Technology*. The aircraft will be modular and its speed high. Engine companies, including Pratt & Whitney Canada, have been pitching powerful turboshafts for the MA700, with the idea that even if operators routinely choose to save fuel by flying at moderate speeds, a crew running behind schedule will have the option of opening the throttles. The 5,600-kw GE38 from the Sikorsky CH-53K was considered to be an option, but

Avic Aircraft is refining the design of the MA600 based on customer input.



ZHANG XIAOLI/FEATURE CHINA-NEWS.COM

a third industry executive says that, because it is a U.S. military engine, it cannot be offered, even for a completely civil Chinese aircraft, for fear of technology transfer during integration.

Indeed, the MA700 and probably most of China's blossoming civil aircraft projects are raising a challenge to the Western embargo on supplying arms and arms components to China.

The MA700, whose Xian-built airframe will almost certainly be fitted with Western engines and systems, has clear military uses: most obviously as a trans-

time at which a large team began working on the preliminary design. It is not launched in the conventional Western sense however, since it awaits approval for full-scale development from the central government. That is now expected this year.

The first version will be one that seats more than 70, meaning 72 or 76, since the cross-section will allow four abreast. After that, Avic Aircraft will develop a stretched version that officials have previously said will seat more than 90—presumably 92 or 96. A business transport

well as the old, it aims for orders for 25-35 aircraft a year, with deliveries of 10-25. In the following decade, it banks on booking orders for 50-70 aircraft a year and delivering at least 40 a year.

So far, sales have been scattered across China, Southeast Asia, Africa and South America. Program officials see Africa as the best prospect for further orders. The MA60 (and MA600), as derivatives of a Soviet aircraft, cannot obtain Western endorsement of their Chinese certification and are therefore not sellable in developed countries. The MA700, like all new Chinese civil aircraft, is to have certification accepted in the West.

Comac has copied Avic Aircraft's tactic of owning an airline to learn how to support an airline. Two years ago it agreed to take part in the recapitalization of a carrier that is now called Chengdu Airlines, which will operate ARJ21s.

According to one Avic official, in 2008 the company had to face the unpleasant fact that it was having trouble selling its products even in China. It accepted that its dearth of after-sales service experience was a key problem; hence the idea of setting up Joy Air. To further speed up the process of learning, the new carrier was set up in association with China Eastern Airlines, which assigned some of its people to run it. They came with experience and expectations developed from dealing with Airbus and Boeing, so the demands that they put on Avic Aircraft simply reflected the service quality that they—and presumably managers of potential customers—were used to.

Joy Air was based at Xian so communications between the carrier and its deliberately demanding customer could be easier.

It is easy for Avic Aircraft to claim to be delivering better service. More tellingly, customer OK Airways, which should have no reason to ease pressure on its supplier, says there has been a change in service attitude at the manufacturer. The airline's general manager of maintenance, Zhang Weihong, told an MA60 customers conference that Xian Aircraft had stopped passively waiting for the airline to demand that something be fixed; now the manufacturer was actively approaching the carrier.

The service team has been doubled to more than 200 employees—three for every aircraft in operation. The service center now runs continuously. Another Avic official says that the next step is to set up regional spare parts depots, probably beginning in Southeast Asia. 



Avic Aircraft is also listening to Joy Airlines as it designs the MA700, which should be launched this year.

port, but potentially in a wide variety of surveillance roles. Avic Aircraft says it will develop freight versions with side and rear doors. A 5,000-kw-class turboshaft unveiled by Avic Engine in September is probably intended as a substitute for a Western engine in a military version, but it would be surprising to see the aircraft thoroughly reengineered to expunge Western electronics, flight controls, fuel equipment, cockpit displays and so on.

Already, some MA60s, with Pratt & Whitney Canada engines and Western systems, have been bought by the Chinese military, says an industry official. A sibling company proposes a transport with about 30 seats; again, military uses are obvious, including, potentially, operation from aircraft carriers in various roles.

Internally, the MA700 program is regarded as having been launched in May 2009, which probably means the

version is also planned.

To Western executives, Avic Aircraft appears to be moving at a suitably modest pace—first developing the MA60 as a derivative of the Antonov An-24, then moving onto the larger but similar and Western-certificated MA700—in contrast to Comac, which with the C919 is trying to sprint almost as soon as it has learned to walk, or even before, since the first Chinese jet—the ARJ21—is not expected to be certified until late this year.

Avic Aircraft's Xian unit has taken orders for 112 MA60s and MA600s so far, with "intended orders" covering a further 71. Customers have received 66 aircraft.

Xian Aircraft has set out program targets for its turboprop range, including the MA700. According to this plan, in 2011-15 the company will have a global marketing initiative in place that would take in 15-25 aircraft orders a year, while delivering 10-15. The backlog would therefore rise. In 2016-20, offering the new aircraft as

Come About

Development, life-cycle costs and tight budgets are triangulating on destroyer-based effort

MICHAEL FABEY/WASHINGTON

The future of U.S.-led missile defense around the world could come down to hard decisions about two ships that were never intended for the mission.

As defense budgets tighten, questions continue to mount about the U.S. Navy's decision to truncate the fleet of DDG-1000 Zumwalt-class destroyers to three ships and restart the legacy DDG-51 Arleigh Burke line. Neither ship was originally envisioned for a national missile defense mission, but both lie at the heart of looming budget decisions whose ramifications could affect the proposed Phased Adaptive Approach (PAA) and Air and Missile Defense Radar (AMDR) systems.

An Aviation Week Intelligence Network (AWIN) examination since last summer into the Navy's destroyer programs and accompanying combat sys-

The Navy's plan to build improved Arleigh Burke-class destroyers with advanced radars for expanded missile defense is in jeopardy because of budget concerns and mounting maintenance bills.

tems and missile defense applications indicates the Navy may have to overhaul \$121.8 billion worth of plans.

Besides affecting shipbuilding, renewed uncertainty about these destroyer programs also puts at risk the Obama administration's PAA plan to protect U.S. allies from missile attacks, starting in Europe later this decade and possibly being repeated in Asia-Pacific.

After earlier Aviation Week reporting, the Government Accountability Office (GAO) started its own investigation into Navy decisions about the fleet, and that report is due to be published as soon as this month.

