

U.S. ARMY'S NEW ROTORCRAFT PROGRAM

\$7.95 APRIL 18, 2011

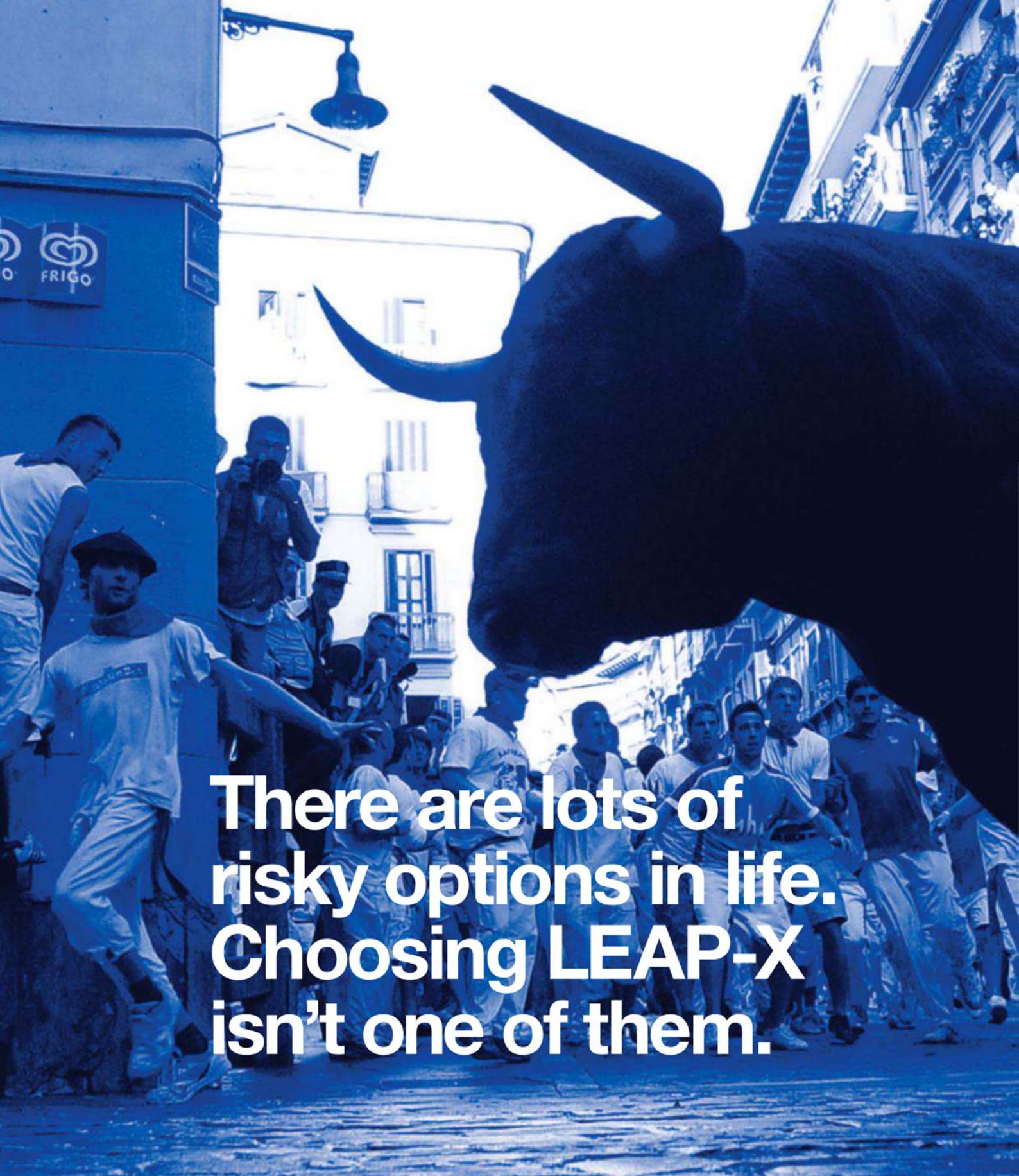
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For individual e-mail addresses, telephone numbers and more,
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EDITORIAL OFFICES

2 Penn Plaza, 25th Floor, New York, NY 10121
Phone: +1 (212) 904-2000, Fax: +1 (212) 904-6068
Editorial Administrator: Norma Maynard

BUREAUS

BEIJING

D-1601, A6 Jianguo Menwai Ave., Chaoyang, Beijing 100022, China
Phone: +86 (186) 0002-4422
Bureau Chief: Bradley Perrett

FRANKFURT

Am Muhlberg 39, 61348 Bad Homburg, Germany
Phone: +49 (6172) 671-9817 Fax: +49 (6172) 671-9791
International Air Transport Editor: Jens Flottau

GENOA

Via Martiri Liberazione 79/3, 16043 Chiavari (Ge), Italy
Phone: +39 (185) 308-606, Fax: +39 (185) 309-063
Contributing Editor: Andy Nativi

LONDON

20 Canada Square, 7th floor
Canary Wharf, London E14 5LH, England
Phone: +44 (20) 7176-7000

LOS ANGELES

10 Whitewood Way, Irvine, Calif. 92612
Phone: +1 (949) 387-7253
Bureau Chief: Guy Norris

MOSCOW

Box 127, Moscow, 119048, Russia
Phone: +7 (495) 782-1435; Fax: +7 (495) 245-4946
Contributing Editor: Alexey Komarov

NEW DELHI

C 35 Panchsheel Enclave, New Delhi 110 017 India
Phones: +91 (11) 2649-7724; +91 (11) 2649-9764
Contributing Editor: Neelam Mathews

PARIS

11/13, Avenue de Friedland, 75008 Paris, France
Phone: +33 (14) 075-2501, Fax: +33 (14) 075-2533
Contributing Editor: Pierre Sparaco
Phone/Fax: +33 (44) 261-5439

SAN FRANCISCO

310 Brandon Court, Pleasant Hill, Calif. 94523
Phone: +1 (925) 934-6813

Bureau Chief: Michael Mechem

SINGAPORE

30 Cecil Street, Prudential Tower #13-01
Singapore 049712
Phone: +65 6530-6532

Bureau Chief: Leithen Francis

WASHINGTON

1200 G St., NW, Suite 922, Washington, D.C. 20005
Phone: +1 (202) 383-2300, Fax: +1 (202) 383-2347

Bureau Chief: James R. Asker

Administrator of Bureaus: Angela Smith

Art Department: Gregory Lewis, Scott Marshall

Copy Editors: Andrea Hollowell, Patricia
Parmalee, Nora Titterington

Director, Editorial and Online Production: Michael O. Lavitt

Production Editors: Elizabeth Campochiaro, Bridget Horan,
Ellen Pugatch

Contributing Photographer: Joseph Pries

Publisher: Mark A. Flinn mark_flinn@aviationweek.com

President, AVIATION WEEK: Gregory D. Hamilton hamilton@aviationweek.com

Director of Finance: Maurice LoBasso

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TELEPHONE/FAX NUMBERS,

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36 *Technology for future airliners is being tested in NASA's Environmentally Responsible Aviation program. The most promising technologies will be focused on platforms that NASA will pick under its preferred-system concepts competition. Boeing's concept for a hybrid wing body, powered by either geared turbofans or open rotors, is one of three finalists. Our review also takes a glimpse into Boeing's crystal ball to see what technologies could be featured on an all-new aircraft, should the company opt not to re-engine the 737.*



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All Rise.

Distinction is always confined to the few. Jones Day proudly congratulates Giovanni Bisignani as the 2011 winner of the L. Welch Pogue Award. First presented in 1994 to Welch Pogue, former Chairman of the Civil Aeronautics Board and US Delegate to the Chicago International Civil Aviation Conference, the award goes each year to an individual considered a visionary and preeminent leader of contemporary aviation. The award was jointly presented on March 29 by Aviation Week and the International Aviation Club of Washington, D.C. to Mr. Bisignani, Director General and CEO of the International Air Transport Association, recognizing his many contributions to the field.

Since the founding of Jones Day's aviation law practice by Mr. Pogue some 65 years ago, we have counseled clients on their most challenging problems. With offices across North America, Europe, and Asia, our experience now ranges from civil aviation regulation and safety enforcement ... to aircraft and engine finance ... airport expansion ... climate change ... aircraft accident litigation ... employment matters and labor negotiations ... airline joint ventures and antitrust investigations ... complex mergers and acquisitions ... and airline reorganization and restructuring.

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TYPHOON IN THE FIGHT

✈️ Some of the first images of the Eurofighter Typhoon's initial engagement in air-to-ground combat were posted last week on *Ares*, our defense technology blog. In an attack in Libya (see photo), the Typhoon dropped an Enhanced Paveway II. AviationWeek.com/ares

CANCELED ORDERS

💬 **Senior Transport Editor Adrian Schofield** confirms that Air Pacific has canceled its Boeing 787 orders, citing financial difficulties and the program's delays. A Fijian government minister announced the news even as the airline and Boeing remained tight-lipped. The two companies ultimately confirmed the news. Read the post at AviationWeek.com/wings

A380 COLLISION VIDEO

✈️ **Transport Editor Andrew Compart** posts video of the dramatic incident at New York Kennedy Airport in which an Air France A380 clipped the wing of a Delta Connection CRJ700. The post also features the audio recording from the tower during the incident, which can be played simultaneously with the video. To read the post and listen to the media, go to AviationWeek.com/wings

GLASS HALF FULL

💬 **Business Aviation Editor George Larson** writes that the fractional-ownership business jet sector should not be given up for dead. In fact, it is healthier than most analysts imagine. Operator Flight Options reported its first-quarter fractional sales jumped a whopping 467%. AviationWeek.com/biz

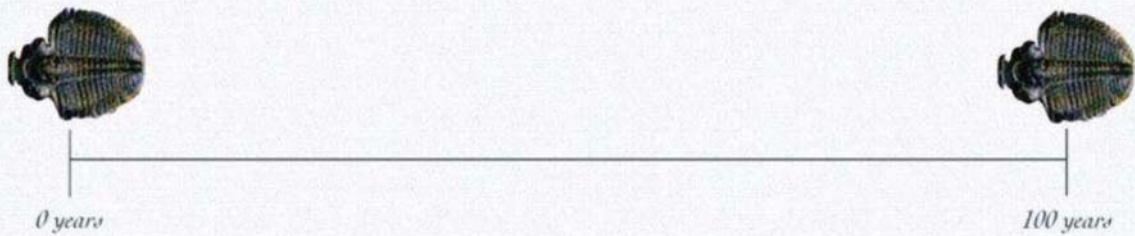
SPACE CONVERT

💬 **Senior Space Editor Frank Moring, Jr.**, reports on Pratt & Whitney Rocketdyne's plan to convert excess engines from Delta IV to Atlas V use and writes about the legacy of U.S.-Russian cooperation that comes out of the space shuttle program. AviationWeek.com/onspace

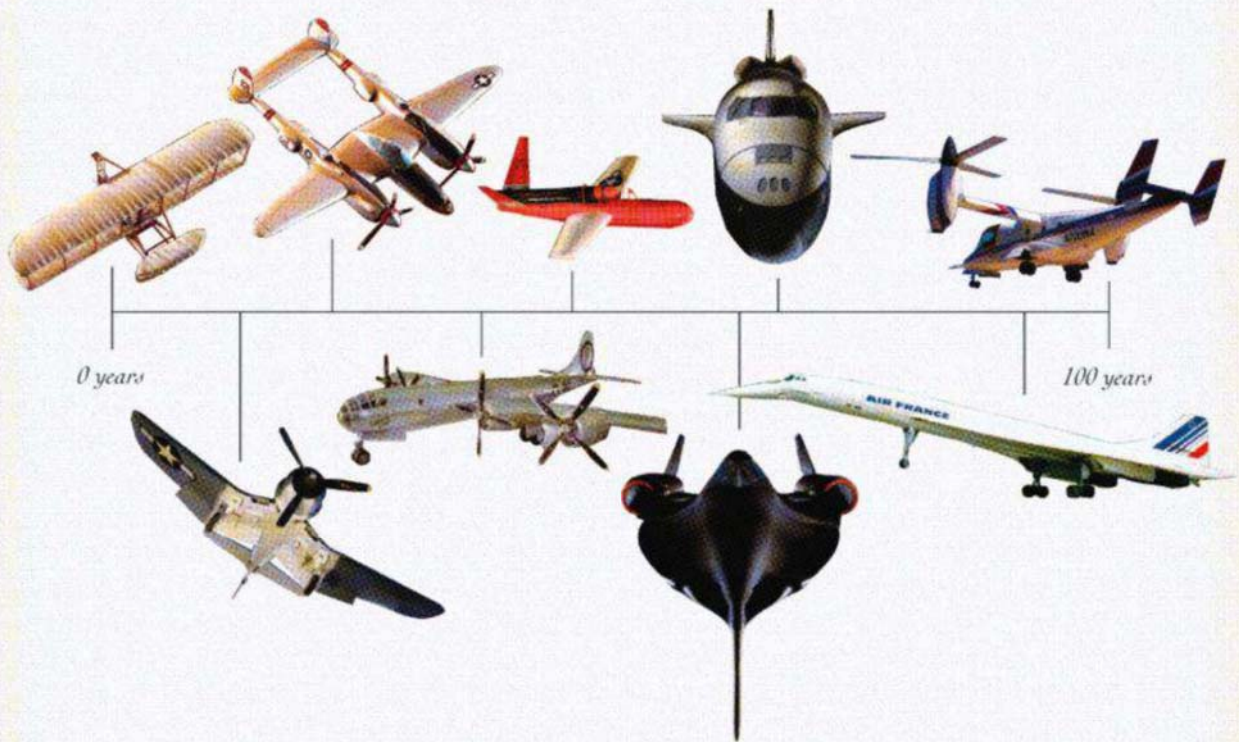
PREMIUM CONTENT

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ALWAYS A CHOKE HOLD

The Libyan armed forces have shown themselves to be agile in learning to avoid a NATO airpower "Choke Hold" (AW&ST April 4, p. 25).

The SA-24 surface-to-air missile is optically guided and all the electronic countermeasures in the inventory will not stop them.

When it comes to man-portable anti-aircraft weapons, it turns out we, and our allies, may not rule all the airspace.

If you add in tactics that will ensure high civilian casualties if attacked, and a lack of coordination with insurrectionist forces, it is clear that allied airpower is becoming irrelevant.

We are handicapped by our own rules to the point of impotence.

Peter J. Peirano

RIDGEWOOD, N.J.

(Laser-based missile defenses were developed and are being refined by the U.S. and its allies for that very reason. Infrared and electro-optical guidance can be detected and either fed false targets or damaged by lasers—and, they are becoming smaller, lighter and cheaper. Foes learn quickly and adapt to advanced technology—Ed.)

GOOD, BUT COULD'VE BEEN GREAT

Following a 25-year career in naval aviation with the air arm of the British Fleet, I was pleased to read "100 Years of Naval Aviation" (AW&ST April 4, pp. 56-80), but was disappointed to find



no mention of the major part played in development of U.S. carrier capabilities by the U.K. Fleet Air Arm, which invented many important techniques adopted by the U.S. Navy. These include the angled deck, stabilized mirror landing system, steam catapult shuttle sealing system and the ski jump for vertical/short-takeoff-and-landing aircraft.

In the same package, Michael Fabey's "Carrier Cat" (p. 58) covered the Elec-

tromagnetic Aircraft Launch System (Emals) but did not mention that the U.K. is developing a system called Em-cat, similar to but distinct from Emals, for its two new carriers, which will have two catapult systems (which may yet be steam) and arrestor gear. I don't know the percentage of successful launches by C13 catapults over the years, but it must be close to 100%. I wonder if Emals will be able to match that.

Ben Chilcott

DORSET, ENGLAND

THE BIGGER PICTURE

Nobody should believe that American Airlines' bid to remove the global distribution system (GDS) from the travel booking process is merely an attempt to eliminate GDS service fees. Ancillary revenues and passenger loyalty are very much at the heart of the "direct connect" philosophy.

From an airline's perspective, improving the quality and consistency of engagement with customers is a priority. Third-party bookings deny the airline visibility of the wider customer spend at the time of the transaction. The airline knows of the flight booking, of course, but did the passenger also order cultural guided tours at the destination city, for example, or winter sports insurance? Without such customer-specific data, airlines will struggle to offer the kind of customized loyalty and rewards packages that allow them to build long-term, profitable relationships with passengers.

This battle is not for short-term gain. Airlines are fighting to secure customer loyalty—and the consequent direct and ancillary revenues—that will last for many years. No one should be surprised, therefore, if they fight hard.

Janet Titterton

LONDON, ENGLAND

FROM THE TOP DOWN

I applaud Boeing executive Rick Stephens' Viewpoint "Soft Skills Vital to Workforce, Too" (AW&ST April 4, p. 84) regarding a world where "when something goes wrong, [students] just turn it off, reboot or start over." But I believe it must go further.

He nailed the cause of insufficient numbers of people with the right skills to fill a workforce. The "reboot"

mentality fosters a "whatever" attitude because when ammo is free, you get an infinite number of shots and are bound to hit the mark eventually—not a good way to run an industry. However, we put these same people in front of computer consoles and let them do what they do—in lightning-speed iterations. This is where garbage in/garbage out comes to play. It still takes judgment to set up a problem creatively and to recognize and implement an elegant solution.

Industry can deal with this immediately, but it has to start high up—at Stephens' level at Boeing and elsewhere—and permeate whole systems. The attitudes, talent and judgment he is calling for must be fostered from within, which means less reliance on paper credentials and more on real talent and personal qualities. How much of value is turned away at the door or is quietly burning out in a project group doing routine work, either for lack of the right credentials or because those qualities are threatening to the status quo?

I suggest we find a way to identify these people, invest in them, give them freedom to develop and then fast-track those who prove themselves.

This has to start at the top to effect a true culture change. That in itself takes no small measure of judgment and talent to execute correctly. Do it right, though, and the efficiencies will follow.

Steve Dorsey

ST. JOSEPH, MINN.

NEW PAIR FOR BOEING?

Boeing should think big for the follow-on of the 737 Next Generation. It should be replaced by two families of aircraft covering the 100-210-seat market. A 100-150-seat single-aisle type would counter new entrants like the Bombardier CSeries, and a 150-210-seat twin-aisle could go head-to-head with the Airbus A320 successor.

Philippe Cauchi

OUTREMONT, QUEBEC

WHO'S WHERE

Judy Perry Martinez (see photo) has been named vice president and chief compliance officer of Los Angeles-based *Northrop Grumman Corp.* She was assistant general counsel for litigation.

Michael Rogers has been appointed vice president of customer service at Long Beach, Calif.-based *JetFlite International*. He was the founder and owner of Los Angeles Helicopters until the company's sale and earlier was director of customer services for Diagnostic Products Corp.

Jeff Miller has become Houston-based *Landmark Aviation's* general manager for Dallas Love Field, Dallas Addison Airport and Wichita Falls (Texas) Airport. He held the same title at Atlantic Aviation. **Russell Halasz** has been promoted to general manager from assistant manager at Landmark's Raleigh-Durham (N.C.) International Airport fixed-base operation.

Barbara Margulis (see photos) has been named vice president of safety and performance management and **Stacey Lora** vice president of security, both at *JFKIAT*, manager of Terminal 4 at New York John F. Kennedy International Airport. Margulis, who joined *JFKIAT* in 1998, has held positions in operations, marketing and concession management. Lora has been operations manager at *JFKIAT* since 2005 and earlier was security manager for American Airlines at JFK's Terminal 8.

Stephane LeRoy has been appointed sales director for South America and the Caribbean at *Bombardier Aerospace*. LeRoy, who is based at company headquarters in Montreal, has spent 13 years in international sales in the aviation industry, 10 of them at Bombardier.

Paul Eckert has joined Englewood, Colo.-based *Jeppesen* as vice president of aviation for Europe. A senior adviser to the Jeppesen leadership team for several years, Eckert also has been a safety expert for national and European Union aviation regulatory authorities.

Bob Buckhorn, newly elected mayor of Tampa, Fla., has been chosen assistant secretary and assistant treasurer of the *Tampa International Airport* board of directors. **Christopher Minner** has been named vice president of marketing and **Damian**

Brooke vice president of business planning and information technology.

Michael Wisbrun (see photo) will become managing director of Amsterdam-based *SkyTeam* on June 1, succeeding **Marie-Joseph Male**. Wisbrun, whose support staff will include new Deputy Managing Director **Su Liang**, is currently executive vice president of KLM Cargo.

John Purvis has been named president and chief executive officer of *AME Unmanned Air Systems*, formerly AeroMech Engineering, San Luis Obispo, Calif. He succeeds **Jay McConville**, who will become chairman and executive vice president at unmanned aerial system ground control station integrator *ChandlerMay*.

Christophe Million-Rousseau has been hired by San Francisco-based aviation lessor *Jackson Square Aviation* to set up the company's Toulouse office. He joins Jackson Square from Airbus Customer Finance.

Bob Holt (see photo) has joined San Francisco-based *URS Corp.* as senior vice president and national director of program and construction management. He was vice president of program and construction management at Jacobs Engineering.

Philip Balaam has been appointed vice president of business development at *Asia Satellite Telecommunications Co.* of Hong Kong. He was Singapore-based Asia-Pacific sales and marketing director for Arianespace.

Ron Stefano (see photo) has been named vice president of Mission Operations Solutions for *Raytheon Co.*'s Intelligence and Information Systems business in Garland, Texas. He came from Lockheed Martin Information Systems and Global Solutions, where he was head of the Enterprise Information Technology Solutions business.

Andrew Gibson has been named interim chief executive officer of Zurich-based *Gategroup*, succeeding **Guy**



Judy Perry Martinez



Barbara Margulis



Stacey Lora



Michael Wisbrun



Bob Holt



Ron Stefano



Steve Moulton

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

Dubois, who has resigned. Gibson is group senior vice president and president for North America.

Sam Jantzen has been tapped to lead sales and marketing at *BDN Aerospace Marketing*, Mesa, Ariz. He has held senior executive positions at Cessna Aircraft, Fairchild Aircraft, Commuter Air Technology and Raisbeck Engineering.

Oliver Gritz has been named managing director-Europe for *Southern Air Holdings*, Norwalk, Conn. He held senior management positions at DHL Express.

Steve Moulton (see photo) has joined Chicago-based *Parsons Brinckerhoff* as a vice president, responsible for oversight of airside/landside aviation design and engineering projects. He was a vice president and National Airfield Service Group leader for a Florida-based consulting firm.

Richard Addi has been promoted to president and chief executive officer of *Exostar*, Herndon, Va. He was vice president of finance at Data Systems & Solutions and had been director of tax at Rolls-Royce North America.

Robert Osborn has been named chief information officer at the *National Nuclear Security Administration*. He was deputy director for Command, Control, Communications and Computer systems and distribution portfolio manager for the U.S. Transportation Command, at Scott AFB, Ill.

James Fults has been promoted to director of engineering from principal engineer in the space business sector of Chatsworth, Calif.-based *Aitech Defense Systems*, succeeding **Anthony Lai**.



BY JOSEPH C. ANSELMO

Senior Business Editor
Joseph C. Anselmo blogs at:
AviationWeek.com
Joe_Anselmo@aviationweek.com

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(as of 4/13/2011)

PERCENT CHANGE

MARKETS	INDEX VALUE	WEEK AGO	YEAR-TO-DATE	YEAR AGO
AW Aerospace 25	1406.8	-2.3% ▼	17.5% ▲	4.4% ▲
AW Airline 25	990.5	-0.2% ▼	12.7% ▲	0.1% ▲
S&P 500	1314.4	-1.6% ▼	17.9% ▲	8.6% ▲



Weekly Market Performance

Closing Prices as of April 13, 2011

Company Name	Current Week	Previous Week	Fwd. P/E	Tot. Ret. % 3 Yr.	Tot. Ret. % 1 Yr.
AEROSPACE & DEFENSE					
AeroVironment Inc.	28.66	30.11	20.8	39.2	11.6 ▲
Allegheny Technologies Inc.	64.18	66.62	20.5	-9.9	17.8 ▲
Alliant Techsystems Inc.	69.41	71.64	8.6	-34.8	-13.6 ▼
BAE Systems plc	5.44	5.41	7.9	-21.6	-9.1 ▼
Boeing Co.	72.13	73.72	17.6	1.9	3.0 ▲
Bombardier Inc. 'B'	7.16	7.44	17.6	15.0	30.3 ▲
Cobham plc	3.83	3.84	11.1	18.3	-13.8 ▼
Curtiss-Wright Corp.	33.08	35.35	12.8	-25.5	-3.6 ▼
DigitalGlobe Inc.	28.33	28.29	83.8	...	1.5 ▲
EADS NV	30.29	29.90	22.7	43.6	42.0 ▲
Elbit Systems Ltd.	56.50	55.02	11.3	10.0	-17.7 ▼
Embraer-Empresa Brasil ADR	32.54	33.76	16.5	-16.3	35.8 ▲
Esterline Technologies Corp.	66.92	71.83	14.1	21.8	29.5 ▲
Finmeccanica SpA.	12.79	12.81	6.7	-47.7	-11.0 ▼
FLIR Systems Inc.	33.35	34.30	19.3	16.1	15.8 ▲
General Dynamics Corp.	71.81	74.74	10.0	-7.9	-3.9 ▼
General Electric Co.	19.94	20.55	14.9	-28.6	6.0 ▲
GKN plc	3.31	3.41	10.3	12.9	42.6 ▲
Goodrich Corp.	84.28	86.81	15.4	52.4	18.1 ▲
Harris Corp.	49.74	51.40	10.5	8.7	1.9 ▲
Hexcel Corp.	18.79	20.03	19.6	1.8	29.4 ▲
Honeywell International Inc.	57.31	58.85	14.9	11.2	26.9 ▲
ITT Corp.	57.77	59.77	12.1	8.0	5.5 ▲
Kratos Defense	13.67	14.20	12.2	-26.1	-3.7 ▼
L-3 Communications Hldgs. Inc.	77.01	79.86	9.1	-25.9	-17.7 ▼
Lockheed Martin Corp.	78.31	81.49	11.1	-17.0	-1.6 ▼
Moog 'A'	43.48	46.30	15.7	3.0	14.8 ▲
Northrop Grumman Corp.	61.53	62.36	9.2	-3.0	4.7 ▲
Orbital Sciences Corp.	18.21	19.21	20.2	-23.3	-1.8 ▼
Parker-Hannifin Corp.	93.58	95.98	14.0	37.3	34.7 ▲
Precision Castparts Corp.	143.68	147.71	17.6	30.4	15.9 ▲
Raytheon Co.	48.68	51.23	9.8	-18.8	-13.6 ▼
Rockwell Collins Inc.	62.92	64.38	15.2	6.8	-0.6 ▼
Rolls-Royce Group plc	10.16	10.23	14.1	51.2	2.5 ▲
Safran SA	34.75	35.41	13.1	107.4	24.4 ▲
SAIC Inc.	17.00	17.42	12.0	-8.7	-4.1 ▼
SIFCO Industries Inc.	17.19	17.88	...	35.4	7.8 ▲
Singapore Technologies Eng.	2.59	2.59	18.3	12.7	2.0 ▲
Spirit Aerosystems Holdings	24.05	25.21	13.3	-5.5	5.1 ▲
Textron Inc.	26.60	28.02	22.5	-52.5	17.3 ▲
Thales	41.42	41.77	13.0	-25.3	-3.2 ▼
TransDigm Group Inc.	79.18	82.71	18.4	161.7	45.0 ▲
Triumph Group Inc.	82.14	87.83	11.1	50.4	15.3 ▲
United Technologies Corp.	84.21	85.66	15.7	29.5	16.4 ▲
Zodiac Aerospace SA	73.72	76.35	12.8	82.8	35.8 ▲

COMMENTARY

A Manageable Debate on Defense, So Far

House Budget Committee Chairman Paul Ryan (R-Wis.) laid down a marker with his proposal to cut the U.S. budget deficit by \$4.4 trillion over 10 years. Ryan's bold plan focuses on curtailing entitlements such as Medicare and Medicaid, while sparing the Pentagon from cuts and the rich from tax hikes. U.S. President Barack Obama fired back on April 13, with his own plan to reduce government borrowing by \$4 trillion over 12 years (p. 23). But the Democratic leader's proposal would both raise taxes on the wealthy and cut security spending—to the tune of \$400 billion.

If the debate stays within those two goal posts, the outcome should be manageable for defense contractors. Bernstein Research analyst Douglas S. Harned notes that even if Obama's \$400 billion cut prevails, it would be spread over a dozen years. The result, Harned calculates, is that the baseline defense budget would decline by about 0.5% a year after adjusting for inflation. That's hardly draconian, and much lower than the deep cuts in military spending seen in the U.K.

The danger, however, is that as lawmakers on Capitol Hill finally get serious about deficit reduction, weapons platforms could be targeted for even deeper cuts. Rep. Barney Frank (D-Mass.) is part of an odd bipartisan cadre of liberal Democrats and fringe Republicans that wants to slash security spending by nearly \$1 trillion during the next decade. Not long ago, that idea was greeted with laughter. But Obama's new proposal has emboldened them. "Six months ago we weren't even in the ball game," Frank tells Aviation Week's Jen DiMascio. "We're going to keep it up."

Frank and his allies point to the huge increase in U.S. defense spending during the past decade. There has been a lot of hand-wringing in the U.S. about China's new military capabilities, although by some estimates the proportional gap between U.S. and Chinese defense spending has actually widened since 2000, as it has with the rest of the world. "Washington is tired of defense," says Lazard Capital Markets analyst Michael S. Lewis. "The negative sentiment against defense is the highest I've seen on the Hill in 10 years."

And therein lays the danger. Lewis believes the programs most vulnerable to attack are big-ticket items, including shipbuilding, fighter aircraft such as the **Lockheed Martin F-35**, and electronics. "If you see much more of a cutback, it's going to make it very difficult for defense contractors to generate organic growth," he says.

But reaching an agreement to bring the deficit under control will require a grand compromise between Republicans and Democrats. A key question is whether Republicans will yield on their opposition to raising taxes. Late last year, they exacerbated the deficit crisis by forcing Obama to agree to extend tax cuts that were set to expire. Now Ryan and his colleagues could be forced to make a choice: protect funding for the military or the wealthy from higher taxes. Stay tuned. ☺

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.

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DEFENSE

Global Hawk Wings Clipped

The Northrop Grumman unmanned aerial system (UAS) is facing its second 25% breach of cost projections, triggering a review in accordance with the Nunn-McCurdy program-monitoring statute. The preponderance of the cost growth is attributed to the U.S. Air Force's decision to halve the buy of Block 40 UAS from a projected 22. If approved by Congress, the reduction will drive up the per-unit price. Other contributors to the breach include escalating costs resulting from diminishing manufacturing sources, depot activation activities for the Global Hawk's sensors and program execution, Air Force Secretary Michael Donley notes in an April 6 memo.

Dutch Duo

The Dutch government has decided to proceed with the purchase of a second F-35 Joint Strike Fighter test aircraft to be heavily involved in the operational test phase. The issue had been under review, with the Pentagon giving the Dutch government an extension until April 30 to decide. The Dutch defense minister, Hans Hillen, notes the involvement will give the ministry more insight into the operational potential of the aircraft and Dutch-specific requirements. Interoperability of the F-35 with other Dutch military equipment also will be examined.

Typhoon Strikes

The Royal Air Force has completed the first air-to-ground strike with the

Eurofighter Typhoon. The mission took place April 12 as part of combat operations in Libya. One Typhoon was flying with a Tornado GR4 when the two engaged ground targets near Misratah. The Typhoon employed an Enhanced Paveway II and the Tornado used a Paveway IV. The debut could be significant for export campaigns where the Typhoon lacked combat credentials.

Tornado Targeting

With the Tornado GR4 fleet now forming the backbone of the RAF's ground attack capability, the U.K. Defense Ministry has decided to fund an urgent operational need for a helmet-mounted, air-to-ground cueing system. The device is being adapted from the Harrier GR9, which should help to limit development time and effort. The goal is to have the system operationally ready this year.

Tanker Flying

Airbus Military has begun flight trials of the United Arab Emirates' first A330 Multirole Tanker Transport. Delivery of the first of three aircraft is planned for next year, although flights in the UAE are due to begin this year. The program involves some extra certification activities since the UAE is receiving Rolls-Royce Trent 700-powered A330 tankers that can also be used to receive fuel, a new configuration.

JAGM Cost Duel

The formal request for proposals (RFP) for the U.S. Army's multibillion-dollar Joint Air-to-Ground Missile contains no

major surprises, meaning the winner between a Raytheon-Boeing team and competitor Lockheed Martin could be determined by the long-term life-cycle costs of their respective pitches.

Sbirs Prepped for Launch

The U.S. Air Force and Lockheed Martin are planning April 22 to encapsulate the first Space-Based Infrared Satellite, GEO-1. Mating to the United Launch Alliance Atlas V launcher is set for April 25 in advance of a May 6 launch attempt. The satellite took on about 5,000 lb. of fuel April 8-11. Baseline integration testing has been completed on GEO-2, and it is being readied for environmental testing. Air Force officials expect to have GEO-2 ready for launch in about one year.

BUSINESS AVIATION

Pilatus Plans

Pilatus is planning to introduce a new general aviation aircraft, the PC-24, next year and to add workforce this year to support development of the aircraft. The PC-24 would augment the PC-12, which recently underwent a major upgrade into the PC-12NG. The Swiss aircraft maker delivered strong performance last year in both the military and civil sectors, with the United Arab Emirates order for 25 PC-21s (deliveries are due to begin this year) and the Swiss air force placing a top-up order for two more of the turboprops. Nevertheless, Pilatus acknowledges continued difficulty in the business aviation segment, highlighting lack of economic recovery in the U.S.

New Owner For SJ30

The SJ30 business jet is facing a potential new life as long-time supplier Metalcraft Technologies has emerged as the owner of the beleaguered aircraft program.

Metalcraft, a producer of sheet metal and precision parts in Cedar City, Utah, bought the light-jet program for \$3.5 million, plus the assumption of debt including \$1.688 million related to the production of SJ30 No. 12, court documents say. The U.S. Bankruptcy Court in Delaware cleared the sale on April 7, and an asset purchase agreement was executed the same day.

The former owners of the SJ30, Dubai-based Emirates Investment & Development Co., purchased the then-Sino Swear-

ingen in 2008 and renamed it Emivest.

Metalcraft bought the San Antonio-based company as rumors circulated about strong interest from Chinese buyers. China's Avic initially evaluated the program in 2005. While opting against the program then, Chinese investors reportedly renewed interest as they looked to expand their presence in the business and general aviation market. But just a month ago, Avic announced plans to buy piston-aircraft manufacturer Cirrus Aircraft.

Metalcraft has been involved with the SJ30 program since the mid-1990s, says Emivest, noting the company builds the aft fuselage and about 70% of the sheet metal parts for the \$7.25 million SJ30. The

long-term agenda for the aircraft remains uncertain, as Metalcraft executives spent their first week in San Antonio reviewing their new purchase.

"They plan to move the SJ30 into production," Emivest says. Metalcraft expects to provide further details of its plans after executives complete their review.

At the time of the purchase, Emivest had 31 employees, primarily to maintain the aircraft's type certificate and support the four aircraft delivered to date. The SJ30 program launched about 25 years ago as the vision of Ed Swearingen, but has been plagued with funding and production delays ever since. FAA granted type certification in 2005.

Israel Mulls Gap-Filler for JSF Delay

Changes in the F-35 Joint Strike Fighter program are forcing Israel to consider buying a squadron of used F-15Es or F-16s as a gap-filler, although such a move is not uniformly supported by the country's military.

Israel has pledged to acquire 20 F-35As under a \$2.75 billion contract, the first of which are to be delivered in 2016. However, schedule slippage in the core F-35 program means the aircraft will be delivered in their most basic configuration, without any Israeli electronic warfare systems. Those could only be incorporated into the JSF by 2018.