The DDG-51 restart is needed, the Navy says, to fulfill the service's ballistic missile defense (BMD) mission obligations, which envision the destroyers equipped with Lockheed Martin's venerable Aegis Combat System, ready to take down enemy targets with Raytheon's Standard Missile-3 interceptor.

But some defense analysts believe the GAO will recommend that the Navy ditch its current plan to buy more Burkes—including redesigned models in years to come—and build more Zumwalts instead because the DDG-1000s will offer greater growth potential for more weapons and lower life-cycle costs.

Regardless, the Navy has provided contradictory public statements about which destroyers they need and why. Neither Burkes nor Zumwalts were designed specifically for BMD, but some Navy brass have asserted that the DDG-1000s could not accommodate Standard Missiles. Yet other Navy documents, analysts and industry sources do not support that conclusion.

Moreover, the current fleet of destroyers and their Aegis systems needed for missile defense are a maintenance headache, to say the least. Just to get the vessels and systems shipshape could cost the price of an entire new destroyer, and an additional untold sum of money might be needed to keep the Burkes and their radar systems in good working order through coming decades.

It is this huge repair bill, plus mounting maintenance costs and the budgetary battles being waged on Capitol Hill, that led naval analysts to believe it is unlikely the Navy will be able to afford the proposed next-generation Burkes, planned improvements to the ships' Aegis combat systems or the AMDR, the supposed linchpin for maritime-based BMD.

Still, a course correction also could be a blow to the Navy, which has been bolstered in recent years through its BMD role. "The Navy is becoming the centerpiece of national missile defense," says Lexington Institute defense analyst Loren Thompson. "But it can't afford to stick with the program of record."

At particular risk is the Navy's proposed AMDR, with its estimated price tag of \$15.7 billion. "There doesn't seem to



U.S. MISSILE DEFENSE AGENCY

be enough money to develop it," says Norman Friedman, an author on naval issues.

Navy officials say forgoing AMDR and relying on Aegis is simply not an option because the threats are too complex and dangerous. Further, they say, costs are coming down on the new proposed radar system.

But a cursory analysis shows the service could save up to \$14.3 billion if the Navy bought DDG-1000s in the coming decades instead of newly designed variants of the DDG-51s, assuming further major programmatic changes are not planned.

Ironically, the systems' potentially high price tag can be linked partly to the starts, stops and sudden shifts in shipbuilding plans during last decade. Debate over these issues should gather steam as soon as this month with the GAO report, followed by the president's fiscal 2013 request and congressional hearings through the spring. ☛

Editor's note: This article is an abstract of a five-part series based on data analysis and interviews with Navy and contractor program officials, defense analysts, service and Pentagon leaders, testing officials and others associated with the destroyer programs. The full "Come About" series is available to AWIN subscribers online.

SPECTRAL COMBAT

New technologies must be paired with the proper problems

DAVID FULGHUM/WASHINGTON

The weapons and new technologies of future wars are going to involve fewer things that explode. In fact, weapons effects will often be so quick and insidious that victims will be left grasping for clues—perhaps literally in the dark—as to what just happened to them.

Some of those key technologies will include directed energy—such as lasers and high-power microwave (HPM) weapons—and artificial brains that can train themselves to manage dangerous battlefield jobs.

“It’s all about saving money,” says Mike Booen, Raytheon’s vice president for advanced security and directed-energy systems. “If you can defeat mortars and Kayusha [artillery rockets] with a laser, you can relieve yourself of the big logistics tail required to bring ammunition to the front and having to maintain the guns. By using the speed of light, you can beat the simultaneity problem [of lots of incoming projectiles] that you face with kinetic weapons.”

Finding the right problem to solve is also critical. Raytheon grafted a fiber laser to its AIM-9X missile’s pointer-track subsystem. That proved to researchers that they could take a device off a fixed-price production line and add a laser that has been validated in the medical and precision measurement markets.

“You take the risk down to zero for integrating [a small, lightweight] directed infrared countermeasures [Dircm] system that can go on the U.S. Army’s small-

est helicopters,” says Booen. “That’s a great application of the technology,” as opposed to putting a high-energy laser on a large airborne platform full of toxic chemicals and presenting a large target for anti-aircraft weapons to shoot at, he adds. “I can come up with 15 ways to solve that problem kinetically with existing products. The key is focusing directed energy on the problems that require the speed of light.”

A class of problems illustrates the need for HPM. For example, foes could put satellite communications and GPS navigation jammers—to lead precision weapons astray—on top of hospitals and schools. This type of target cannot be attacked with conventional bombs, nor does it lend itself to lasers.

“That’s a problem screaming to get solved,” Booen declares.

The precision application of effects will be guided by some new schemes for fusing intelligence, surveillance and reconnaissance (ISR).

“There are things that are improving dramatically such as connectivity, the quality of information, miniaturization of components and advanced, high-resolution optics that are combined with the ability to link that data and share it,” says a senior ISR specialist. “Once you understand the battlespace and what is happening there, you can make decisions about how to deal with it.

“From a budget standpoint, it is going to be interesting to watch what is done with all the platforms the U.S. has bought,” he says. “We will want to up-

grade the sensors and content of those vehicles, UAVs, aerostats and airplanes because there has been such a monumental improvement in the ability to observe things.

“The metric we use operationally is that now you can see the whole town in high fidelity [instead of just a spot within the town],” he says. This is a capability that has only matured since 2006. “If something happens, you can see the reaction. You can track it back to see where people came from and track it forward to see where the participants went. I can see the vehicles, the people and what the people are carrying—a gun or a shovel.”

The need to use lots of battlefield robotics is going to create another opportunity for technology. How can all those unmanned ground, air and maritime robots operate autonomously and then later as part of a group of unmanned systems?

Alan Taub, General Motors vice president of global research and development, says autonomous cars with sophisticated self-driving systems can be ready for commercial sales by the end of the decade. Many are already equipped



The F-15C (right) and -E will soldier on at standoff ranges as launch platforms for long-range electronic attack missiles.

with sensors, radars, portable communication devices, GPS navigation, cameras and digital maps. Combined with other safety options such as lane-departure warnings and blind-zone alerts, there is a foundation for autonomous driving.

With survival cited as the goal, the system starts sounding familiar to military planners.

Vehicle-to-vehicle and vehicle-to-

infrastructure communication systems gather information from other vehicles, roadways and traffic signals to warn about possible hazards ahead, including slowed or stalled vehicles, slippery roads, sharp curves and upcoming intersections. These systems can be embedded in the vehicle or be added as applications to portable devices and smartphones that connect wirelessly to the vehicle, Taub says.