Therefore, the Israel Defense Forces (IDF) general staff, as well as the defense ministry, are suggesting deferring acquisition of JSFs until 2018 and filling the gap with a squadron of third-generation

fighters. Knowing that the Israeli air force (IAF) will soon be forced to decommission its aging fleet of F-16A/Bs, the plan is to buy F-15s or F-16s, which could be supplied on a short schedule. An F-15E purchase is seen as more likely if the aircraft are available. But the IAF strongly opposes this notion, saying the JSF should be deployed as early as possible, even if it means compromising on its electronic warfare requirements for a couple of years.

"The bare F-35s would still be ready for combat and provide a much required qualitative edge over our enemies," a senior IAF source told Aviation Week.

Delaying JSF procurement will enable other IDF services to use much-coveted U.S. military aid funds for other programs. The decision on what course to pursue will be left to Israel's prime and defense ministers.

PROPULSION

F-35 Diet Plan

Lockheed Martin is studying initial airframe weight savings of 100 lb. plus an additional 100 lb. in engine thrust as part of plans to increase the vertical-lift bring-back margin of the F-35B short-takeoff-and-vertical-landing variant, one of the key characteristics that will determine whether the F-35B survives the two-year probation period imposed by Defense Secretary Robert Gates.

Kakuda Checks

Inspectors for the Japan Aerospace Exploration Agency (JAXA) will know by May whether Kakuda Space Center (KSPC), the research group's leading site for rocket engine work, will require a major refitting after the earthquake that struck northeast Japan on March 11. The JAXA facility is the closest research site to the epicenter of the earthquake and is threatened by potential radiation from the damaged Fukushima Daiichi nuclear power plant. Despite the Nuclear Safety Commission of Japan raising the crisis level at the plant on April 11, JAXA officials say radiation levels appear not to be a concern at the space site.

LEA Back on Track

The Franco-Russian Mach 8 LEA hypersonic test vehicle in development by MBDA, French research agency Onera and several Russian aerospace partners is back on track for the first ground test runs of the complete engine, following resumption of funding. The project aims to use several flights to prove that a hypersonic aircraft or missile can be developed through a methodology based on rigorous

ground tests and simulations. For the tests, the 4.2-meter-long (14-ft.) LEA will be dropped from a Tupolev Tu-22M3 bomber at Mach 1.7 and boosted by a modified Raduga Kh-22 (AS-4) anti-ship missile.

MAINTENANCE

Poseidon's Adventure

The U.S. Navy's P-8A Poseidon multimission patrol aircraft will be the first of the service's airborne weapons systems to undergo a new Support System Design Review initiative. The Navy is trying to develop and implement a formal design review construct "to ensure that all aspects of the support system are appropriately designed, integrated, testable and sustainable." Rear Adm. Timothy Matthews, commander of the service's Fleet Readiness Centers, highlighted the initiative at Aviation Week's MRO Military conference in Miami Beach.

UAS Sustainment

While annual sustainment spending for U.S. manned fighters will remain around \$1 billion or even decline for the rest of the decade, unmanned aerial system (UAS) sustainment will grow to nearly \$3 billion a year by 2018, according to Hal Chrisman, a principal at AeroStrategy. Moreover, operators are beginning to look for alternative providers to the original equipment manufacturers, he says. Now that "affordability" is driving the Pentagon's budget-making, the Air Force is looking for more competition for sustainment of the combat capabilities that were quickly mounted in Iraq and Afghanistan operations.

Gear Service Broadened

Boeing Material Services business unit has extended a landing gear overhaul and exchange program to cover the 777-300ER, -200LR and 777F. The overhaul and exchange program is used by 75 customers with eight aircraft types.

AIR TRANSPORT

Three's a Crowd

Air Canada is contemplating a third attempt at a low-cost subsidiary that leaked documents show will operate as many as 50 aircraft, including 30 Airbus A319s and 20 Boeing 767s. The subsidiary, proposed under a new tentative labor accord with the mainline carrier's pilots, will hire crews under a separate mechanism, with hourly wages and defined contribution pensions instead of the salaries and defined benefit plans offered legacy pilots.

China Compromise

Embraer and Avic have reached a compromise to avert the shutdown of a joint Chinese production line that has been assembling Embraer jets since 2003. Output would shift from ERJ 145 regional jets to Legacy 600/650 business jets, which are derived from the now-discontinued ERJ 135/145 family. The last of 41 to be assembled at the Chinese plant in Harbin is scheduled for delivery this month.

Correction: An article on p. 80 in the April 4 edition incorrectly described aircraft activities from the USS Enterprise. The carrier was near Libya but its aircraft were not pressed into operations there.



BY MICHAEL MECHAM

Northern California
Bureau Chief Michael Mecham
blogs at: AviationWeek.com
mecham@aviationweek.com

COMMENTARY

Right on the Button

Boeing gives RFID a needed boost

The application of radio-frequency identification (RFID) tags has been slow in coming to commercial aviation. Costs are the big restraint and the technology is not applicable in quite as many ways as early supporters hoped.

But low-cost chips are being embedded by some airlines in luggage tags because RF tracking has a better success rate than straight-line bar-code scans.



SNAP-ON



MACSEMA

More complex tasks include an instant read on the maintenance pedigree of a replaceable part to see if its useful life is up or whether it is time to overhaul a rotatable part. The ability to drill down into the history of a part is limited only by the chip's memory size.

Boeing and Airbus helped to lead the Air Transport Association's Spec 2000 drive for common RFID standards, and they later moved on to an electronic product code in a push to advance an aviation e-marketplace.

Despite all these developments, U.S. military services, not commercial aviation, are the leaders in RFID technology. Still, Boeing, Lufthansa and others are persistent. Boeing has teamed with Fujitsu to create airline maintenance's newest remote-sensing technology application. Called Component Management Optimization (CMO), it grew out of a 2005 request from Japan Airlines, which was spending as much as 13 hr. to perform one-by-one visual inspections of oxygen generators. JAL wondered if RFID chips might reveal the maintenance and performance status of the

generators in a simple scan. It could. A technician walking down an airplane aisle can complete an RFID oxygen generator check in a mere 8 min., says Boeing CMO Program Manager Phil Coop. Similarly, passenger life vests can be quickly inventoried. Because the chip detects if the vest's storage pouch has been disturbed, it also can reveal if it needs to be inspected or replaced.

Boeing expects to announce its launch customer for CMO this week, Coop says. Initially, it will be applied to managing cabin emergency equipment. Later, Boeing will add asset management features to cover rotatables, repairables, airframe degradation, essential cabin equipment and powerplants.

Through trial and error, Boeing found that RFID is not the solution for every task. Sometimes its antenna can be fooled; in other instances the environment is too harsh. So CMO also will make use of Contact Memory Buttons from MacSema of Bend, Ore. The golden-colored, coin-size buttons have been used for years on military aircraft, such as the two shown monitor-

ing a line-replaceable unit on an AH-64 Apache (right photo), says MacSema Vice President Denis Boulet. Boeing is the first to apply them to civil aircraft.

Even when RFID is not the best solution, it has prompted a search for something that is. For the better part of a decade, Snap-on struggled with how to apply the chips for better inventory control of aerospace hand tools. But even the smallest chip could not be applied to a thin-wall socket without jamming it. Snap-on's solution was to adapt laser technology that it sells to auto repair shops for wheel alignments.

Customers such as Raytheon Co., Sikorsky and the U.S. Air Force wanted better accounting of hand tools to improve their asset management control. They also were interested in anything that might reduce the chance that an unaccounted-for tool became a source for foreign object damage (FOD), Joe Chwan, director of Snap-on's worldwide aerospace sales, explained during Aviation Week's MRO Conference and Exhibition in Miami last week.

The Kenosha, Wis.-based company has introduced a roll-away tool chest that uses a laser scanner to record the position of every tool in a drawer, right down to replaceable screwdriver heads called Apex bits (left photo). If a torque wrench is due for recalibration, the chest warns a technician. And it always demands that tools be put back in their rightful location. Even a worn-out Apex bit must be replaced so it can be accounted for. The chest will alert the tool-crib manager so it can be disposed of properly.

Lufthansa Technik Logistik is one of many maintenance specialists pushing for RFID acceptance. By the end of the year, the company expects to introduce its own RFID applications. The chips will first be applied to manage oxygen generators, says Tom Burian, Lufthansa's RFID project manager.

In the early days, RFID technology was not mature enough for aviation applications, says Burian. Now cost is one big restraint, the need for wider acceptance by supply-chain managers another. Asset managers at MRO say the best solution will come when big commercial businesses start ordering RFID so chip prices plunge. As one of them says: "Hurry up, Wal-Mart!"



Transport Editor
Andrew Compert blogs at:
AviationWeek.com/thingswithwings
andrew_compert@aviationweek.com

COMMENTARY

Big Questions

A380 incident at Kennedy Airport heightens ground safety concerns

The April 11 mishap at a taxiway intersection at New York's John F. Kennedy International Airport, in which the wingtip of a taxiing Airbus A380 struck the tail of a Bombardier CRJ700 regional jet and spun the smaller aircraft nearly 90 deg., is raising some big questions.

More precisely, the incident raises questions about how to ensure safe ground operations of really big commercial aircraft.

The incident occurred at nighttime, and the Air France A380 crew, taxiing to a runway for takeoff, may not have noticed that the regional jet, operated by Delta Connection carrier Comair, had stopped instead of proceeding to its gate, especially with the light rain, darkness, reflections of light and glare, suggests Kevin Hiatt, a former Delta Air Lines pilot who is now executive vice president of the Alexandria, Va.-based Flight Safety Foundation.

No one was injured, but the mishap drew wide media coverage and Internet saturation, largely because of a video showing the strike and spin. Inevitably, size-related safety questions arose.

The Airbus A380 is the biggest of the commercial airplanes, with dimensions that include a wingspan of nearly 262 ft. (80 meters), about 50 ft. wider than on a Boeing 747-400. But the conversation also included Boeing's 747-8, a freighter with a wingspan of 225 ft., about 13 ft. longer than on a 747-400.

The FAA sets design standards that govern how an airport must be configured to safely accommodate aircraft with certain dimensions. A 747, for example, operates under Design Group V standards. The A380 and 747-8 are supposed to operate under Design Group VI standards, which call for wider taxiways and more separation from the service road.

Some of those standards are intended to reduce the risk of aircraft bumping into each other while moving on the ground. But those standards are much easier to accomplish if an airport is starting from scratch; it might not be feasible or practical to implement

them at an existing airport, particularly one with limited space.

That is why many airports have applied for waivers from the Group VI standards by submitting alternative proposals for maintaining an acceptable level of safety, which must be accompanied by safety studies. The FAA has granted more than dozen waivers for airports that committed to precautions such as restricting which taxiways and ground routes the larger aircraft can take, or perhaps adjusting what other aircraft can do while

the bigger aircraft are on the move.

One of those airports is Kennedy, so it is not surprising that the incident draws the waivers into question.

It is not a trivial concern for safety—or the airplane manufacturers, which need the waivers so their aircraft can operate at more airports. The idea of the A380, after all, is to provide more capacity at congested airports, and many more of the airplanes will be flying in the coming years, serving airports with a lot of moving pieces.

"Kennedy is one of those places where things are always moving and always changing," says Hiatt, who flew for Delta for more than 26 years.

In reality, however, both Airbus and Boeing probably can rest easy. The NTSB investigation is likely to focus as much on the Air France crew and ground control as on the waivers, if not more so. But the incident should create more caution.

"I don't think really it's a systemic problem, but I do think it's an issue that needs to be looked at," Hiatt says of the movements of aircraft with larger wingspans. "You have to make sure those big guys have the proper clearance."

Dick Marchi, a senior adviser for Airports Council International-North America, suggests controllers, who devote more attention to runway clearance, might be given more responsibility for taxiways.

So, is this incident indicative of a big problem? Based on the evidence seen so far, it is not yet. But a little more vigilance would be helpful, lest it become one. ☹

An Air France A380's wingtip was damaged when it struck a Delta Connection CRJ700's horizontal stabilizer at JFK Airport April 11.





Senior Editor Frank Morring, Jr., blogs at: AviationWeek.com/onspace
morring@aviationweek.com

COMMENTARY

Spacefaring Planet

Global space economy becomes more global

China is getting ready to roll out its answer to the U.S. Global Positioning System, following launch of its eighth Beidou (Compass) navigation satellite April 10. The launch—on a Long March 3A from the Xichang launch center—underscores a point made by the Space Foundation in its annual report on the state of the spaceflight endeavor.

"The space community continues to grow in size and scope, and the number and range of countries partaking in space-related activities continues to increase each year," states the foundation's Space Report 2011, released at the annual National Space Symposium in Colorado Springs last week.

It isn't news that China is undertaking an ambitious program of human and robotic spaceflight. But while China's may be the most spectacular emerging space program—tying the U.S. with 15 space launches last year—it is not alone.

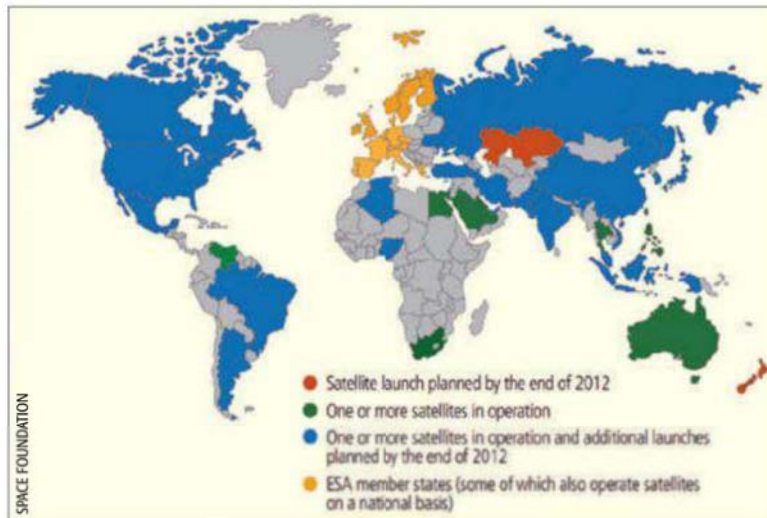
"As of the end of 2010, government, commercial, or academic organizations in at least 52 nations—including the 18 member states of [the European Space Agency]—were operating one or more satellites, or planning

to launch a satellite before the end of 2012," the report states in its outlook section. "Space participation is poised to continue this internationalization."

As this map indicates, most of the world's territory can claim a piece of a satellite. Among the new nations becoming involved are Mexico and South Africa, both with new space agencies. Australia, long a spacecraft-communications venue for other nations, set up a unit in 2009 to craft its own national space policy.

Space business is also internationalizing, according to the foundation's evaluators. They counted headquarters

in 26 countries for the top 75 satellite manufacturers, operators and service companies of various types, as measured by revenue in 2010. Among them was the Isle of Man, a self-governing British dependency in the Irish Sea that claims the world's oldest continually operating parliament, the Tynwald. It



has parlayed that quasi-independence into becoming a space-industry financial entrepot, where commercial space companies can find favorable conditions for their risky business.

"Elements of the Isle of Man's policy and regulatory approach to space commerce offer possible models for spacefaring nations to adopt as they seek to develop competitive programs," the Space Report states.

At the other end of the scale is China, which in October 2003 joined Russia and the U.S. as the only nations able to put humans into space. Plans for Beidou show China's continuing ambitions

in civil space. The latest Beidou bird went into an inclined elliptical orbit designed to increase coverage over China, according to Chinese press reports. The Beidou constellation now consists of three spacecraft in the inclined orbits focused on China, and five in geostationary orbits. Officials of the China Satellite Navigation Management Office say the constellation is ready to begin system checkout and adjustment, after which it will offer "basic navigation services," according to *China Daily*.

China plans at least two more launches by the end of 2012. Ultimately, it aims to orbit 35 Beidou spacecraft to provide an indigenous alternative to the U.S. GPS, Russian Glonass and European Galileo satnav systems.

India, too, is ramping up efforts, moving away from its traditional use of space assets to provide its rural villages with crop and water-table data. Hard on the heels of the Chandrayaan-1 lunar orbiter, which proved that there is water on the Moon, the Indian Space Research Organization plans to launch its first astronomy mission, Astro-sat, later this year, and it continues to build toward its own human spaceflight capability.

Meanwhile, Russia, the first to achieve that feat, included ambitious plans to use its energy wealth to upgrade its space program in celebrating the 50th anniversary of Yuri Gagarin's flight April 12.

With a new cosmodrome being built at Vostochny in eastern Siberia, slated to begin launching humans in 2018, Prime Minister Vladimir Putin called for Russia to boost its share of the international launch market to 50% from 40% and send robotic probes into the Solar System again.

As space becomes more important, the traditional cooperation in civil space is moving into defense as well.

"Decision-makers . . . must consider the implications of any actions they take, as it is seldom possible to effect a change in a particular space activity without having an impact in other areas," the 2011 report says. ☛



BY JAMES R. ASKER

Managing Editor
James R. Asker blogs at:
AviationWeek.com

jim_asker@aviationweek.com

COMMENTARY

Here We Go Again

Roles? Missions? Budgets? Who can predict

The newly invigorated discussion here over how much—not whether—to cut defense spending may trigger another no-less painful re-examination: What are the roles and missions of the U.S. armed services? The debate will be the second such national security review in as many sessions of Congress. Legislators seem no more prepared for this review than the last.

President Barack Obama and Defense Secretary Robert Gates announced last week that a deep re-assessment of

UPI/LANDOV FILE PHOTO



‘I have completed the program required by the FAA.’

SEN. JAMES INHOFE

military roles and missions was underway in the Pentagon—a condition Gates has long argued was necessary before any more major budget cuts occurred (see p. 24).

“It is important that any reduction in funding be shaped by strategy and policy choices and not be a budget math exercise,” one Gates aide emphasizes. The Pentagon provided a Quadrennial Roles and Missions Review Report to Congress in January 2009 after then-chairman of the House Armed Services Committee Ike Skelton (D-Mo.) demanded it following the Iraq surge. But that document satisfied no one. Current lawmakers are not much further on the issue. Skelton’s successor as committee chief, Rep. Howard “Buck” McKeon (R-Calif.), says even declaring \$400 billion in future reductions over multiple years is at least premature before “completion of a comprehensive review of our military’s roles and missions.”

SALES TIPS

Ronen Sen, a former ambassador of New Delhi, shares some insight for companies seeking to get in on India’s multibillion-dollar defense modernization. First, India will remain heavily dependent on Russia for defense equipment, at least for the time being.

Next, price alone will not determine the winner of competitions. “Russia, the U.S. and other partners will have to demonstrate their competitiveness through a substantially increased serviceability of their [weapons] systems,” he says. That includes product support as well as upgrades. He also decries the “inadequate involvement” of India’s privately held companies, but is not optimistic that will change anytime soon. Procurement procedures effectively have tied the hands of India’s own defense industry. “From all appearances,” Sen says, “the defense minister is very suspicious of the private sector.”

SLEEPING DISORDER

Heads start to roll at the FAA after yet another snoozing air traffic controller prompts an angry Transportation Secretary Ray LaHood to mandate at least two controllers in towers across the nation’s ATC system. Henry Krakowski, the top official at the FAA’s Air Traffic Organization, resigned last week after his politically appointed superiors assured the traveling public

they would make all involved with these safety breaches accountable. FAA Administrator Randy Babbitt named chief counsel David Grizzle—like Krakowski a seasoned industry veteran—as ATO’s acting chief operating officer while he seeks a permanent replacement. LaHood’s mandate, meanwhile, is received with the partisan support now expected in Washington. Democrat Jay Rockefeller (W.Va.), the transportation chief, applauds the decision; Republican John Mica (Fla.), his counterpart in the House, criticizes it as a waste of resources. These two legislators will likely have more to say as LaHood and Babbitt join forces with the National Air Traffic Controllers Association to conduct an independent review of the FAA’s air traffic control training curriculum and qualifications and to expand Natca’s Professional Standards committees.

PUT THAT CAP BACK ON

After nearly shutting down the government, Congress and the White House opted to squeeze \$446 million out of the Transportation Security Administration’s budget request and restore the cap on airport screeners at 46,000 full-time employees. Rep. Harold Rogers (R-Ky.), the chairman of the House Appropriations Committee, was a proponent of the caps back when he led the Homeland Security subcommittee. When the Democrats took control of the House in 2007, it was scrapped. Now, it’s back.

STUNT FLYING

The piloting antics of Sen. James Inhofe (R-Okla.) returned to public consciousness this week when document clearinghouse The SmokingGun.com circulated FAA records and recordings about an incident last year when the lawmaker landed his Cessna 340 on a closed runway. In a conversation with the FAA, the manager at Port Isabel-Cameron County Airport in Texas says Inhofe “is famous for these violations” and needs to be stopped, adding, “I have never seen such a reckless disregard for human life.” Inhofe attended remedial lessons and contends that this is old news: “I have completed the program required by the FAA, and this matter is over.”

DIVIDE AND

Electronic battlefields are carved out, but their management remains a mystery

DAVID A. FULGHUM/WASHINGTON

With warfare in the electromagnetic spectrum a rapidly growing reality, the U.S. Navy and Air Force are dividing up the world of airborne electronic attack and planning to create a battle management system to organize the nation's electronic shield on the model of its kinetic air-to-air defenses.

It would tie together the military with an IP-based network to coordinate electronic effects (like disabling air defenses) and manage the spectrum (perhaps by jamming a foe's secure communications). The plan also explains why the Navy is packaging its Next-Generation Jammer (NGJ) in an underwing pod that ruins the radar cross section of any low-observable aircraft.

The Air Force and Navy have divided up the aerial electronic battlefield to ensure that each can validate its spending. The Air Force has invested heavily in stealth and wants to keep those units relevant for the electronic attack mission despite the improving lethality of new air defense systems. The Navy has spent the most on electronic surveillance, attack and warfare. Additionally, it has volunteered for the standoff and escort jamming mission for joint warfighting.

"To take an externally carried asset like NGJ and clap it on a low-observable [LO] airplane, they believe, doesn't make sense," Capt. John Green, the Navy's airborne electronic attack program officer, told Aviation Week at the Navy League's Sea-Air-Space Exposition.

The Navy will use its non-stealthy, electronic attack aircraft like the EA-18G Growler for standoff jamming, often for stealthy Air Force strike aircraft and other platforms that must penetrate modern air defenses. The Navy also will use unmanned aircraft such as the jamming variant of the Miniature Air

Launched Decoy (MALD-J). Navy equipment will use longer periods of jamming to affect their target. Such high-density emissions can make aircraft vulnerable to home-on-jam missiles.

The Air Force will slip deeper into enemy air defense rings with its LO aircraft to deliver cruise missiles and Mk. 84-like conventional bomb shapes as well as internal multi-shot payloads that deliver fast pulses of high-power microwaves (HPM) designed as anti-electronics weapons. The fast-weapons-release capability of stealth aircraft allow the use of short-pulse weapons without giving home-on-jam missiles time to track them. The cruise missile and Mk. 84 type weapons are being developed by the Air Armaments Center at Eglin AFB, Fla.

"Expendables are very important," Green concurs. "They solve some of those self-protection issues. I certainly see [the Air Force's side of electronic attack] that way. We have done bombing with low-observable aircraft, but the window of vulnerability [when the weapons-bay doors are open] is very small."

Vulnerability will still be low for a stealth aircraft if it drops a bomb with an HPM warhead or carries a multi-shot payload that emits only a short-duration blast of high energy.

"Concepts of operation for any kind of stand-in is going to be critical," says Green. "How close can you get and for how long? Are there exotic ways we can do the [airborne electronic attack] mission? Can we bombard systems with electronic warfare and not get caught?"

In addition to stealth aircraft, the stand-in jamming and electronic attack mission will be carried out by unmanned aircraft and standoff weapons such as cruise missiles.

"The traditional definition of 'stand-in' is when you are in a weapons-engagement zone," says a veteran Navy pilot.

DEFEAT



TED CARLSON/FOTODYNAMICS.COM

"The need to get closer to the thing you are trying to jam [disrupt or destroy] is buffered by the fact there are lots of things out there that can do jamming and many of them are very capable. That could lead you to unmanned [platforms] for stand-in jamming."

The reality is that there are lots of platforms collecting data but no common operating picture or centralized command and control for electronic warfare (EW) as there is for air-to-air combat. This is a problem that must be solved now, Navy and Air Force officials say. The joint concept is called Electromagnetic Battle Management (EMBM) and includes electronic attack (which includes jamming), electronic surveillance and spectrum management.

"We want to take EW where Link 16 [networked communications] took air-to-air battle management," says Green. "We have to determine the services that are needed and how we ensure they are common across the joint battlefield. The solution, we believe, is an IP-based net-

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The Next-Generation Jammer, to be carried by the EA-18G, will serve as only one node in a massive Electromagnetic Battle Management network

work with lots of relays and bridging.

"We're very reliant on the [EA-6B] Prowler and [EA-18G] Growler; but smaller, less expensive assets are capable of doing that [EW] mission," he says. "Having those assets plugged into the [EMBM] network will lower the cost of doing business. We also want to integrate a lot of national and joint assets that are already out there. There is a lot of capability at the operational and strategic level with information that can be brought to bear."

In fact, the first network merger was in 2009 when Corporal (which allows electronic "fires" to be delivered on demand to small units) and the Intrepid Tiger 1 communications jammer were linked.

"We need the EMBM backbone for a [Defense Department-wide] electronic warfare strategy," Green says. That would allow "real-time management of the EM spectrum, [training of] electronic attack and surveillance planners and executors, [as well as] the incorpora-

tion of compatibility, evaluation and algorithms for control systems." Another need is off-board, remote and real-time programming for fast-reaction, distributed EW.

At least one key question remains: Just how vulnerable are U.S. airborne electronic warriors themselves to electronic attack? Both China and Russia have introduced large phased-array radars into air defense systems. These devices are also available on the international market. The last several reports to Congress on China's military mention directed-energy weaponry.

Industry officials, very briefly and without detail, refer to work underway on the creation of "unbreakable links" that would protect the new network. They also suggest that operations in the world of electronic attack are like those in kinetic combat. You map the defenses and compare them against your capabilities and then create operations that do not place assets where they cannot survive. However, the polluted elec-

tronic environment that the U.S. created around Baghdad and in parts of Afghanistan has proven capable of hobbling some of the coalition's most important communications and data links.

The Navy's top airborne electronic attack expert suggested that there are other options in EW development.

"There is state-of-the-art technology that will let you jam, but not become a victim of home-on-jam," Green declares. "That's an area that the Defense Department is going to have to understand and invest in for the future."

The Navy's unmanned carrier-based unmanned combat aircraft may be a candidate for that mission.

"I know [the Navy's unmanned strike aircraft] program is interested in electronic attack," Green says. "We've had some preliminary discussions on that. I think we have to do some more homework on concepts of operations because the last thing we need is to have a big beacon on a low-observable unmanned [aircraft]." ☐

Fractured by Strategy

'Disaggregated' satellite constellations could follow decades of bloated designs

AMY BUTLER/COLORADO SPRINGS

After years of attempts by the U.S. intelligence and defense space communities to jointly develop satellites to serve their diverse needs, an amicable divorce appears to be under way as the two communities explore future constellation architectures.

And they appear to be taking vastly different architectural approaches.

The Pentagon, which supplies satellite services for deployed forces, is exploring the concept of "disaggregation" or "passive resilience"—distributing its space-based capabilities across more platforms.

The National Reconnaissance Office, which develops and operates U.S. classified satellites, is taking a different approach. Though the NRO often deploys small experimental systems, the preponderance of its requirements will likely continue to be met with very large, highly capable and expensive satellites, says U.S. Air Force Maj. Gen. Susan Mashiko, deputy NRO director.

While Air Force Space Command and others are exploring new ways to provide long-standing services—including missile warning, communications and space situational awareness—there is a deliberate push not to lose sight of the need to execute today's programs in the near term.

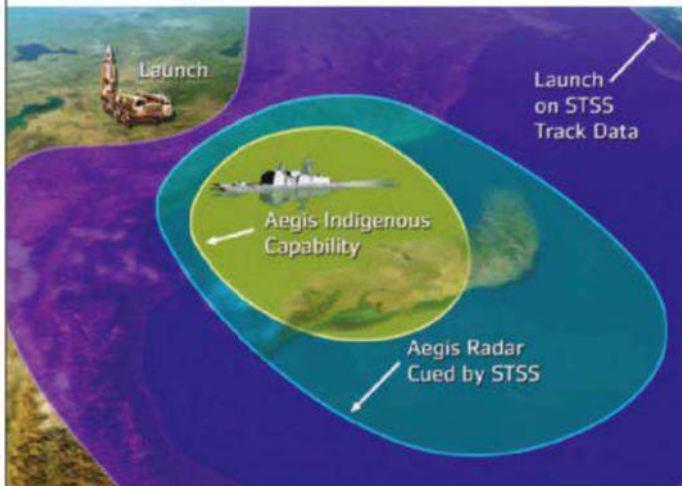
These projects—the Space-Based Infrared System (Sbirs), Wideband Global Satcom, Advanced Extremely High Frequency system and others—came at high cost in the past 15 years of technical and management challenges. Officials are loath to squelch those investments by abruptly embracing a new architecture and plunging into new designs.

So the increased talk by senior Pentagon officials at last week's 27th National Space Symposium here about disaggregation is likely the beginning of a long process to deliberately reshape constellations. "The die is cast for the next 10-15 years just because of the development timelines, . . . but there is an opportunity right now to start to turn this ship," says Gen. William Shelton, Air Force Space Command chief. "I am absolutely convinced there are better ways to do the mission we are charged with doing. . . .

I'm more right now thinking of disaggregation, not aggregation."

There has been sporadic interest in crafting a distributed satellite network, but there has also been little impetus to embrace it. Partly due to the high cost of launch, the Defense Department has continued to build small numbers of very large, sophisticated and expensive satellites. For the foreseeable future, the cost of launch will not change.

But two major factors are changing. Downward pressure on the federal budget may force the Pentagon to get creative and abandon the sophisticated designs of the past. Perhaps more com-



A space-based missile-tracking capability is expected to sharply increase the defended area for ballistic missile interceptors in the U.S. arsenal, allowing for a launch from an STSS or PTSS target cue and earlier intercept.

elling for defense officials is the sharp increase in the number of operators in space, making it more difficult and dangerous to operate there. The vulnerability of satellites, many costing well over \$1 billion, to orbital debris, jamming or an antisatellite weapon has increased.

The disaggregation concept calls for a distributed architecture that can execute the majority of its mission even if one satellite is compromised. It can be achieved by fielding more satellites or more payloads hosted on non-defense platforms or devising alternate data paths.

In addition, to address the increased

threat and reduced funding, Pentagon officials are exploring how to simplify satellite designs, which goes hand in hand with disaggregated architectures, defense officials say.

The Pentagon is buying hosted UHF communications payloads now, but that is due to urgent need, not a strategic bent toward producing a new architecture.

These two new approaches could play out more deliberately in the missile-warning and -tracking arena in the next decade. The Missile Defense Agency will pursue a simpler design for its next space-based missile-tracking system than the two Northrop Grumman Space Tracking and Surveillance System (STSS) satellites now conducting a demonstration in space.

MDA's choice was based on a recommendation from the Johns Hopkins University Applied Physics Laboratory (APL), which leads the study of design options for the follow-on Precision Tracking Space System (PTSS).

Two Northrop Grumman satellites

are designed with both target acquisition and tracking sensors made by Raytheon. Together, the sensors were designed and have proven the ability to conduct "birth-to-death" tracking of ballistic missiles. "It is actually showing that the space layer can contribute birth-to-death tracking," says Doug Young, vice president of missile defense and warning programs at Northrop. "It is causing folks to really rethink BMD

possibilities." During one exercise last month, the satellites proved "stereo tracking"—or passing off target tracking from one satellite to another.

While the STSS acquisition sensor is designed to detect a hot missile plume in the shortwave infrared (IR) bands, the tracking sensor is optimized to follow a cold warhead during its difficult-to-detect midcourse of flight using mid- and longwave detectors. This requires multiple onboard focal planes and telescopes.

For PTSS, however, MDA is opting to forgo target acquisition, and design a satellite for tracking only, to reduce the price

and risk for development. This will drive MDA toward improved communications and networking for offboard cueing.

APL has issued six subcontracts—to Lockheed Martin, Boeing, Northrop Grumman, Raytheon, Ball Aerospace, and Orbital Sciences Corp.—for final design input, but an acquisition and manufacturing plan is not yet firm. APL will likely design and build the first two development satellites, and up to 10 more could be produced by industry. Though launch was originally planned for 2014, it is now expected in 2016.

Meanwhile, the Pentagon could eventually shift to a disaggregated architecture for the IR missile-warning mission beyond Sbir. Prime contractor Lockheed Martin is slated to build four Sbir geosynchronous birds and two more are expected to be purchased through a block buy approach. But senior defense officials argue there is still opportunity for a parallel disaggregation strategy without terminating Sbir purchases.

Technology for wide-field-of-view focal plane arrays needed for a future missile-warning system is maturing. Raytheon is among the companies developing these arrays, partly because the Pentagon funded a parallel sensor path for fear Sbir would crater. But, without some assurance that continued company funding will eventually come to fruition in a formal government program, Raytheon will have to consider leaving the market, says Tom McDonald, a director at Raytheon Space and Airborne Systems.

Raytheon is proposing a modular approach to future space-based missile-warning and -tracking. Building off of its Responder modular satellite concept, the company is proposing a missile-warning toolkit. The concept calls for common-use components—such as processors, cryocoolers and telescopes—mated with specialized focal plane arrays optimized for a particular mission, such as short-wave IR for missile warning and long-wave IR for missile tracking.

Meanwhile, a select group of contractors could pair up for work, if the Lockheed Martin/Northrop Grumman team loses its grip on the early missile-warning mission now occupied by Sbir. Northrop Grumman and Boeing executives have quietly signaled they would be interested in priming a future team, though Northrop now officially supports the Lockheed-led Sbir program because its Azusa, Calif., facility builds the payload.

Other potential payload providers include Raytheon and Goodrich. ☐

And They're Off

Hardware and designs are in place as sprint to replace the space shuttle begins

FRANK MORRIS, JR./COLORADO SPRINGS and JEN DIMASCIO/WASHINGTON

Contractors and wannabes will push hard in the weeks ahead to capture some of the \$18.5 billion NASA has to spend by the end of September.

Congress's compromise continuing resolution finally puts some new money behind the space policy Congress and the White House have debated since President Barack Obama issued his fiscal 2011 NASA budget request in February 2010.

Obama's call for termination of the Bush administration's back-to-the-Moon Constellation program put the entire human exploration program, including replacements for the space shuttle fleet, up for grabs. With Constellation now officially dead, the way is clear to turn its remnants—or something new—into the next U.S. human-spaceflight capability.

The compromise funding measure that runs through Sept. 30 includes \$1.2 billion for a Multi-Purpose Crew Vehicle (MPCV) based on the Orion crew exploration vehicle started under Constellation. Prime contractor Lockheed Martin continued work on that vehicle throughout the Washington power struggle, using funds NASA was required to spend by appropriations language that forbid it to terminate Constellation.

The first Orion test article is about to enter testing at the company's Denver facility, and Program Manager Cleon Lacefield says it can fly as early as 2013, provided a launch vehicle can be found by then. For the first unmanned test flight, that could be a Delta IV Heavy, or an early version of the heavy-lift Space Launch System (SLS) that Administrator Charles Bolden has said may "evolve" in its lift capability to about 130 from 70 metric tons.

That ball is still in NASA's court. Engineers at Marshall Space Flight Center are wrapping up their evaluation of alternatives for a heavy-lift rocket, with a final decision due in June. So far, the tentative choice of a reference design that would use five space shuttle main engines in the first stage and a J-2X in the upper stage is holding up (AW&ST April 4, p. 31).