The new, special-missions MC-130 is expected to be one of the platforms that eventually will carry electronic attack weapons to support ground troops.

The driver's brain, designed to evolve to meet changing demands, may also become a commercial product according to a recent article in *New Scientist* magazine.

A team at Cornell University's Creative Machines Lab has created digital brains using neural networks that mimic biological evolutionary processes, and researchers are working on how to link them to robot bodies. The best-performing brains are allowed to reproduce to create new generations. Within a few



plain why Raytheon bought Ktech during mid-2011. Ktech is involved in airborne electronic warfare, directed energy and pulsed power. These capabilities are needed for the development of airborne

The vision is to give warfighters variants of virtually all of Ktech's weapon systems on Raytheon missiles.

The only way directed energy can establish itself on the battlefield is to show that it can deliver the effect from a reusable platform like a UAV or service multiple targets from a single platform like a cruise missile, and that it is a more affordable way to prosecute a war. So there may be some new options for the conundrum of how to blow up the enemy command-and-control center operating from the school yard.

"Do I wait until school is out and put a 500-lb. bomb in the middle of it?" Booen asks.

"We think there are some other ways. Our time horizons are way shorter than a decade. I think we'll have multiple nonkinetic effectors to offer in the next five years."

Education of decisions makers both in and out of uniform will be part of the process.

"Knowledge of the effects of HPM kind of lean toward the *Ocean's Eleven* kind of movies where they shut the lights off in the Bellagio casino to rob it," says Booen. "I say how about applying it to the bad guys' command-and-control center. If you can find that site and shut it off without the enemy knowing how it happened, tactical commanders will want the capability." ☛



hours of being plugged into the body, one brain was able to make a four-legged robot walk. The Cornell researchers also plan to design soft-bodied robots using printable materials that act as muscles, bones, batteries, wires and computers. The idea is that eventually the entire robot will be printed including the brain.

These battlefield demands and the maturing of new technologies also ex-

weapon systems that can analyze targets and then tailor a radio-frequency or HPM beam to upset or even electronically damage systems dependent on electronics. A directed-energy beam can be varied in width, energy output, modulation and frequency to create precise effects. Such systems will also have feedback monitoring to analyze the impact of these unseen, non-kinetic weapons.

Israeli Angst

Regional air defenses are being improved with new Russian-built weapons



ITAR-TASS/LANDOV FILE PHOTO

ALON BEN-DAVID/TEL AVIV

Israel is considered a world leader in electronic warfare, but the country's military analysts fear that for the first time in 40 years new Russian air defense systems could have an edge over the Israeli air force (IAF).

In the last two years, the Syrian army has deployed Russian Pantsyr-SE1 (SA-22 Greyhound) guns and missiles, short-to medium-range air defense systems and the medium-range Buk-M2 (SA-17) systems. Moscow is still denying constant Syrian requests to procure the S-300PMU (SA-20) air defense system.

"It reminds me of the 1973 war, when

the IAF, assured in its superiority, was surprised by the capabilities of Russian SA-6s operated by the Egyptian army," says Gen. Amos Yadlin, who was until recently head of military intelligence and is now the head of the Institute for National Security Studies in Tel Aviv. During the 1973 Yom Kippur war, the IAF lost more than 100 fighters, mostly to Soviet air defense systems deployed in Egypt.

"When facing a new system, you have to assume that you are not fully aware of its capabilities," said Yadlin. "I remember, as a young pilot, how the Egyptians caught us by surprise. Looking at the

systems being deployed in Syria now, I hope that the IAF is not as complacent as my generation was."

Two years ago, the Israeli defense ministry called on all domestic industries to devise solutions to the emerging air defense challenge in Syria. All responded, with Elbit Systems' Elisra

Syria's Pantsyr-SE1 missile defense system, carrying the SA-22 Russian-made anti-aircraft missile, is an advanced threat for the Israeli air force.

taking the lead. "The features of the Pantsyr's IL36-01 Roman I-band radar represent a serious challenge," an industry source tells Aviation Week. "Yet I believe we have come up with good EW [electronic warfare] answers," he adds.

Gen. (ret.) Itzik Ben-Israel, former head of R&D in the defense ministry, agrees: "We are far from the situation we were at in 1973. If we have to fight Syria today, we could easily defeat its new air defense systems."

Israel maintains a thick veil of secrecy over its EW capabilities and allows Elisra to export only limited technologies to foreign customers, keeping the state-of-the-art systems as a national asset. Shuki Yehuda, Elisra's vice president for R&D, provided a rare glimpse of the company's vision in a presentation at the Third Aerospace Conference in Jerusalem in November. "Starting from platform protection in the past and later mission protection, our EW systems today provide mission support, integrating all detection and prevention capabilities with weapon systems into a full [signals intelligence] solution," he said. "The ability to distribute information in a network-centric [system] enables a short sensor-to-shooter cycle. Combined with cybertools and modern radars, it becomes a force multiplier."

A demonstration of those capabilities was evident in Israel's 2007 strike on Syria's nuclear reactor, for which Israel never assumed responsibility. Reportedly, Israel's Boeing F-15I fighters were able to penetrate deep into Syria's airspace after shutting down Syrian air defenses using cybertools. "It is becoming

Israel Defense Forces Systems Evolution



Source: Elbit Systems

ing hard to separate cyberwarfare from EW as the two realms closely interact,” said the industry source.

“We are now required to operate all across the spectrum [with] what we call ‘spectrum dominance,’” said Yehuda. “Our future systems will cover detection at the 0.1-40-ghz range and jamming at 2-18 ghz. They will be [infrared-] centric as well as bolometric, sensitive to millimeter wave, [equipped] with network-centric capabilities and miniaturized into a single box.”

As an indication of how Israel trusts only its indigenous EW capabilities, the government has insisted on installing its own unique systems on the Lockheed Martin F-35 Joint Strike Fighter. Following excruciating negotiations, the U.S. government agreed to rewire the JSFs in order to accommodate Israel's Bands 2 and 5 EW system in the belly and wings. Israel also plans to install an external EW pod on its F-35s.

The question then arises: Why does Israel insist on adding external EW systems to an aircraft designed as a holistic EW and weapons system? With the U.S. refusing to grant access to the software of the F-35 to any foreign partner, Israel fears becoming dependent on the U.S. for any required changes in the JSF's EW software. Having its own systems on the aircraft will allow Israel to adjust quickly to any emerging threat.

However, other countries also are making progress in EW. The widespread use of low-cost GPS jammers among militant organizations in the region is becoming a concern for the IAF, which is heavily reliant on GPS-guided JDAM bombs.

“Clearly, we have to take that into account, both in terms of protecting against the jammers and expanding the arsenal of GPS-independent weapons,” a defense source says. But GPS jamming works both ways. As Hezbollah and Syria are deploying more GPS-guided rockets, Israel also needs to defend against the improving accuracy of these weapons.

EW technologies that used to be related only to air warfare are now spreading among the land forces. Israel, which has been a pioneer in protecting against improvised explosive devices, is also developing capabilities to counter ground fire. Rafael's Trophy active-protection system for armored vehicles proved itself in combat in 2011, twice defeating antitank weapons fired at Israeli armor. Yet the enormous costs of the hard-kill system are pushing developers to seek other solutions. ☼

Syria Exercises Navy

ALON BEN-DAVID/TEL AVIV

In yet another show of force, amid the intensifying uprising against Syrian President Bashar Al-Assad's regime, the Syrian army held an extensive exercise last month. On display were two recent additions to its arsenal—the medium-range Buk-M2 self-propelled air defense system and the Bastion coastal defense system.

Syrian state television showed the top brass of the Syrian army watching live missile firings of the two systems acquired from Russia. Apparently, the exercise was meant to deter any foreign intervention in Syria; both systems are a major concern to Israel.

In the video, several 9K317E Ural (SA-17 Grizzly) missiles were aimed at what appeared to be a rocket-propelled target. The 50-km (30-mi.) range missiles were fired from 9K317E Telar vehicles, equipped with the Tikhomirov NIIP 9S36 passive, phased-array engagement radar. While the radar's full features are unknown, it is believed to provide extended, low-altitude and surface coverage. The main advantage, though, is the ability of each vehicle to operate autonomously.

While the medium-range SA-17 does not represent a dramatic extension of Syrian capabilities, the Bas-

The Buk-M2, armed with the SA-17 missile, is another new addition to Syrian air defenses.



tion system, equipped with 300-km range 3M55E Yakhont missiles, will enable Syria to threaten naval activity in a wide area, covering most of the Israeli coastline.

The launch of a single Yakhont against a target at sea also was shown on Syrian TV. Syria procured two Bastion systems with 72 Yakhonts from Russia in 2007 under

a \$300 million contract. A Bastion comprises 18 mobile launchers, each carrying two Yakhonts.

The supersonic missile, carrying a 200-kg (440-lb.) warhead, represents a serious challenge to the Israeli and other navies operating in the eastern Mediterranean.

“It will definitely change the way we sail,” a senior Israeli navy official tells Aviation Week. Israel fears that if Syria delivers Yakhonts to Hezbollah, the Lebanese militia could threaten all of Israel's Mediterranean ports.

Israeli naval ships are equipped with the Barak-1 point-defense missile system, and are expected to receive the more advanced Barak-8. However, it's noteworthy that in 2006 Hezbollah almost sank one of the Israeli flagships. Using an Iranian Noor C-802 missile, the militia hit a Sa'ar-5 corvette, which was sailing 5 mi. off the Lebanese shore with its defense systems shut down. The missile killed several servicemen in addition to causing considerable damage to the ship. ☼

Time of Transition

New areas of emphasis may emerge in Europe's electronic warfare future

ROBERT WALL/LONDON

SELEX GALILEO

The age-old electronic warfare adage “friend in war, enemy in peace” is about to be tested again.

With the drawdown of military forces in Afghanistan clearly on the horizon, the era of relatively healthy levels of spending on improvised explosive device jammers and helicopter self-protection equipment may be drawing to a close. The potential turning point comes as many technologies are just starting to come into their own, such as two-color missile-warning equipment and detectors programmed to act as hostile fire indicators (HFI) that can alert pilots when they are being fired at by rocket-propelled grenades or small arms.

In Europe, where spending levels and, commensurately, the pace of technical development lags that of the U.S., some of these technologies are on the cusp of entering the market, which could mean that a sharp funding decline would cut those developments off at their knees. Research for HFI detection “will mature in the next few years,” says Steve Roberts, Selex Galileo vice president and chief technology officer for electronic

Under U.K. technology funding, Selex Galileo is working on the next evolution of its Hidas helicopter self-protection suite.

warfare. “We are getting that sorted.”

So what is the outlook for electronic warfare in Europe? The bleak prospect is that—with defense spending increasingly under pressure and troops being removed from “hot” zones—EW will be a convenient area to cut.

But industry representatives see a more positive landscape, where requirements may shift but the underlying need for EW capabilities remains.

Rather than money disappearing, buying behaviors may change. “With the reduction of military budgets, especially in Europe and the U.S., it is likely that nations will be more hesitant and selective as to which aircraft to protect,” says Bjarke Legind Larsen, director of strategic business development at Terma Airborne Systems. “It is therefore to be expected that customers will demand shorter delivery times, and tend to favor systems that are mounted externally in pods or pylons to allow for

fewer systems that can be rotated within the fleet.”

Another factor to be considered is the Libya experience, which has highlighted the need for radar protection, says Andreas Hulle, head of EW strategy at EADS's Cassidian defense unit. Some of the existing equipment, such as on Tornados, is aging.

The Royal Air Force experienced some of these issues during the Libya operation. Wing Cdr. Dicky Patounas, commanding officer of the 3(F) Sqdn., says that because of its greater capabilities, the Eurofighter Typhoon's Praetorian electronic warfare suite was also used to provide situational awareness for Tornado GR4 crew.

The renewed attention on radar-guided threats could manifest itself in multiple ways, including greater interest, again, in towed decoy devices. The advent of more sophisticated surface-to-air missile systems will also require advances in radar warning equipment to a higher-end, almost electronic support measures-type capability.

The increasing availability of digital ra-

radio frequency memory technology should help tackle the advanced threats to produce jamming waveforms that more accurately represent the radar return and thereby spoof an adversary's surface-to-air missile system, Roberts notes. Representing the complex scattered returns would not have been possible in the past, he says. The waveform generation is coupled with advanced phased array jammers that can allow airborne platforms to deal with multiple threats at different locations and frequencies.