Pratt & Whitney Rocketdyne is posi-

tioned to forge ahead on a throwaway shuttle engine, designated the RS-25E, and is gearing up for the first hot-fire test of a complete J-2X. Alliant Technologies has continued working on the five-segment version of the shuttle solid-fuel booster rocket that was to have been the first stage of Constellation's Ares I crew launch vehicle and is now the twinned booster for the reference design.

Boeing, prime contractor on the Ares I upper stage, is putting the finishing touches on a more affordable version of that stage that would retain the J-2X and the liquid oxygen tank from Ares I, but substitute a shorter and wider liquid hydrogen tank for simpler production.

James Chilton, who managed both the Ares I upper stage and the shift to the new design Boeing is fleshing out, says the thrust is on innovations in production and elsewhere that will be affordable at the low flight rates that are likely for a government rocket aimed primarily at deep-space exploration.

The compromise budget includes \$1.8 billion for the heavy-lift Space Launch System (SLS) in fiscal 2011, so there should be plenty of money to begin whatever new design NASA chooses. The launcher and Orion-based crew vehicle were both spelled out in NASA's three-year authorization act, which Obama signed in December, as government-owned alternatives to the commercial cargo and crew vehicles the administration originally intended to be the sole U.S. route to the International Space Station (ISS) when the shuttle retires.

That work has also proceeded while the debate raged, and some of the results were on display at the 27th National Space Symposium in Colorado Springs last week. A tent on the grounds of the Broadmoor resort contained the Dragon capsule that Space Exploration Technologies Inc. (SpaceX) has flown to orbit and recovered at sea, as well as mock-ups and test articles of Orbital Sciences Corp.'s Cygnus cargo vehicle and Boeing's CST-100 crew vehicle.

Dragon is the clear leader in the commercial race to begin delivering cargo



The first Orion test article arrives at Lockheed Martin's Denver facility, where it is being fitted with its thermal protection system prior to ground testing.

to the ISS, and it can be configured to carry crew as well on the SpaceX Falcon 9 launch vehicle. The first Taurus II developed to carry Cygnus to space is at its new launch facility at Wallops Island, Va., and the first Cygnus is in final assembly. Both were developed with public and private funds under the \$500 million Commercial Orbital Transportation System (COTS) seed-money effort, while Boeing started work on the CST-100 with federal stimulus-package money awarded under the first phase of the Commercial Crew Development (CCDev-1) program kicked off in conjunction with the fiscal 2011 budget request.

Sierra Nevada Corp., the big winner in the CCDev-1 competition at \$20 million, is developing its Dream Chaser lifting body as another crew vehicle candidate, while Orbital Sciences has proposed a "blended lifting body" shape for its commercial crew candidate (AW&ST Jan. 24, p. 166).

NASA has been ready to announce the winners of CCDev-2 for weeks, waiting for the logjam over the continuing resolution to clear on Capitol Hill before going public. Officials have said the second tranche will total about \$250 million and, after the \$3 billion total for the heavy-lifter and MPCV, there are still

plenty of funds in NASA's \$3.8 billion exploration account to cover that.

As has been the case since the fiscal 2011 budget request was released last year, NASA had little to say about its final budget figure in the continuing resolution or about precisely how it will be spent. "We're evaluating the information now regarding the fiscal year 2011 budget, and it's too early to speculate on specifics," a NASA spokesman says.

Privately, officials say the mood at agency headquarters was one of relief at the figure. The topline amount was \$516 million less than the original fiscal 2011 request, which was not bad, given the fierce budget-cutting rhetoric in Congress since the Republicans took over the House in the 2010 midterm elections.

NASA's final spending levels for fiscal 2011 include \$5.5 billion for space operations, an increase of \$621 million from the budget request, according to figures tabulated by Marcia Smith, founder and editor of the Space Policy Online website.

That should cover the final flight of Atlantis on the STS-135 mission in June,

which will wrap up the shuttle program and buy NASA an extra year for the commercial cargo carriers to finish their vehicles and begin operations.

That is important, because the space operations figure also includes funds to begin utilizing the ISS as an orbiting research facility, work that will continue at least until 2020. Present plans call for U.S. commercial cargo vehicles such as Cygnus and Dragon to start regular resupply operations in 2012, and Atlantis's final flight will allow that to stretch into 2013 without a reduction in the six-person crew or other cutbacks (AW&ST March 7, p. 26).

As has often been the case, NASA's aeronautics program was held flat in the compromise funding measure, rising only \$34 million from its fiscal 2010 level, to \$535 million. That is \$617 million less than was requested.

The agency's science program did better. It will have \$4.9 billion to spend for the remainder of the year, up \$476 million from fiscal 2010 and just \$61 million less than requested.

The bulk of the rest of the spending will go for cross-agency support, funded at the requested level of \$3.1 billion. NASA education programs will receive \$146 million, the requested amount. ☐

A \$400 Billion Fight

Obama, Congress square off on budget debate

JEN DIMASCIO/WASHINGTON

President Barack Obama did more than lay down a marker last week when he proposed \$400 billion in new cuts to security spending in the next 12 years; his remarks emboldened a corps of fiscal hardliners seeking to lop nearly \$1 trillion from military accounts.

Here's the kicker: They may have a shot.

Although the momentum had until now been on the side of those who want to protect defense coffers, the president's plan moves the starting point of negotiations on future budgets in the direction of deep cuts—something the nation's top executive has heretofore been unwilling to do.

His new plan adds fuel to the already raging battle on Capitol Hill over how much to cut defense spending in the midst of efforts to rein in the nation's swelling deficit.

The first chapter played out recently over how to fund defense in fiscal 2011.

On April 8, in an 11th-hour agreement reached to avert a government shutdown, the Defense Department wound up with amounts close to those agreed to by the House earlier in the year, along with \$2 billion in cuts spread across a long list of defense programs—from Boeing's canceled Future Combat System, its C-17 aircraft and Lockheed Martin's Joint Strike Fighter—all of which had unspent money from previous years.

Lawmakers and contractors are still quibbling about the details.

Sen. John McCain (Ariz.), the ranking Republican on the Senate Armed Services Committee, denounces the deal for the remainder of fiscal 2011 as a "gross misallocation of defense resources."

In addition to failing to budget for operations in Libya, McCain says, the Pentagon war spending accounts include items not applicable for the fight there or in Afghanistan. That includes a line item for \$189 million toward the SM-3 Block 1A missile interceptor system. "There was no request for these funds, and missile defense is in no way related to the fight in Afghanistan," he says.

The biggest loser in the agreement on the 2011 budget is certainly the Joint Strike Fighter's alternative engine.

General Electric/Rolls-Royce has been adamant that it will continue to push for the engine, and the House Armed Services Committee, its largest bastion of support on Capitol Hill, could include funding for it when it marks up the defense authorization bill in May.

But Defense Secretary Robert Gates could change a 90-day stop-work order on the engine to an outright termination as early as April 18, according to an industry official. That would make restarting the program all the more difficult, particularly in the current anti-spending climate.

Other programs seemed to survive.

In the proposed continuing resolution, the Marine Corps Expeditionary Fighting

Vehicle still has a chance. The General Dynamics' program scores \$223 million for termination costs or system development and demonstration, if it's certified by the defense secretary.

And Lockheed Martin was encouraged that it received money to make 35 Joint Strike Fighters instead of 32.

"The 2011 roller-coaster ride is over," Loren Thompson, the chief operating officer of the Lexington Institute, told institutional investors last week. "There were moments when it was kind of scary. It has now come to a soft stop."

Without a moment to pause, the look-ahead to 2012 and beyond begins. From here, the Pentagon, which has been holding back on spending while it was being fed on short-term arrangements, will be "flush with cash," according to a defense lobbyist.

And in the coming weeks, he predicts, Capitol Hill will receive enormous requests from the Pentagon to shift money around, before the drawn-out process to complete the 2012 budget begins.

On one side are the Republicans who now hold the majority in the House.

Even though early this year top members of the GOP said defense needed to be "on the table" for cuts, House Budget Committee Chairman Rep. Paul Ryan (R-Wis.) left the Pentagon alone in his plan for \$4.4 trillion in deficit reduction over a decade.

That lent clout to Rep. Buck McKeon (R-Calif.), the chairman of the House Armed Services Committee, who has been calling for increases in the overall size of the defense budget and is ready for combat against the Obama plan.

"Holding defense below inflation is a huge problem," McKeon says.

Rep. Todd Akin (R-Mo.), an armed services committee member who was

With funding for the JSF's alternate engine now out of the fiscal 2011 budget bill, prospects for the GE/RR F136 engine are dimming.



deployed to the House Budget Committee to make the case for stable defense spending, sees Obama's announcement as a baseline for budget talks.

He's deepening his arguments about why defense should escape cuts and why the mantra of cutting waste at the Pentagon has reached its limits.

"The first thing was everything should be on the table. The second thing is 'the cuts will be wise and get rid of money where money is wasted.' I think that's a false assumption," Akin says. The waste in Pentagon spending is too intertwined with money spent smartly, he says.

Defense insiders downplayed Obama's plan, dismissing the long-range predictions of term-limited politicians as meaningless. "When you hear an announcement such as the president made today about defense spending, the first thing you have to ask yourself is where are the cuts going to come from, what are the Republicans going to do and where will [Obama] be when the cuts are supposed to arrive," Thompson says.

Certainly, Obama is taking on this new push to cut Pentagon spending just as he's kicking off his re-election campaign and the top two people reviewing the details of his cuts—Gates and Adm. Michael Mullen, the chairman of the Joint Chiefs of Staff—are on their way out.

Despite those predictions, Obama's plan is far beyond the early forecasts of deficit hawks who want to dial back the military's international commitments to make cuts to the Defense Department that would make the Heritage Foundation, a conservative pro-defense think tank, weep.

Last June, Rep. Barney Frank (D-Mass.) led the Sustainable Defense Task Force, which recommended nearly \$1 trillion in security cuts over 10 years. At the outset of his budget push, Frank, along with fringe Republicans Rep. Ron Paul (Texas), and Rep. Walter Jones (N.C.) announced they wanted to remove the taboo of cutting defense spending.

But by early last year, even top Republican leaders had pledged to put defense "on the table for cuts" and now Frank is getting reinforcement from the top.

Frank is most encouraged that the next review of defense spending will cover the nation's global military commitments and invest cuts in the Treasury rather than back in the Pentagon. "We can't just do it with efficiencies," Frank says. "Six months ago we weren't in the ball game. We're going to keep it up." ☐

'Joint' at the Hip

Norway forges on with its Joint Strike Missile and Joint Strike Fighter ambitions

ROBERT WALL/LONDON

In many capitals, discussions about purchases of the F-35 Joint Strike Fighter have revolved heavily around "what is in it for me." But few have as well-defined objectives as Norway, which is looking to tap a huge customer base for a new stealthy cruise missile, the Joint Strike Missile (JSM).

Befittingly, as Oslo moves one step closer toward the fighter procurement it is advancing, in tandem, the JSM—the air-launched derivative of Kongsberg's Naval Strike Missile (NSM). The Norwegian government is seeking parliamentary approval to fund the JSM through its critical design review. The 535 million kroner (\$98 million) contract also would raise the technology readiness level

(TRL) of the hardware to TRL 6, setting the stage for flight trials after this development phase concludes in 2013.

The move comes as the government is putting forward plans to jump-start procurement of the F-35 Joint Strike Fighter. This is to ensure delivery of the first aircraft in 2016 so that pilot training can be initiated as soon as possible. The budget request to parliament is for an initial buy of four Lockheed Martin F-35s. Those would arrive about two years ahead of the broader introduction of the stealth fighter into Norwegian air force inventory.

The government puts the price tag for the deal at 4.8 billion kroner.

Defense Minister Grete Faremo says

Battle Tested

Israel is planning to expand its Iron Dome shield

ALON BEN-DAVID/TEL AVIV

If there's one fact illustrating the extent of Israel's exposure to rocket and mortar fire from hostile forces it is that a looming tripling of systems to counter such threats will still leave large parts of the country vulnerable.

If there is an upside to the situation, it is the knowledge that years of investment to field an effective defense—first into lasers and then a missile interceptor—have proved fruitful. Now the focus is turning to increasing defensive capacities and capabilities.

Deployed in the towns of Beersheba and Ashkelon in southern Israel, the Iron Dome counter-rocket system intercepted eight rockets fired from the Gaza Strip out of nine attempts in recent days.

Most of the rockets were standard 122-mm Grad-type, with a range of 42 km (26 mi.), and some were 22-km-range

Qassam rockets, indigenously made by the Palestinians. In one case, the Iron Dome destroyed a salvo of four rockets simultaneously.

Having received the batteries only several months ago, the Israeli air force (IAF) did not plan to deploy them operationally so early. But rising tensions between Israel and Hamas-controlled Gaza prompted Israeli Chief of Staff Lt. Gen. Benny Gantz to order the deployment, declared as an "operational test."

"This extraordinary achievement ends the debate over the efficiency of Iron Dome," says Defense Minister Ehud Barak following the successful interceptions.

"We never promised 100% protection," Yossi Drucker, Iron Dome program manager at Rafael Defense Systems, told Aviation Week, "but these are very, very good results."

the purchase "is an important step to maintaining a satisfactory operational combat aircraft capacity in the transition phase between the F-16 and F-35." The government also says it has reviewed the broader F-35 costs and found that the purchase price for the 56 fighters used in the planning assumption is only 2.5% above the 2008 cost assumption. The figures reflect the latest updates from the U.S. government, the defense ministry says. The total procurement cost has increased to 52 billion kronor from 43 billion kronor in the past three years; of that figure, five billion kronor reflects an inflation adjustment and four billion kronor is related to exchange rate fluctuations, according to the ministry.

The government explains that the relatively modest cost increase takes into account the fact the U.S. is absorbing the cost overruns in the development phase, and that the 2008 estimate already encompassed many of the changes in procurement costs.

As to the JSM, Kongsberg has adapted the Naval Strike Missile design for the JSF application, including switch-

ing to a dual-intake configuration (from a singlet) and a top-wing, rather than mid-wing, arrangement. Kongsberg designers were eager to maintain large wing surfaces to ensure that the missile retains its maneuverability in the final seconds of flight, while still being able to fit it into the tight JSF bomb bay space.

The missile has been lengthened 40 cm (15.7 in.) to offset a slimmer missile body. It also features a larger fuel tank to boost range. A low-altitude shot should allow the JSM to fly more than 150 nm.

One of the key design drivers has been to modify the missile without compromising its low radar cross-section. To that end, the nose stabilization feature has been retained to make it more difficult for a ship self-defense radar to spot the weapon, even in a bank-turn maneuver. The missile is keeping its thrust-to-weight ratio at greater than one because this provides a continuously changing acceleration that makes the missile harder to track.

The weapon's design is now largely frozen. In addition to being able to

carry a JSM in each bomb bay, F-35s also would be able to carry it on wing stations.

Flight testing is scheduled for the phase to follow in 2013.

In a statement announcing the planned program continuation, Kongsberg Defense Systems President Harald Aannestad says: "The JSM development contract will contribute to secure Kongsberg and several [other] Norwegian defense suppliers with exports related to the fighter program." Partners include ProPartner Defense, Kitron, Eidel, Natech, Berget and Kongsberg Devotek.

JSM will feature land-attack and anti-ship modes. The seeker-based land-attack capability will be retrofittable to NSM, which currently has only a GPS-guided land-attack capability.

Australia has shown interest in JSM, and Kongsberg hopes the U.S. Navy will buy into the program.

Beyond the JSF, developers see an opportunity for the missile to secure a berth on the F/A-18E/F, if the U.S. Navy and Australia are customers. ☐

In parallel with the operational success, the Iron Dome system also won U.S. congressional approval of \$205 million for four additional batteries for Israel.

Developed by Rafael, the Iron Dome is designed to defend against rockets fired from a distance of 4-70 km, and protect a 10 X 10-km area, roughly the extent of a medium-sized town. The battery deploys six launching systems, each with 16 interceptors around the protected area, with Elta's EL/M-2084 multimission radar (MMR) positioned in the front. The radar detects the launch of enemy artillery rockets and the battle-management-controlled unit calculates whether the rockets are threatening to hit the protected area. If they are, one or two interceptors are launched to destroy the incoming rocket at an undisclosed altitude.

However, Israel has, at the moment, only two Iron Dome batteries, which means that only two urban areas can be secured.

The most modest estimates suggest that at least 13 batteries will be required to defend against rocket attacks from Gaza, Lebanon and Syria. Israel is still debating whether to augment the U.S. funding for additional batteries.



EMILANDOV

On April 9, the Israeli army fired an anti-missile missile from its Iron Dome systems on the outskirts of Ashkelon to intercept an incoming Grad rocket, fired by Palestine militants from inside the Gaza Strip.

The issue is acute given the rising levels of tension in the region. If Israel faces a conflict against Hamas in Gaza and Lebanon-based Hezbollah, the two existing batteries will provide negligible defense. "We will use existing assets, including launchers and radar, to create a third battery this year," says a senior

military source. "Eventually, we plan to match the U.S. funding with local budgets for procurement," added another military insider.

In addition, Israel plans to expand the Iron Dome's capability to counter rockets with a firing range of 180 km, which includes the Syrian 220-mm and 302-mm munitions, widely also deployed in Lebanon.

Critics have raised concerns over the economic rational of using a \$30,000 missile to intercept a \$200 rocket, claiming that a wide conflict, with thousands of rockets fired, will drive Israel into bankruptcy. "This is a miscalculation," says a senior defense source. "We should examine the interception costs vis-a-vis the damage prevented, both in human life and in real estate."

One cost-saving measure designed into the system is that Iron Dome can be configured to ignore a target that will fall into an area that does not require protection.

Iron Dome's early success has already generated interest among potential international consumers. Singapore will be the first export customer, and the U.S. along with some other countries have shown interest in the system, which is the first of its kind. ☐

Brazilian Bonanza

Embraer, rivals step up to Brasilia's new defense and security agenda

ROBERT WALL/RIO DE JANEIRO



Brazil is planning further large-scale regional security programs such as the SIVAM Amazon surveillance project that involves the Embraer EMB-145 Eerie.