The underlying technologies to handle the increasingly complex threats exist, but managing that information is a work in progress. The U.K. has been funding the common defensive aids system technology demonstrator program. The goal is not just to better integrate elements of a self-protection suite, but to optimize the use of the systems in a tactical scenario, Roberts says.

For instance, the system is supposed to alert pilots during an engagement where to fly to gain the maximum effect from their countermeasures or, depending on the distance between the helicopter and an infrared threat, adjust the pattern at which flares are dispensed. "The combination of maneuvers and countermeasures is more effective than maneuvers alone or countermeasures alone," Roberts notes.

The concern regarding radar-guided threats could also lead to a shift in priorities in signals intelligence. During the focus on insurgency campaigns, low-band communications intelligence has had primacy over the traditional high-band electronic intelligence-gathering domain. Given the uncertainties in the global political landscape related to where the next conflict may erupt, it increasingly important to have both strong communications and electronic intelligence capabilities, Hulle says.

Another threat that may gain increasing attention is laser-guided surface-to-air missile systems. Warning systems already exist to detect those threats, but developing the appropriate countermeasures has lagged. Options are available, Roberts notes. One is to try and defeat the missile in its final phase of flight, which may be difficult, while another is to disrupt the optical tracking system. Directed infrared countermeasures (Dircm) systems, now used to defeat infrared-guided-missile sensors, may have applicability when it comes to disrupting optical trackers.

The underlying theme regarding elec-

tronic warfare developments—whether to defeat radar, infrared or small arms threats—is a reduction in systems costs. Larsen believes demand will remain for infrared protection for post-Afghanistan operations, given the ubiquity of the man-portable air defense threat. And, he adds, "with several ongoing Dircm development and test programs under way, it could be anticipated that the price of such systems could go down and thus gain a more widespread use."

Hardware and software reuse will also become more important, Hulle says. In the RF domain, for instance, he sees a move to using a common core across a variety of applications, starting with equipment serving as an improvised explosive jammer and then being modified for electronic countermeasures or even electronic support measures.

On the signals-intelligence side, too, he adds, the key will be to reduce size, weight and price so the technology can go on smaller mission aircraft or unmanned air systems.

a gigabit Ethernet interface aimed at keeping pace with the employment of advanced radars, such as active, electronically scanned arrays, and more modern displays.

EADS is looking to bring to market this year a Block 2 upgrade to its ubiquitous Milds missile warning sensor to provide hostile-fire-indicator functions.

Selex, too, has been working in this area. The company's Sage digital electronic-support measures system and the related Seer digital radar warning receiver are aimed at bringing those technologies to lower-cost platforms.

Developments in Italy prove that even cash-strapped countries are finding funds for electronic warfare. The defense ministry recently contracted Elettronica to develop the Virgilius self-protection suite for the country's AW101 combat search-and-rescue helicopter. The multi-phased effort first will see an electronic-support measures system with radar-warning-receiver functionality added to the helicopter. Later, radar-jamming electronic



LUTWAF/INCO BICKER

The German air force this year expects to begin testing the Euro Hawk, one of several signals intelligence efforts EADS is working on.

The new market outlook is already shaping product strategies. For instance, the increased interest in radar threats helps explain Terma's decision to add a third Mil-Std. 1553 bus interface to its ALQ-213 as part of the new reliability, maintainability and performance upgrade that is slated for next year. The feature is aimed at allowing for an easier interface of radar warning systems, such as the ALR-56M.

Moreover, the company is adding

countermeasures are to be added, as is the ELT/572 Dircm system.

Because budgets in Europe will not be sufficient to sustain all these development paths, industry is focusing on the export market. Hulle says that though EADS sees a business case in places such as India or Saudi Arabia, it still needs to spend its own money to develop a product and bring to market a new technology that it then can also sell elsewhere. ☉



Turned Off

Directed energy becomes a battlefield reality

DAVID FULGHUM/ST. LOUIS

The biggest problem with creating an anti-electronics attack missile is to control the electromagnetic interference (EMI) created by its directed-energy warhead that could affect actuators, flight controls, onboard computers and communications of the vehicle that carries it, say airborne electronic attack specialists.

"With any [high-power microwave] HPM system, you get back lobes and side lobes that will induce currents in structures and create an EMI environment in the vehicle," says Keith Coleman, Boeing's program manager for the Counter-electronics High-power microwave Advanced Missile Project (Champ). "That's a key integration factor. [Nonetheless,] Champ has already demonstrated that you can isolate all those effects. That is a done deal. Can it be put on a manned system? Absolutely."

The Champ's HPM warhead is designed to recharge itself and continue firing narrow pulses of microwaves at frequencies tailored to disable specific electronic systems and devices until the air vehicle—described by U.S. Air Force officials as a cruise missile—runs out of fuel or targets.

The Air Force first tested cruise missiles with directed-energy warheads in the early 1990s. The test vehicles were Air Launched Cruise Missiles modified with apertures in the nose to help direct beams produced by the warheads, which were electrically charged coils surrounded with a tube of high explosives. When

the explosives were detonated, destroying the cruise missile, a pulse of high energy would "squirt" from the ends of the device. However, directing the pulse remained an elusive skill. The project was shelved after an incident in which electrical ignitions of cars in a parking lot were damaged by an errant pulse.

"One of the goals of the Champ demonstration project is to demonstrate multiple events during a single flight," Coleman says. "In HPM systems in general, repeatable, multiple pulses have been demonstrated over and over. Average power is actually very low. It's only peak power you worry about; therefore, your power supply can be fairly small. You don't need gigantic systems like a laser that require a lot of current from batteries or [power] generation systems."

The warhead's beams are flexible enough to be fired to the side, below or ahead of the missile. That indicates the use of an active, electronically scanned array (AESA) antenna which gives more reliability, greater power and longer effective range (perhaps up to three times as much) than that achieved with a mechanically scanned emitter. Program officials would not confirm the use of an AESA antenna, but they did address that technology's advantages.

"The antenna set is very important for [effective radiated power]," Coleman says. It is known that an AESA offers an advantage in power output 2-3 times higher than single-aperture radar with mechanically scanned emitters. "As I understand AESAs, they can be tailored to many different things," Coleman says.