Brazil's defense and security ambitions seem insatiable. The laundry list of new programs keeps growing and is so full that efforts such as a new reconnaissance and helicopter program on the horizon appear as mere "noise."

As Brazil begins to step up its global presence, while also securing its vast natural resources, large land-surveillance programs—the \$6-7 billion Sisfron effort—and the \$4 billion coastal surveillance Sigsaz project are garnering much of the near-term interest. But the government insists that it wants to do more. An indigenous fighter is planned to emerge in 2019, a patrol aircraft (P-X2) is to be purchased around 2020, and a cargo aircraft even larger than the Embraer KC-390 is already in development with a 2025 acquisition date. A new airborne early warning and reconnaissance aircraft also is on the agenda.

The ambitions go far beyond ensuring security for the 2014 Football World Cup and the 2016 Olympics in Rio de Janeiro, although those events are expected to be a near-term spending driver.

The extent of the spending aspirations is reshaping Brazil's industrial landscape. Aviation national champion Embraer is becoming more assertive in the defense and security arena, position-

ing itself to serve as systems integrator for the complex Sisfron and Sigsaz networking programs. This is a field where European and U.S. rivals have considerably more experience, so the Brazilian company is having to play catch-up.

To expand its technical reach, Embraer acquired a 50% stake in Atech, a small Brazilian company with command-and-control expertise; it played a key role in the SIVAM Amazon surveillance project. Luiz Carlos Aguiar, president of Embraer's newly established defense and security business, says the deal should strengthen his unit's ability to serve as a systems integrator. Even rivals acknowledge that this was a shrewd tactical move.

Aguiar says more ventures are in the offing as a small mergers and acquisitions team pursues additional investment opportunities.

But rivals are not ready to give ground. Saab's Bo Torrestedt, vice president of corporate marketing for the region, says his company is closely tracking both Sisfron and Sigsaz, and has drawn up concepts for the coastal surveillance effort to offer the Brazilian government.

Any actual request for proposals (the one for Sisfron is still expected this year) is likely to also draw interest from the

likes of EADS, Thales, Raytheon and Boeing.

Outside companies, meanwhile, are establishing new business ties to strengthen their local presence and meet Brazil's appetite for technology transfer. Israel's Elbit, for instance, has struck a deal to cooperate with Embraer on unmanned aircraft that could see the creation of a new company, with Embraer having a majority stake. That runs against Elbit's usual corporate philosophy, but is seen as the global-market entry price, a company official notes. Embraer also could take a minority stake in Elbit's Brazilian AEL Sistemas subsidiary.

Boeing, another key player, has teamed up with Santos Lab to work in Brazil on the Scan Eagle unmanned aircraft, with the potential to also cooperate on other unmanned platforms, says Joe McAndrews, Boeing's vice president for international business development for the region. The deal was struck as part of Boeing's offset package in support of its F-X2 fighter bid.

A new twist in Brazil's industrial dynamics can be seen in the country's growing interest in developing indigenous systems, rather than acquiring foreign products. The government is working with industry to take the first

steps to demonstrate a scramjet-powered waverider concept. The goal is to build a Mach 14-capable launcher to deploy microsattellites, says a Brazilian air force official. The scramjet is to operate using oxygen/hydrogen fuel.

An initial subscale waverider demonstrated is due to fly next year. It is merely a test vehicle to gauge the durability of materials and the aerodynamic configuration. The vehicle will be lofted from the Alcantara Launch Center in northern Brazil. The hope is to use the results for more advanced trials in 2016.

At the other end of the spectrum, Novaer Craft this year expects to start building the first prototype of its T-Xc Pilgrim basic trainer. The carbon-fiber design is being targeted at the pending T-25 replacement program in Brazil, says President Graciliano Campos. The side-by-side trainer will feature a glass cockpit developed by Brazil's Flight Technologies.

Critical design review of the aircraft was completed recently, says Campos. Its wingspan measures 9.14 meters (30 ft.); empty weight is 810 kg (1,780 lb.), with maximum takeoff weight of roughly 2,500 lb. The aircraft is powered by a 300-shp Lycoming AEIO-540, for a maximum cruise speed of 202 kt. and a maximum climb rate of 2,665 fpm. First flight is planned in the first half of 2012, with certification due a year later.

In other cases, the government is opting for codevelopment efforts, as long as Brazilian companies have meaningful technical responsibility. This is playing out in the tactical missile realm. Sao Jose dos Campos-based Mectron is completing the first indigenously developed anti-radiation missile for the country. Trials are due to end at mid-year, clearing the way for use on the AMX fighter, says Commercial Director Antonio Hugo Pereira Chaves. The 12.7-ft.-long, 9.1-in.-dia. missile weighs 586.4 lb., and features a 198.4-lb. warhead and a wideband passive seeker. The weapon can be used against emitting targets or (relying on its GPS/INS guidance) known but non-emitting threats.

Mectron, which also is completing work on a major upgrade of its MAA-1 air-to-air missile, is

one of the country's major partners on the A-Darter codevelopment with South Africa's Denel Dynamics. Flight trials of the dogfight missile are to conclude next year, with the South African air force expected to soon launch series production and the Brazilian air force ready to begin integrating the weapon on the F-5, says a Denel Dynamics official. Mectron's workshare includes guidance and control, the autopilot and fuze; Avibras is working on the warhead and motor.

Export opportunities for A-Darter also are being sought, particularly aimed at Gripen users. Thailand is seen as a potential buyer, which would increase the system's exposure to the Asian market.

Furthermore, discussions continue in Brazil and South Africa over codevelopment of a solid-motor, beyond-visual-range air-to-air missile called B-Darter.

Meanwhile, Brazilian and South African naval officials are slated to define requirements for a cooperative surface-to-air missile program. The project would be built on the Denel Dynamics Umkhonto-IR short-range air defense system. But the new missile would have a much longer range and represent an entirely new class of weapon, says an industry official during the Latin American Aerospace and Defense (LAAD) exhibition here.

While the long-term outlook for Brazil is one of strong growth, even here there are budget issues. The new government led by President Dilma Rousseff has created some anxiety as it cuts back defense spending owing to concerns about inflation and a potential reprioritization of resources. That is

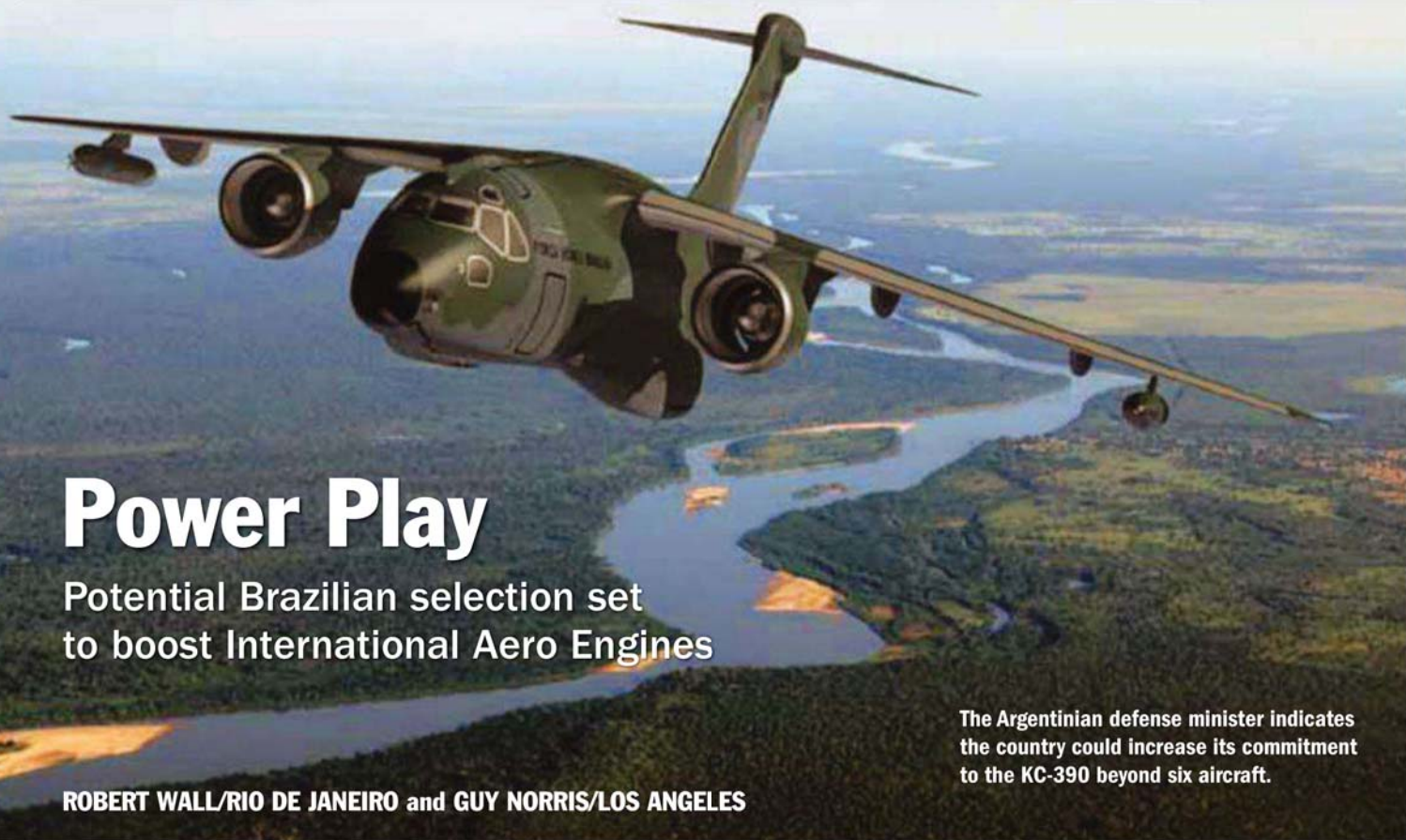
Brazil's hypersonic waverider concept will undergo preliminary flight testing next year.

most clearly demonstrated on the F-X2 fighter competition. A decision on whether to buy the Boeing F/A-18E/F, Dassault Rafale or Saab Gripen has been delayed. The candidates are willing to wait; but if the decision drags into 2012, commercial offers now on the table may have to be revisited.

Nevertheless, the opportunity to sell products here remains. The manufacturers of advanced jet trainers, for example, have their eyes on an emerging program in Brazil as well as in neighboring Chile. The BAE Systems Hawk, Korea Aerospace Industries T-50 and Aermacchi M-346 are already gearing up for the contest. Brazil also is looking to buy a strategic refueling tanker. And the country would like to augment its tactical airlifter fleet. Having previously acquired 12 Airbus Military C295s, it may now buy eight more. ☐



ROBERT WALL/AW&ST



Power Play

Potential Brazilian selection set to boost International Aero Engines

ROBERT WALL/RIO DE JANEIRO and GUY NORRIS/LOS ANGELES

The Argentinian defense minister indicates the country could increase its commitment to the KC-390 beyond six aircraft.

As Embraer looks to finalize industrial teaming arrangements for the KC-390, it is poised to throw a lifeline to International Aero Engines and the V2500 turbofan program.

Despite the recent launch of the V2500 SelectTwo upgrade, the future for the IAE joint venture was beginning to darken after Airbus opted to pursue an A320NEO (New Engine Option) re-engining with the CFM International Leap-X and Pratt & Whitney PW1100G. But industry officials indicate that IAE has secured Embraer's endorsement to power the KC-390 tanker/transport, which is due to fly in 2014 and be delivered to the Brazilian air force in 2015.

The move is particularly surprising, since Embraer previously suggested the A320NEO choice could sway its own selection. The company had been examining the CFM56 and V2500, but was worried that if NEO went forward, the powerplant for which it had opted would no longer be in mass production at the time the KC-390 program ramps up.

Industry officials acknowledge that was a concern, but indicate an arrangement with IAE has been found to ensure that there's no competitive handicap as the KC-390 sales team pursues orders throughout the life of the program. Details of the arrangement are being close-

ly held until customers are fully briefed. In March, senior sources at CFM indicated that the General Electric-Snecma joint venture had essentially backed out of the bidding for the Brazilian project, while Pratt & Whitney is believed to be focusing resources almost exclusively on its existing commercial-airliner geared turbofan applications.

Details of the potential IAE derivative, which also beat out early competition from Rolls-Royce's RB282/285 twin- and triple-shaft concepts, remain unclear. It is not yet known, for example, if the engine consortium is proposing an off-the-shelf V2500 or a tailored military version with special tactical adaptations such as directed-flow thrust reversers capable of deployment in flight. A similar feature on the Boeing C-17's Pratt F117 engines redirects both the fan and core exhaust streams. This contributes to the aircraft's exceptional short-landing capability and enables the C-17 to maneuver in restricted ramp space and reverse up a 2% slope.

At the Latin American Aerospace and Defense (LAAD) show in Rio de Janeiro, senior government officials also reinforced their backing for the program. In fact, Argentina's defense minister, Arturo Puricelli, suggests that his country may boost its KC-390 commit-

ment. Argentina says it wants to buy six aircraft, but that is just a "first batch," Puricelli adds.

Puricelli was speaking as Embraer announced that Fabrica Argentina de Aviones will be a major structural parts supplier on the project. The company will provide spoilers, doors for the nose landing gear, ramp door, flap fairings, tail cone and electronic cabinet. Embraer promised to offer significant work-share to industries in countries making an early commitment to the KC-390.

Similarly, Embraer says Aero Vodochody will supply parts of the rear fuselage, crew and parachutist doors, emergency doors and hatches, cargo ramp and fixed leading edges in return for the Czech Republic's commitment to buy two aircraft.

Chile, Colombia and Portugal also have signed on to the program. No additional partner countries are being sought, with the focus now shifting to beginning the joint definition phase.

The Brazilian government's 28-aircraft commitment is by far the largest, with industry officials pointing out that is merely a first batch. Brazilian Defense Minister Nelson Jobim signaled the need for more acquisitions, noting that there is a huge need for air mobility in his country. ☐

Star-Crossed

The Sitara's expected initial operational clearance date has slid another six months.

India's new intermediate jet trainer suffers another setback

ASIA-PACIFIC STAFF/NEW DELHI

New delays in India's development of an intermediate jet trainer, the HJT-36 Sitara, could mar what military officials were hoping would be a model procurement effort.

The aircraft is now expected to achieve initial operational clearance (IOC) no sooner than December. In February, the Indian air force leadership projected reaching IOC in June. However, fresh problems unearthed in flight trials have set the program back at least six months.

The delay puts even greater strain on the Indian air force's nearly obsolete HJT-16 Kiran intermediate trainer fleet.

The HJT-36 is apparently facing problems in spin recovery, a mandatory test-point to reach IOC.

After major setbacks earlier—both HJT-36 prototypes were severely damaged and grounded in separate accidents in 2007 and 2009—the program appeared to be finally on course.

For the Indian air force, which says it wants 70 aircraft initially and more than 200 in all, the Sitara ("star" in Hindi) will not come a moment too soon. With the HJT-16 Kiran fleet on the verge of retirement, the air force has been forced to implement stop-gap refurbishments to stretch the fleet for at least 18 more months. The patchwork has not been easy to implement, though.

Nonetheless, an Indian air force officer

embedded with Hindustan Aeronautics Ltd. (HAL) to oversee the HJT-36 trials' final phase is not pessimistic. He says most of the aircraft's performance parameters are satisfactory and that IOC is expected to be achieved "more or less" on the terms agreed upon in 2009.

"We should have been training our pilots in HJT-36s right now, but the program was set back because of two accidents," the officer says. "There have been some performance issues, particularly related to spin recovery characteristics and overall stability, but we're moving toward sorting these out quickly."

The Sitara program, a spinoff of the Tejas Light Combat Aircraft program, kicked off in 1999 and is often considered one of the quickest, most efficient design efforts by the Indian aerospace establishment. That now hangs in the balance, however, with the program's reputation depending on delivery of 12 limited-series production aircraft before the end of 2012, and full-rate aircraft soon thereafter.

HAL has said the aircraft will cost \$10 million each, considerably less expensive than Stage 2 trainers that have been offered to India in the past.

As trials progress, HAL has begun procedures to weaponize the HJT-36. The aircraft will be used as a primary weapons training platform for pilot cadets in gunnery, rocketry, bombing and

targeting. To begin with, HAL is soliciting bids for a 12.7-mm gun pod for the aircraft's inboard wing stations. While designers had initially planned to spin off an armed variant for counterinsurgency operations, HAL instead will offer an optionally armed version exclusively for export.

Grappling with its dwindling Stage 2 trainer fleet, the Indian air force is also facing huge challenges maintaining the last of its persistently problematic HPT-32 Deepak primary piston trainers. Following trials last year on six platforms, the Indian air force hopes to conclude a contract in the next few months for a replacement. Contenders include the Hawker Beechcraft T-6C, Korean Aerospace KT-1, Grob G120TP, Embraer Tucano, EADS PZL Orlik and Pilatus PC-7/9. HAL's own primary trainer effort, the HTT-40—unveiled in model form at the Aero India show in February—will not fly until 2013.

Delays in the HJT-36 program have also forced the Indian air force Surya Kiran aerobatic display team to opt for a gap-filler aircraft as its signature red HJT-16s age out. The Surya Kiran team will temporarily conduct display flights with the BAE Systems Hawk Advanced Jet Trainer, being built under license in Bengaluru by HAL, a move that does not please advocates of the indigenous defense industry. ☐

Saving Saras

New design changes slow development but improve light transport's certification prospects

ASIA-PACIFIC STAFF/NEW DELHI



Russia's Myasishchev Design Bureau and Italy's Piaggio Aero Industries are consulting on major design changes to the Saras that auger further schedule delays.

Two decades of development problems have seen India's Saras light transport aircraft program pushed to the brink, but the project may get a new lease on life.