"It depends on how you build the modules. You can shoot from the side, the bottom or wherever you like. It's a matter of time and money." Those individual modules can be fo-

An artist's concept of the Champ cruise missile suggests it has a very small radar and infrared signature and a miniaturized high-power microwave weapon.

cused on a single point to create large pulses of energy, say radar specialists. AESA also offers the option to use many airframe parts for a distributed antenna. By comparison, manually scanned electronic components are prone to low mean time between failures.

"When you build something mechanical into any integrated design, moving parts are going to bite you in reliability and maintainability," Coleman says. "I've built many aircraft and missiles. The more moving parts, the more potential there is for mishap."

Raytheon has already demonstrated a billboard-size, electronically scanned array-based HPM defense for airports to disable man-portable anti-aircraft missiles in flight.

"You can tailor HPM systems for different spot sizes," Coleman says. "[Moreover,] HPM systems have been proven to be frequency-agile if desired. The more agile any system is, the more [operational] flexibility you have."

Primarily, the tailoring of HPM is a matter of creating databases about the effectiveness of specific frequencies on equally specific targets. "So, for whatever frequencies you [operate the HPM emitter] at, you have to have the appropriate database [of the effects], and a key function of the Champ program is to develop those databases," he says.

The first flight test validated Boeing's pointing system for the HPM beams.

"The demonstration . . . proved that we could point within the needed parameters," Coleman says. "Think of the typical speeds that an aerial vehicle flies and the environments that they fly through—low-altitude, terrain-following—and trigger at the right time and point a weapon that is designed for minimum collateral damage." ☐

To see a video of two EW concepts from AFRL, read our accompanying Ares blog post: tinyurl.com/EW-AFRL



Depopulating War

21st century combat calls for robots and non-kinetic weapons

DAVID FULGHUM/WASHINGTON

The next-generation battlefield—whether high- or low-intensity—may not appear less busy to the unaided eye, but the number of soldiers and airmen immediately involved and in danger will shrink significantly.

Instead of troop-carrying helicopters, manned reconnaissance and close air support aircraft, the battlefield and the air over it are going to be thickly populated with a few heavily armored manned vehicles, a lot of robotic ground vehicles, airborne standoff weapons and both unmanned strike and reconnaissance aircraft, say Israeli and U.S. officials.

The reasons for this shift in manpower and tactics is the increasingly lethal nature of a battlefield filled with remotely detonated explosive devices, advanced anti-tank missiles and sophisticated new anti-aircraft missiles—both the small, shoulder-fired versions such as the Russian-made SA-18 and SA-24 and the large, vehicle-carried designs such as the SA-20 with its advanced, electronically scanned, long-range radar.

The weapons used in such combat also will change as the U.S. Navy, Air Force, Marine Corps and Army all develop new, interlinked electronic warfare systems that can apply non-kinetic fires as easily as they can rain down howitzer shells. Perhaps it will even be easier, since non-kinetic and other directed-energy weapons do not require ammunition production, warehousing and transport to the battlefield, as conventional weapons do.

For Israel, the need to tailor the way it fights was brought home in 2006, by operations in Lebanon. Iranian signals intelligence revealed Israeli assembly areas, vehicles were channeled in to killing zones, advanced Russian-made weapons destroyed the heaviest armor and a void appeared in Israel's response to Hezbollah's massive use of easily deployed artillery rockets.

"We wanted to participate in national budget-cutting by doing the same with less," says Israel Defense Forces (IDF) Brig. Gen. (ret.) Shmuel Yachin, former head of IDF research and development

and chief coordinator for Israel Aerospace Industries' land systems. "There was the thought that we could create more decisive effects with firepower only. This is wrong."

Survivability of aircraft over the modern battlefield is another concern.

"The amount you can rely on your air force has gone down because they will be solving the problems of [man-portable air defense systems] and anti-aircraft fire before they can come and help you," Yachin says. "We need to give more capabilities to the tactical levels [of the army] so that they can conduct more

tems," Yachin says. "I'm the chairman of G-NIUS, a partnership with Elbit [Systems] to develop those land-war robots. Within five years, robots will take their place in the most dangerous areas. In the future, [these autonomous vehicles] will be able to conduct a mission as a group."

However, there are already critics of reshaping traditional forces.

"The most avoidable wars—challenges pitting the United States against competitor states boasting high-end asymmetric threats—are the very challenges [U.S. decision makers] would prefer to refocus on," says a new report, *Endangered Ground Forces*, from the Center for Strategic and International Studies.

"The less preventable crises, on the other hand—those against which large numbers of Army and Marine Corps general purpose forces would be indispensable—are anathema," the report states. "These involve the very failures of political authority within important states and between important populations that

The mainstay of the U.S. Army's brigade-level electronic warfare capability will remain the Shadow unmanned aerial system.



U.S. ARMY

of the mission with less outside help."

One need is to gather persistent intelligence for the tactical mission area, which can be done with assets from the division downward, such as a few advanced sensors placed on smaller UAVs. In addition, signals intelligence and advanced communications are being designed to bring all the targetable data to a central site at the brigade level to understand what is happening.

Another plan is to remove airmen and soldiers from the battlefield and to replace them with relatively inexpensive but thoroughly networked machines.

"The next thing we need to explore is the use of robotics with ground sys-

are increasingly likely. Recent events like the Arab Spring demonstrate, for example, how quickly circumstances like these can breed violence [and] put vulnerable populations at extreme peril. Disentangling these challenges from stand-off ranges is, in a word, impossible."

In addition to robotics, non-kinetic and directed-energy weapons will be active on next-generation battlefields. Their applications with the U.S. Army date to 2006, when ground operations were bedeviled with improvised explosive devices triggered remotely with cheap radios. Such weapons were neutralized by Air Force EC-130 Compass Call, Marine Corps EA-6B Prowlers and

Navy EA-18G Growler electronic attack aircraft. But those are not considered the long-term solution.

"We are, as well as the Israelis, looking at the modern battlefield and drawing some of the same conclusions," says Col. Charles Ekvall, chief of the Army's new electronic warfare division. The focus is the brigade because that is the smallest warfighting unit that has to be on its own and its commander needs the tools to sustain [combat] inside the electromagnetic spectrum. We want a scalable, flexible, open and modular [system] so we can keep upgrading it."

A brigade area of operations would likely be 4-5 sq. km (1.5-1.9 sq. mi.). In that area, it could build an electronic order of battle, conduct network analysis to see what is emitting and where

the package involve a Multi-Function Electronic Warfare System (M-FEWS), which is part of the larger Integrated Electronic Warfare System (IEWS). The analysis of alternatives is still under way, so the final product is unknown, but there are lots of possibilities.