Grounded indefinitely after the second Saras prototype crashed in March 2009, killing three Indian air force flight test crew, the Bengaluru-based National Aerospace Laboratories (NAL) are hoping to continue test flights this year using the first prototype, currently being converted to the second prototype's more advanced standards. NAL is also building a weight-optimized production series aircraft and is working toward flight certification under FAR Part 23 by early 2013.

But the NAL face a dilemma. With major design changes under way in the airframe and engine mounts, it is likely that dates may slip again. Until the final design is fully flight-tested, flight certification and approval for production from India's testing and civil aviation regulatory authorities will remain elusive.

The Directorate General of Civil Aviation (DGCA) issued a damning crash report in the wake of the 2009 accident, concluding that there were major and minor flaws in several aspects of the Saras design. At the time, the program had undergone six years of flight-testing.

Russia's Myasishchev Design Bureau and Italy's Piaggio Aero Industries are consulting on refinement of the aircraft's design characteristics, including engine nacelles, control surface parameters, hydraulics and landing gear.

This is Myasishchev's second round on Saras; the design bureau exited what was initially a joint development program in the mid-1990s to pursue other opportunities. Initially, Myasishchev, the State Scientific & Research Center of TsAGI and Gromov Flight Research Institute were brought into the effort to modify core aspects of the aircraft's design. Some of that work is still ongoing, and the Russian team is likely to continue working with the NAL for the remainder of the test phase.

Design optimization now under way involves a major weight-reduction exercise, the use of carbon fiber composite

wings, vertical and horizontal stabilizers, and rear pressure bulkhead on production series aircraft.

An officer with the NAL's fabrication division indicates HAL has been chosen to build the production series aircraft once certification comes through. The Indian air force, the nominal launch customer, will order at least 50 aircraft for tactical communication duties.

The twin pusher-prop aircraft is expected to be pressed into various roles, including executive transport, remote sensing, aerial reconnaissance, border patrol, tactical maritime surveillance and air ambulance services. An internal marketing assessment by the NAL suggests that it could sell at least 195 aircraft immediately after certification.

The NAL anticipates orders of 10 aircraft each from the Indian coast guard and navy, 40 to the corporate sector, 10 to other government agencies such as the railways and tourism board, and at least 75 to feeder airlines. A 2008 business plan document indicated that the NAL planned to price the aircraft at \$8-10-million, depending on configuration; new pricing is not available.

NAL officials say that while the agency has begun allocating design and planning resources for the prestigious National Civil Aircraft (NCA) program, there is pressure to deliver the Saras and conclude the program without any further delay. An officer with the civil aviation authority, which will finally clear the program for full-rate production says, "the team now has help from Russian designers and from [key] suppliers. Any further delays in correcting design flaws will mean the effort is wasted. The focus is now to reduce weight, get the aircraft into the air and build back confidence."

The NAL are also building the five-seat NM5-100 in a joint venture with the Mahindra Group. NAL Director AR Upadhyaya said last year that the NM5, parts of which are being built in Bengaluru and Australia, is likely to make its first flight this year. ☛

Tall Order

ACAE expects to launch its own engine for the C919 this year

BRADLEY PERRETT/SHANGHAI

A facial expression hints at the Chinese aerospace executive's concern. "Yes, it is indeed a big challenge," he says, sounding serious. As he stops to sip his coffee, he begins to look a shade more serious. Maybe the challenge is just too big.

The problem he's thinking about is how an inexperienced company can go straight into integrating a competitive commercial aero-engine, leaping from almost zero to a world-class product in a decade. And in this notoriously difficult part of aerospace technology, how can the company achieve such a goal without Western help in the hardest parts of the engine, help that will almost certainly be withheld for military reasons?

The company is Avic Commercial Aircraft Engine Co. Ltd. (ACAE), the aero-engine equivalent of national airliner builder Comac, whose C919 aircraft is due, sometime early next decade, to take to the air with Chinese high-bypass turbofans generating 30,000 lb. thrust.

ACAE might also take a share in a

ACAE is aiming to match the performance of the Leap-X1C (right) with an engine that would be certified 6-8 years later.

foreign engine, such as a development of the Pratt & Whitney PW1000 geared turbofan family—but that would be a side project, not an experience-building precursor to its main aim of manufacturing its own engine. Although neither ACAE nor any other part of the Avic group has built a commercial engine even close to the global leading edge of efficiency, reliability and safety, it wants to do so immediately.

ACAE expects to formally launch its C919 engine program this year, subject to approval from the Ministry of Industry and Information Technology, say industry officials, although the company began large-scale work in 2010. ACAE is already seeking help from potential foreign partners, with a request for information is-

sued last month. Its next step will be to issue a request for proposals for cooperation around July, with partners perhaps chosen by the end of the year.

The aim is to build an engine that matches the performance of the CFM International Leap-X1C, which will be the C919's first powerplant. The ACAE engine is supposed to be certified between 2020 and 2022, 6-8 years after the U.S.-French engine. That interval measures how nearly ACAE hopes to approach the pack of global commercial engine leaders: Rolls-Royce, Pratt & Whitney and CFM partners General Electric and Snecma.

of rising engine efficiency slowed down somewhat in the 1990s, technologies including Pratt's geared fan are now again promising big advances.

Among ACAE's many challenges in building a commercial engine, industry officials point above all to integration and the hot section of the engine—the high-pressure spool and combustor. "If it must, ACAE is prepared to pull together all the resources of China to independently develop as much of the engine as necessary," says the executive.

Rolls and Pratt are showing minimal interest in any deep cooperation that would help ACAE to build the engine and thereby learn how to become one of their competitors, says an official with direct knowledge of that matter. General Electric and Snecma probably have exactly the same attitude, but can cite other reasons: They are already building the competing engine for the C919, and they have an agreement to cooperate exclusively with each other in this size of engine.



That leaves the fifth Western expert in big commercial engines, MTU, which in late 2009 agreed to work with ACAE in exploring how the Chinese industry could develop. Regardless of its willingness, even that German company would probably be forbidden from showing ACAE how to tackle the hardest part of the engine—the high-pressure spool and combustor—because the technology could be used for the core of a combat aircraft engine. The same restrictions will apply to high-level suppliers to the engine prime contractors.

Aero-engine technology is a notable area in which the otherwise surging Chinese military establishment is struggling to catch up. This crucial strategic issue sets ACAE's program apart from

"China does not want to be later than 2022," says the Chinese executive. By then, the aero-engine industry should be on the cusp of the much-heralded open-rotor revolution that threatens to render commercial turbofans obsolete. Indeed, even the 2010s are a bad time for a newcomer, he and other industry executives note. Whereas the long march

the usual negotiations between Chinese companies looking for technology and Western companies looking for access to the Chinese market.

And so it seems to leave ACAE struggling with the hot section on its own or, at best, relying on a Russian partner without enough experience in advanced commercial engines. Russia's NPO Saturn is building the low-pressure spool for the Sukhoi Superjet's SaM146 engine, while partner Snecma makes the high-pressure spool.

MTU has told ACAE it would like to build the Chinese engine's low-pressure turbine, a kind of turbomachinery in which it has considerable expertise.

ACAE has already drawn up a preliminary design. Like the Leap-X, the engine is a direct-drive two-shaft turbofan with a thrust of roughly 30,000 lb. Bypass ratio will be comparable with that of the Leap-X1C's figure of 10. Other details have not been disclosed; and in many cases, even such basics as the number of compressor and turbine stages are not yet determined. The engine must aim for the performance of the Leap-

X1C because it is supposed to satisfy the same Comac specification.

But ACAE and Comac executives would hardly be realistic if they did not accept the considerable probability of the engine missing the specification for specific fuel consumption and weight.

The ACAE engine must aim for the performance of the Leap-X1C because it is supposed to satisfy the same Comac specification

The engine would be usable by Chinese state airlines, if not exactly welcomed by them, as long as it could be certified, notes one industry official watching the program closely.

As with the C919, the initial certifying authority would be the Civil Aviation Administration of China. Western endorsement would follow. Achieving even that, regardless of performance, must look

like a mountain to climb for the Chinese engineers.

The schedule calls for a demonstrator engine meeting a lesser initial target in 2016, which means that it would probably begin running in 2015. While entry into service is supposed to follow in the early 2020s, there is a sense among executives that the schedule will not be too strict—while bearing in mind that there is some unknown point at which the engine will become difficult or impossible to sell in the face of open-rotor competition.

If there are delays, they will be more serious for ACAE than for Comac and its customers, which can be expected not to rely heavily on the schedule being met. In many ways the engine parallels the ARJ21 regional jet, which was launched in 2002 as China's first commercial aircraft, with the aim of matching the technology of the Embraer E-Jet and going into service in 2007, just three years behind the Brazilian aircraft. The ARJ21 is still in flight testing, with a first delivery now due late this year—but its Chinese customers are believed to be re-

Material Benefits

Comac is still studying which parts of the C919 should be composite, which aluminum

BRADLEY PERRETT/SHANGHAI

Adding to the many decisions to be made in designing a commercial aircraft, the choice of material is becoming more complicated as more choices become available. Yet the issue is as decisive as almost any other, since overly costly construction will burden an aircraft with a competitive disadvantage throughout its life, while an airliner that is cheap but heavy will burn too much fuel for decades ahead—decades in which fuel prices could rise far beyond expectations.

This is a key question that Comac is now working on as it refines the design of its C919 narrowbody airliner.

One theme in the design of the C919 is to aim for moderate advances while preparing conventional alternatives, say executives involved in the Chinese program. And that applies particularly to the structure, which is far from fixed, even though the first flight is now only about three years away.

One structural decision that has been made is the material for the tail and moveable surfaces: they will be of composite, as they routinely are on new commercial aircraft these days. But the material for the center wing box, outer wing boxes and fuselage is still under study.

According to current program thinking, the inner wing box should be composite, as the Airbus A380's is. But an aluminum design has been prepared just in case. The outer wing boxes could be either aluminum or composite; officials are leaning toward composite as the likely choice, but this cannot be assumed to be final. Again, Comac has prepared designs for both types.

Although the Boeing 787 is almost all composite, the benefits of the costly material are lower for smaller aircraft that spend less of their lives in cruise. Moreover, Comac's structural suppli-

ers, plants belonging to Avic Aircraft, have not done well in delivering aluminum structural sections for the Comac ARJ21 regional jet on schedule; shifting to large-scale composite construction can only increase their challenges.

The C919 design will use more titanium than is usual for its size, says an executive whose company supplies that metal. Titanium is becoming popular partly because its inertness and thermal properties are well matched with carbon fiber.

Composite is least likely to be used for the fuselage, industry officials say.

While considering aluminum, Comac must also consider the specific kind of aluminum. Essentially, three types are available: the traditional alloy used in the Boeing 737 and A320; so-called advanced aluminums, which are stronger; and the latest aluminum-lithium alloys.

The latter use significant portions of the low-density metal lithium to increase the bulk of the material and therefore its resistance to bending. So less weight is needed to take a given load, but it costs a great deal more.

Material cost is a greater factor in structural design than is often imagined. Mitsubishi Aircraft's studies led it to choose the heaviest but cheapest ma-

laxed about the delays, since they were not relying on the aircraft turning up on time or performing as promised.

C919 customers will be able to take aircraft with the Leap-X until the Chinese engine is ready.

ACAIE has let it be known that it is very much open to collaboration in any part of the engine, even for final assembly—reflecting the many points of difficulty that a newcomer meets in developing a commercial turbofan.

The company does not regard itself as lacking technology, but it has very little experience at system-level design and integration. To address that and other problems, it is hiring Western workers (*AW&ST* March 28, p. 24). The process is held back by contracts that prevent the foreign experts from working for rivals of their former employers within a set period after resignation. Moreover, foreign aerospace industry executives think hiring from abroad looks more effective on paper than it will be in practice. An expert in one part of the engine needs a team of experienced people to achieve results; in

such a challenging field, no one can be a one-person solution.

In keeping with Rolls-Royce tradition, the ACAIE engine will be named after a river. Chinese military engines are named after mountains. The 30,000-lb.-thrust engine follows the 2008 proposal by sibling company Avic Engine to build a 7,100-8,800-lb.-thrust turbofan for a small business jet.

ACAIE is a spinoff from Avic Engine, which will carry forward China's military engine development and production. Avic Engine will also be a supplier to ACAIE.

Like Comac, ACAIE has only minority Avic ownership, but unlike Comac it still answers to Avic headquarters. Avic owns 40% of the authorized capital and two companies owned by the Shanghai city government hold 15% each, leaving 30% for future investors—or possibly a single foreign strategic investor, says an official close to the company.

Six billion yuan (\$900 million) of capital is available from the original three shareholders. Apart from the money to be raised by selling the remaining 30%

stake, other sources of capital are available. One would be a government fund for high-technology developments.

For a start, the money is paying for a 1-sq.-km production base to be built at Lingang near Shanghai that will be used for testing and maintenance, repair and overhaul as well as production. The vast plant will need work, and one candidate would be participation in the PW1000 program, perhaps building the low-pressure turbine. Pratt & Whitney has said that it is in negotiations with Comac for installing the geared turbofan on the ARJ21 and C919. If Comac accepts the PW1000 for the C919, then the aircraft will have three alternative engines, which would be most unusual for a six-abreast airliner.

And if Pratt does bring China into the PW1000 program on a large scale, then the partner can only be ACAIE, because of Avic Engine's military focus. But in Chinese planning, no such foreign program would be inserted before ACAIE attempted its own engine. Instead, ACAIE would do both at the same time. ☐



Although Avic has exhibited this structural scheme for the C919, wing and fuselage materials have not been decided.

material for its MRJ regional jet, traditional 7050-alloy aluminum.

One executive who would like the C919 to be made entirely of the material that his company makes expects that Comac will go for a mix: an all-composite wing and an aluminum-lithium fuselage. One reason for doing so would be that the latest Western narrowbody airliner, the five-abreast Bombardier CSeries, uses that combination.

Moreover, Bombardier has proposed that it and Comac standardize their materials so that they can purchase jointly. The two companies are looking at a long-term cooperation agreement that would increase commonality between their commercial aircraft.

A sample nose section of the C919 was built in 2009 of aluminum. A tail cone sample section built last year is of composite.

Comac's published figures for the C919 suggest that the aircraft will be disappointingly heavy for one that can employ technology far newer than that used in the 737 and A320 (*AW&ST* Nov. 22, 2010, p. 20). One executive working on the program believes those figures are deliberately conservative, however.

The C919's joint definition phase was scheduled to be completed by late 2010, but loose ends are still being tied up. Suppliers are addressing questions that arose in the review at the completion of the phase.

The seating of the C919 has increased by two to 158 since data was last shown, at the Zhuhai air show in November. That is presumably because of a cabin rearrangement, such as squeezing six narrow seats instead of four standard seats into a row in the tapering rear cabin. The galley and lavatories might have been repositioned, too.

The low priority now accorded to the ARJ21 was evident at the Shanghai International Business Aviation Show, held here April 13-15. For many years, Comac has displayed a model of a business jet adaptation of the ARJ21-700, the launch version of the regional aircraft. At the show, whose sole focus was business aviation, only an airliner model was on view, suggesting that Comac is not interested in making even a small engineering effort to widen the appeal of the ARJ21.

The ARJ21 looks increasingly likely to be an unloved orphan until the C919 enters service—in 2016, according to the schedule. The C919 is a project of national priority for the government of President and Communist Party Chairman Hu Jintao. The ARJ21 is not. ☐

Fare Play?

American Airlines implicates all GDS providers in antitrust lawsuit



ANDREW COMPART/WASHINGTON

American Airlines is pursuing a lawsuit that, if successful, could have broad implications for the business models of global distribution systems (GDS). In doing so, the carrier is launching another offensive in its distribution war just as the fight seemed to be abating.

American filed a civil lawsuit April 12 against Travelport alleging the GDS provider is violating federal antitrust law by using its monopolistic leverage to impose extremely high fees on airlines and thwart competition. The carrier argues that Travelport achieves the latter under the contractual terms it reaches with agents and essentially imposes on airlines, and by refusing to let some third-party application developers obtain access to its GDS application programming interface. But the case reads as a challenge to every GDS provider and the nature of their contracts with airlines and travel agencies—even though American recently suspended a separate lawsuit against Sabre until at least June 1 while it tries to work out an agreement with it, and just made peace with online travel agency Expedia.

Travelport owns the Worldspan, Galileo and Apollo GDS. But American's lawsuit, which it filed against both Travelport and online travel agency Orbitz, hardly confines itself to them.

In the 36-page lawsuit filed with the 5th U.S. District Court in Fort Worth, American refers to "other industry participants" 10 times and "other GDS providers" three times. All of the GDS are fighting American's effort to try to get travel agents to connect directly with its internal reservations system rather than make bookings via GDS providers, which charge the airline a fee that American considers exorbitant.

"Travelport, Orbitz and other industry participants have, individually and collectively, retaliated against American in an unprecedented manner in response to American's Direct Connect technology initiative," American tells the court. "Recognizing that American's AA Direct Connect could undermine the GDS providers' dominance in the provision of airline booking services to travel agencies, Travelport, Orbitz and other industry participants with an interest in preserving the GDS' dominant market positions have engaged in a broad and unlawful multi-part anti-competitive scheme."

American also attacks provisions that all GDS providers use in contracts with agents, such as incentive payments for GDS bookings and other financial inducements that encourage them to use one GDS exclusively. Incentives tied to an agent's total volume of air bookings, it adds, mean American would need to

compensate agents for lost payments on all of its airline bookings just to encourage them to switch to a different system solely for American's bookings.

Travelport blasts the lawsuit as "ludicrous," derides it as a negotiating tactic for airline agreements with the Travelport GDS that soon expire, and describes American's Direct Connect push as an attempt "to limit consumer

With its recently filed antitrust lawsuit against Travelport, American Airlines appears to be escalating its GDS war.

choice in shopping for fares and to limit consumer access to other relevant data." Orbitz describes American's intentions similarly and accuses the carrier of "resorting to groundless litigation in a desperate attempt to revive an unsuccessful strategy."

Henry Harteveldt, vice president, principal analyst and travel distribution expert for Forrester Research, says American has legitimate complaints about the GDS business model. But, he adds: "It seems very extreme to me that they would choose to have a lawsuit to try to force a company to do business with them . . . American is sounding like a wounded lion."