"[M-FEWS] has the potential to be small enough to go onto a [relatively light] unmanned aircraft," Ekvall says. "It will have the ability to communicate among [the system's] elements, to jam, to provide some measure of protection and to attack enemy communications in all those various configurations."

Both the Army and Marine Corps use the Shadow as their largest, brigade-level, unmanned aircraft. "If we can develop an airborne electronic attack [AEA] package that can go on a Shadow, it

hicle, have it flying overhead or operating from a fixed site, it is providing the electronic attack you need in a particular part of the battlespace," Ekvall says. "But you may not know what it is doing. Perhaps it's getting its instructions from the electronic warfare officer via the battle management system. All you know is that it's turned on and that it's conducting electronic warfare. It's providing a measure of protection as you move through the battlespace."

In addition, the systems and maturity of the technology may give a squad leader the capability to directly attack a target that is not being seen—optically or electronically—outside his narrow, personal view of the battlefield.

"I think there is a bad guy in that building right now and I'm going to attack his ability to communicate," Ekvall says. "Do I use directed energy, or is he using a particular radio and a certain frequency so I can tell my system to jam that frequency right this second? Is it a direct attack or is it passed through the battle command and targeted remotely?"

In the brigade headquarters, "there will be a fire support cell that has an EW working group that will include intelligence, signals and fires specialists working together to synchronize operations within the electromagnetic spectrum," Ekvall says. "Available to the commander is a staff element to do the planning that allows him to maneuver within that spectrum. This is a new organization based on a new way of conducting [combat]."

The next big step for the Army's new EW capability is the analysis of alternatives, which is to be completed this spring or summer. The IEWS system will consist of three simultaneous efforts: development of an EW planning tool and a battle management system; the multi-function EW capability; and a defensive electronic attack capability that is separate from but related to the defensive capability residing inside the MFEW.

"Are we going to have [the Marine Corps' F-35B] Joint Strike Fighter on call?" asks Ogden. "The answer is 'yes,' but the Army is not going to change its entire battle command and give all new radios to every unit on the ground so they can talk to JSF on Link 16. We're going to invent Armylink. The Army is going to have 50,000 [link users] and the Navy will have only four squadrons [of expeditionary EA aircraft]. Modern radio technology says I can simultaneously talk to people on different networks, and we can figure that out." ☛

Once it is available, the U.S. Marine Corps' F-35B, with the Next-Generation Jammer, may eventually supplement the U.S. Army's electronic attack forces.



and maintain radar surveillance of moving targets. All that information provides a target-rich environment for electronic attack. But the Army only now is coming to grips with operational use of electronic warfare (EW) on the battlefield.

"We were having a really difficult time [in 2006] with radio-controlled, explosive devices," he says. "The enemy was using \$5-10 radios to detonate them and we didn't have anything to jam them. The platforms that the Air Force, Navy and Marine Corps could bring in the air are not available all the time to the brigade commander."

The Army's initial focus is to give an electronic warfare capability—man-packed, ground-vehicle-mounted, airborne and fixed—to the Brigade Combat Team. The first two elements of

certainly would make life a lot simpler," Ekvall says. "As UAVs get more powerful and carry bigger payloads, they get closer and closer to what the Prowlers and Growlers can do."

But do not expect big, expensive aircraft programs for brigade-level EW.

"We don't anticipate building something that's going to be around for 30 years," says Clay Ogden, an Army EW specialist. "We need cheaper, disposable options. Once the Marines get rid of the Prowler, they want lots of cheaper EW [devices] all around the battlefield."

Given that the analysis of alternatives is not complete and defense budgets are being cut, how might the Army's EW system function? The vision is that parts of the IEWS will be dispersed on the battlefield at the squad or platoon level.

"If you wear it, mount it in your ve-

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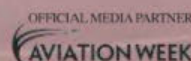
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Aviation Week & Space Technology
January 16, 2012 VOL. 174, NO. 3 (ISSN 0005-2175)

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Jan. 24-25—SMI Conferences' Joint Forces Simulation & Training. Grange City Hotel, London. Call +44 (207) 827-6000 or see www.jointforcetraining.com

Jan. 28—American Heroes Air Show. Lee County Sports Complex, Fort Myers, Fla. See www.heroes-airshow.com/fortmyers/

Jan. 31-Feb. 2—Aerial Refueling Systems Advisory Group's Winter Planning Meeting. Hilton Palacio del Rio, San Antonio. Call +1 (937) 431-8106 or see www.arsaginc.com

Feb. 2—Business Aviation Regional Forum. Landmark Aviation, Lakefront Airport, New Orleans. See www.nbaa.org/events/forums/20120202

Feb. 7-9—Association for Unmanned Vehicle Systems Program Review 2012. Omni Shoreham Hotel, Washington. Call +1 (703) 845-9671 or see www.auvsi.org

Feb. 13-16—Practical Aeronautics Short Course: "Introduction to Jet Engines—A Practical Perspective." The Aero Institute, Palmdale, Calif. Call (970) 887-3155 or see www.practicalaero.com

Feb. 14-19—Singapore Airshow. Changi Exhibition Center. Call +65 6542-8660, fax +65 6546-6062 or see www.singaporeairshow.com

Feb. 15-16—FAA's 15th Annual Commercial Space Transportation Conference. Walter E. Washington Convention Center, Washington. Call +1 (202) 267-8568 or visit <http://faa.gov/go/ast>

Feb. 22-23—MIU Events/Exhibitions India Group's Indian Business Aviation Expo 2012. Manekshaw Center. New Delhi. Call +44 (124) 351-3606 or see www.miuevents.com/ibae2012

Feb. 23-24—Fifth Society of Experimental Test Pilots' Annual Southeast Symposium. Ramada Plaza Beach Resort, Fort Walton Beach, Fla. See www.setp.org/table/southeast

Feb. 27-29—Defense Maintenance Sustainment Summit. Hilton Torrey Pines, La Jolla, Calif. See www.wbresearch.com/dms/

March 5—Speednews' Second Annual Aerospace Raw Materials & Manufacturers Supply Chain Conference. Also, **March 5-7**—26th Annual Commercial Aviation Industry Suppliers Conference. Both at Beverly (Hills) Wilshire Hotel, Calif. See www.speednews.com/conferences

March 9-11—Valiant Air Command's 2012 Tico Warbird Air Show. Titusville (Fla.) Space Coast Regional Airport. See www.vacwarbirds.org

March 19-21—International Academy of Astronautics/American Astronautical Society's Conference on Dynamics & Control of Space Systems. Hotel Ipanema, Porto, Portugal. See www.astrodynamics.org.pt/

March 19-22—Practical Aeronautics Short Course: "Introduction to Aeronautics—A Practical Perspective." National Institute of Aerospace, Hampton, Va. Call (970) 887-3155 or see www.practicalaero.com

March 21-22—Avionics Europe 2012 Conference & Exhibition. MOC Event Center. Munich. Call +44 (199) 265-6619 or see www.avionics-event.com

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Jan. 31-Feb. 2—MRO Middle East 2012. Dubai, United Arab Emirates.

Feb. 14-16—Defense Technology and Affordability Requirements. Arlington, Va.

March 7—55th Annual Laureate Awards. Washington.

March 13-14—Innovation Supply Chain Showcase. Orlando, Fla.

April 3-5—MRO Americas 2012. Dallas.

April 3-5—MRO Military Conference & Exhibition. Dallas.

April 23-25—NextGen Ahead: Air Transportation Modernization. Washington.

May 8-9—Civil Aviation Manufacturing. Charlotte, N.C.

May 23-24—MRO Regional: Eastern Europe, Baltics and Russia. Vilnius, Lithuania.

Sept. 19-21—MRO IT Conference & Showcase. Miami.

Oct. 9-11—MRO Europe. Amsterdam.

PARTNERSHIPS

Jan. 26-27—Global Space Technology Convention. Singapore.

Feb. 9-10—Global Space Technology Conference. Singapore.

Feb. 11-14—HeliExpo. Dallas.

Feb. 14-19—Singapore Airshow.

March 27-April 1—Fidac International Air & Space Fair. Santiago, Chile.

April 3-6—Aircraft Electronics Association's 55th Annual International Convention & Trade Show. National Harbor, Md.

June 11-15—Eurosatory. Paris.

July 9-15—Farnborough air show.

Oct. 1-5—63rd International Astronautical Congress. Naples, Italy.

Oct. 9-14—Japan Aerospace. Nagoya.

Dec. 11-13, 2012—Middle East Business Aviation. Dubai.

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Meeting China's Military Challenge



U.S. Rep. J. Randy Forbes, R-Va., is chairman of the House Armed Services readiness subcommittee and founder and co-chairman of the Congressional China Caucus.

For six decades, America's military strength has helped preserve a relatively stable Asia-Pacific environment. However, in recent years Beijing has rapidly modernized its military with aspirations of supplanting the U.S.'s position. If present trends continue, China's growing capabilities may help it win a bloodless victory so the regional balance of power tilts in Beijing's favor as it is increasingly able to deter U.S. forces from entering the region, coerce neighboring states, or—should conflict ensue—win a rapid victory.

In response, the U.S. needs a long-term military and diplomatic effort that helps develop new methods and capabilities for operating in the Western Pacific while simultaneously strengthening alliances and enhancing new relationships in the region. For its part, Congress must reject an "instant-pudding" mindset that looks only at current problems while failing to adequately plan and then provide resources for our strategy. Endless continuing resolutions,

“Numerous analysts have concluded that China aims for its own ‘Monroe Doctrine’ in the Western Pacific, the ultimate goal being America’s expulsion from the region.”

the defense cuts in last summer's Budget Control Act and the "sequestration" process that essentially gambled away our defense budget for political purposes are signs of a budgeting process that is ill-prepared for use in managing the challenges China will pose in the decades ahead.

Numerous American analysts closely observing China's navy have concluded that Beijing aims to develop its own "Monroe Doctrine" in the Western Pacific, the ultimate goal being America's expulsion from the region. Capabilities to achieve this objective include precision-guided land-attack and anti-ship ballistic and cruise missiles, anti-satellite weapons, diesel submarines and cyberwarfare initiatives. If China is successful, strategists worry that smaller states such as Singapore or the Philippines could have their freedom of action neutralized by China's growing control, suffering a fate similar to Finland during the Cold War. If this develops, Beijing could more easily draw America's allies and partners into its orbit, preventing the U.S. from protecting its regional interests.

While China's desire to assert its role as a rising power is consistent with its national aspirations, many states question Beijing's assertions that it will only act defensively when it develops offensive strike platforms like those described here. And question they should.

In response, the U.S. must adopt a two-pronged approach that does not just look ahead to the next year or two, but carefully plans for the next several decades. First, we must recognize that the best way to avoid great-power conflict is to remain vigilantly prepared. The Pentagon has rightfully developed an AirSea Battle concept that attempts to address this challenge institutionally, conceptually and materially. To be successful, Congress must forge a partnership with the Pentagon to properly support AirSea Battle requirements. At its highest level, we will need to maintain a fleet with an adequate number of aircraft carriers, attack submarines and surface combatants. We will also require new technologies to project power from our aircraft carriers, extend our anti-ship missiles' ranges and distribute capabilities across a range of unmanned platforms.

If we intend to sustain an American-led, liberal-international order in the region, the second thing we must do is commit to a robust diplomatic effort. Maintaining relationships in the region has never been more important. Our allies are situated at critical strategic locations, offering their own capabilities to protect vital shipping lanes or working alongside our forces to deter disruptions.

In Japan, South Korea, Singapore and now Australia, we also maintain a military presence that allows us to sustain a regional posture and avoid the tyranny of distance we face when projecting power from our own shores. Congress must carefully review the proper balance of our forward-deployed military assets and recognize the critical role they play in reassuring our allies and friends. Going forward, we must further deepen existing alliances while developing new relationships with emerging regional players like Indonesia, India, Malaysia and Vietnam.

While the news is often focused on Beijing's aggression toward American surveillance ships or efforts to bully our allies in the East or South China seas, we must not lose our focus on the trends that will define the decades ahead. The Obama administration is right to shift our national security focus toward the Asia-Pacific region, but I fear the president's new budget will fail to properly provide for this effort. Congress has a responsibility to underpin our Asia-Pacific diplomatic long-game with an American military that remains the preeminent force in the region. ☛



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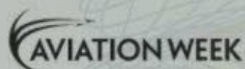


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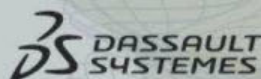
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