American, however, insists its lawsuit is the only way to "stop exclusionary and anti-competitive business practices."

In alleging Travelport is violating federal antitrust laws, American must first convince the court that Travelport has a monopoly. That might seem like a challenge since, according to the airline, Travelport GDS providers account for 30% of all ticket sales made by U.S.-based travel agencies; Sabre and Amadeus are big GDS competitors in the market. But most agencies use only one GDS, American notes, and many business travelers will only purchase tickets through the agency with which their company has a contract.

"Because Travelport provides virtually 100% of the bookings for a large number of corporate customers whose travel agents subscribe to one of Travelport's GDS, it has monopoly power over American," the airline argues, citing previous statements from the Justice and Transportation Departments that could be construed as supporting that position. In the past year, more than \$2.7 billion of American's sales were booked via Travelport's GDS.

Of course, by that definition Sabre and Amadeus have monopolies, too. That's why a lawsuit victory for American could put all the other GDS providers in its sights.

Some of the issues cited, however, pertain specifically to Travelport and Orbitz.

Travelport has a 48% stake in Orbitz, and Orbitz has an agreement to use Travelport as its GDS provider for North American air travel bookings through 2014. After American pulled its flights from Orbitz in mid-December over the direct-connection issue, Travelport agreed to pay Orbitz higher fees for other airline bookings generated by the site to make up for the loss of American—and will revert to the regular fees if Orbitz even talks to American anymore about Direct Connect.

Travelport and Orbitz have agreements "to exclude competition and maintain Travelport's monopoly power," American says. It also accuses Travelport of retaliating against American by doubling the airline's segment fees in foreign markets. ☐

Home Truths

Passenger growth at Singapore Airlines lags behind that of competitors

LEITHEN FRANCIS/SINGAPORE

Low-cost carriers and full-service competitors of Singapore Airlines (SIA) are capturing most of the growth at Singapore Changi Airport, a trend that is expected to continue for at least the next few years.

SIA is one of the world's most profitable carriers, thanks to its market positioning as a full-service carrier that provides consistently high levels of comfort. But there is a danger SIA group may be resting on its laurels.

Changi Airport's traffic grew 13% last year, to 42 million, but SIA's passenger numbers increased at a slower rate—1.8% to 16.6 million from 16.3 million. By comparison, Singapore low-cost carrier Jetstar Asia posted a 44% hike in passenger numbers to 2.6 million from 1.8 million. Jetstar Asia added capacity in 2010 while SIA cut capacity 0.3%.

SIA does have eight Airbus A380s

Delays to the Boeing 787 program put a kink in some of SIA's expansion plans.

on order, but these are to replace the seven Boeing 747-400s that are due to leave the fleet by end of March 2012. The A380s are scheduled to arrive in that time frame.

The carrier also has 20 Boeing 787-9s and 20 Airbus A350-900s (the larger model -900s) on order, with first deliveries originally set for 2011 and 2012 respectively. But first deliveries of the A350s have slipped to the fiscal year ending March 31, 2014. Also, SIA plans to phase out its leased Airbus A330s when the A350s arrive.

As for the 787s, an SIA spokesman would only say that "we remain in discussion with Boeing on delivery dates." But "first delivery will certainly not be in 2011," he adds.

The 787s were ordered as replacements for its older Boeing 777s, mostly the 777-200ERs, and to develop new long-haul routes, but the delay in the 787 program has adversely affected those plans. SIA is continuing to phase out the 777-200ERs, although at a slower pace than originally slated. However, doing so with

no 787s introduces the danger that SIA may reduce capacity further.

The airline has no new 777s on order because it let its options on -300ERs lapse in 2009. Though this may have been seen as prudent at the time—the height of the global financial economic crisis—the market rebounded strongly in 2010.

Boeing assigned the slots to other carriers, some of which are SIA's competitors. Cathay Pacific Airways, Etihad Airways and Garuda Indonesia have 18, nine and 10 777-300ERs on order respectively, according to Ascend data.

While SIA's growth in long-haul services is largely on hold until the 787s

This has created an opening for SilkAir's competitors, including Malaysia-based Berjaya Air. Malaysia Airlines' low-cost carrier, Firefly, also faces no competition on the four routes it serves between Singapore and Malaysia. Firefly Managing Director Eddy Leong says Firefly's turboprop operation has profit margins higher than the industry average. Its most successful route is Singapore-Kuala Lumpur via Subang International Airport, which is closer to the city than Kuala Lumpur International Airport, and so is popular with business travelers. Firefly initiated the route in July 2009 with a thrice-daily service that has grown to a seven-times-daily offering. There is a strong possibility Firefly will add more capacity on routes to Singapore in light of the fact that it plans to add two more ATR 72s this year and three next year.

SIA group has taken note of Firefly's success and is evaluating whether it, too, should move into turboprop operations. Embraer is also trying to persuade Silk-



and A350s arrive, the group's short-haul operation, SilkAir, faces its own set of challenges.

SilkAir ordered 11 A320-family aircraft in 2006, but some were earmarked to replace its older A320s. It still has six A320s on order; the next one is set to be delivered in May, followed by another in March 2012, says an airline spokeswoman. The 18-aircraft short-haul airline faces competition from low-cost carriers, many of which operate the same aircraft type, on the same routes. One of the SilkAir's main problems is its sporadic scheduling—some of its services are offered on a less-than-daily basis. In some instances, the airline is unable to increase frequency profitably because its smallest aircraft is the 118-seat Airbus A319. Many of the new routes it could be developing are unable to support A319s.

Air that the Embraer 170/190 is the best solution for boosting frequency on existing routes and for developing new ones.

If SilkAir were to launch services on new routes into Malaysia and elsewhere, it could provide valuable feed to SIA's long-haul operation. Firefly largely caters to people traveling between Malaysia and Singapore for business and holidays. But there is no reason why someone flying into Singapore from Ipoh, for example, couldn't connect to a SIA long-haul flight. Ipoh, a town in West Malaysia, is Firefly's second-most successful route to Singapore. Ipoh-Singapore services were launched in July 2009 with a four-times-weekly service. Now it is twice-daily.

It is clear there are growth opportunities for the SIA group if it is willing to move out of its comfort zone. ☛

BUILDING BLOCKS

GUY NORRIS/LOS ANGELES

Aircraft makers are banking on a raft of emerging technologies to make their next-generation airliners quieter, more fuel efficient and lower on emissions.

In the U.S., the research effort is spearheaded by NASA's Environmentally Responsible Aviation (ERA) program, which is exploring a suite of airframe and propulsion technologies that could be ripe for full-scale development around 2020 and entry into service five years later. Given the growing environmental pressures on aviation in the 21st century, the ERA goals are suitably ambitious for potential products aimed 15 or so years into the future.

Although the ERA targets are individually challenging, what sets them apart from many previous NASA research projects is that they are expected to be met simultaneously and without compromise. "It's actually a very difficult thing to do as these usually trade off against each other," says Craig Nickol, ERA vehicle systems integration element lead. They include a fuel-burn reduction of 50% relative to current state-of-the-art aircraft, a 75% cut in oxides of nitrogen (NOx) emissions below the current standard, and aircraft noise 42 db below the FAA's Stage 4 certification level.

"It's quite a challenge, and people are asking how we are going to do this," says ERA Project Manager Fayette Collier. "We've done some experiments that lead us to believe that although this is difficult, we think it is achievable."

NASA makes headway on tough goals for efficient narrow and widebody designs

Wind-tunnel tests at NASA Ames assess the interaction effects of a scaled Pratt & Whitney geared turbofan on a Boeing 737-800 fuselage. Larger-diameter tests will follow.

The targets are tough because, NASA believes, without major improvements the growth of air transport will be actively impeded by environmental and related cost concerns. From a cost perspective, cutting the fuel burden makes better business sense with each jump in oil price. U.S. commercial carriers alone spent \$59 billion on fuel in 2008 when oil was at roughly \$3 per gallon. Together with the Defense Department burning 4.6 billion gal., this usage also pumped 250 million tons of carbon dioxide (CO₂) into the atmosphere, while noise continued to be seen as a restraining factor on growth of the U.S. National Airspace System.

Formulated in 2009, and kicked off in fiscal 2010, ERA is approaching the midpoint of Phase I and managers are sketching out plans for a second phase that will take the program through fiscal 2015. Coming at a time when fuel prices and environmental concerns are combining to accelerate new commercial engine and airframe projects, the ERA initiative appears to be well timed for maximum impact. "We're trying to look at those technologies that have a high payoff and, no matter whether the platform is a [Boeing] 737, [Airbus] A320, [Boeing] 777 or regional jet replacement, we believe the portfolio covers it," explains Collier.

"The program has a significant impact on the 737/A320 replacement market as well as the next widebody replacement, irrespective of whether they are conventional tube-and-wing or more advanced configurations. It also depends on the timing; but if the market opportunity moves to 2025-30, it gives us a chance to [include] more advanced configurations where we can bring in more significant gains in terms of environmental metrics," says Collier.

For drag reduction, NASA and Boeing will test an advanced fluidic control system that could increase rudder effectiveness, allowing vertical tail size, and therefore drag, to be decreased. Under ERA, the active flow control (AFC) study will evaluate the use of pressurized jets in place of a conventional mechanical actuator to help control the rudder. The concept—which works by using the jets to alter local airflow and pressure gradients to control surface movement—has previously been tested on experimental aircraft such as the Bell XV-15.

The AFC study comes as Boeing starts development of a drag-reducing hybrid laminar flow-control system for the stretched 787-9, and could eventually become a complementary feature should it prove effective. Active and laminar flow control are NASA's two main areas of investigation for reducing skin friction, which accounts for an estimated 48% of the drag on current airliner designs.

"The intent is to increase its technology readiness level [TRL] so that it could be applied to any generic widebody or single-aisle hinged rudder," says Tony Washburn, NASA's ERA chief technologist. The AFC, in the form of fluidic oscillating jets or synthetic jets, will be located near the rudder hinge line and operated only during takeoff and landing, or in the event of an engine out. Applied to operations in the most critical conditions, it would be sized for airspeeds of 100-150 kt., ± 15 deg. of sideslip and ± 30 deg. of rudder. "Part of what the study will do will determine the limits of the vertical rudder size reduction," Washburn adds.

Noise reduction is being tackled across three fronts: airframe, propulsion and combined propulsion-airframe aero-

acoustics. Under ERA, NASA is working with Gulfstream to test methods for mitigating airframe noise, particularly from flaps and slats on the wing and from the landing gear. Mehdi Khorrami, lead project investigator at NASA Langley Research Center and ERA noise-reduction element lead, says flight tests are being conducted using a specially instrumented G550 to gather detailed noise-source data.

Noise mitigation technologies being tested include a continuous mold-line flap and a faired main landing gear, both of which will be tested on an 18% scale half-model at Langley. Further flight tests of the G550 will gather steady-state surface pressures on the wing and flaps, as well as unsteady pressures on the flap edges, nose and main landing gear. Acoustic tests of the "most promising noise-reduction technologies" will be undertaken on the 18% model; follow-on fly-over noise tests of the selected devices will be conducted at NASA's Wallops Flight Facility, says Khorrami.

Fuel-burn reduction is being addressed via laminar flow control, improved engine performance and weight reduction. NASA's ERA program is funding flight tests of a wing glove with a natural laminar airflow airfoil on a modified Dryden Flight Research Center-based Gulfstream III. Micron-size discrete roughness elements, pioneered by William Saric of Texas A&M University, will be placed on the glove for passive laminar cross-flow control during flight trials starting around 2013.

Dramatic weight savings are expected from the Boeing-developed PRSEUS (pultruded rod-stitched efficient unitized structure) lightweight composite concept. This consists of carbon-epoxy panels infused using high temperature and vacuum pressure, with no autoclave required. Under the manufacturing process, the composite frames and stringers are stitched to the skin to produce a fail-safe structure. After stitching, pre-cured carbon-fiber rods are fitted through pockets in the stringers, locking the structure together and creating a self-supporting preform.

Because no autoclave is required, larger parts can be produced, which increases the attractiveness of the concept, says Collier. "It could be a game changer, and that's what we want to prove—whether it is or is not." PRSEUS is "broadly applicable to fuselages of any shape and wings. It is lightweight, damage tolerant and built with fewer parts," he adds. The frames and stringers provide continuous load paths and the nylon stitching stops cracks.

The process has been used in limited areas so far for Boeing C-17 gear doors and other fairings; but "so far, everything has been done in terms of unidirectional loading," says Dawn Jegley, NASA ERA structures lead. "Now we're going to look at combined loads." Testing of a 127 X 75 X 90-in. curved panel is set for mid-2011. The biggest test for the material comes later this year when a 30-ft.-wide section of double-deck hybrid wing-body (HWB) airframe, incorporating a PRSEUS shell and floor structure, will be tested in the combined-loads facility at Langley.

Chi Lee, ERA combustor task lead, is studying fuel-flexible combustor technology aimed at cutting NO_x by 25% below CAEP6 international levels. "Emissions during landing and takeoff affect local air quality, and above 3,000 ft. they account for 92% of total ozone. We think that improvements here [at higher altitudes] could result in as much as a 60% reduction

The ERA targets are individually challenging, and they are expected to be met simultaneously and without compromise



NASA

the Fischer-Tropsch process “provides more opportunities for emissions reductions because it has no aromatics, no sulfur and its distillation profile is different. That means it can vaporize quicker than jet fuel, and the viscosity is smaller; this, in turn, means droplet size is 10-20% smaller,” says Lee.

Active combustor concepts under study are aimed at devices that will carefully control combustion instability and incorporate an intelligent fuel/air management system, he adds. Work on advanced liners

NASA hopes upcoming tests of a set of second-generation GE open rotor blades will continue the lower noise trend discovered with trials of baseline versions.

is focused on silicon carbide fiber-reinforced silicon carbide matrix ceramic composites (SiC/SiC CMCs). “We need 80% of air in front of the combustor to get fuel/air mixing going and that’s going to come from the combustor liner,” says Lee. “CMC liners will reduce combustor cooling air requirements.”

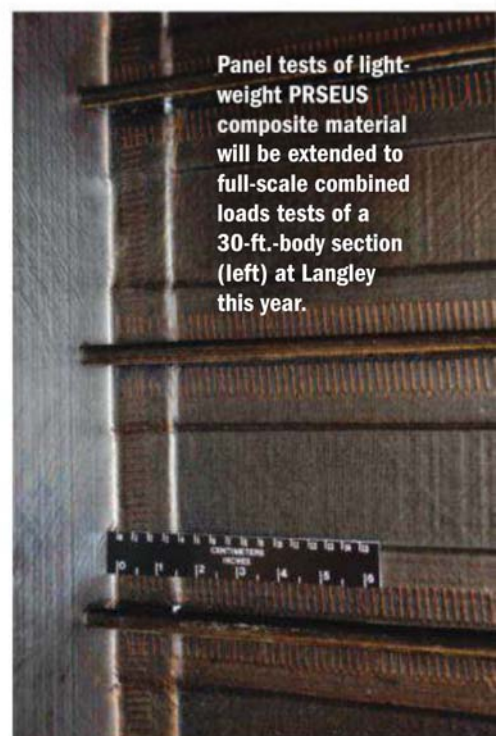
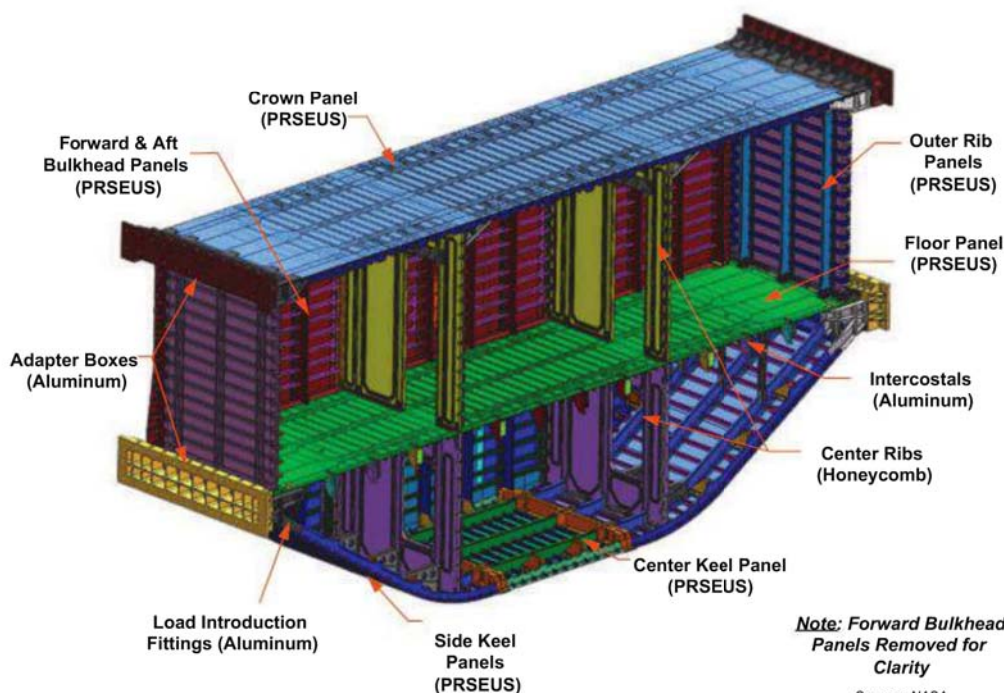
Other engine efficiency improvements, meanwhile, are being tackled through core and propulsor studies aimed at a 50% reduction in fuel burn. Described as “very aggressive” targets by James Heidmann, ERA propulsion technology project engineer, the core research effort is challenged with the age-old conundrum of how to improve thermal and propulsive efficiency without adversely affecting emissions. The key, says Heidmann, is the combined use of improved materials and cooling methods, such as film cooling, to boost turbine performance without generating more NOx.

The turbine film-cooling experiment looks at the fundamental heat transfer and flow field. “The small size of features makes it very difficult to get data, so we’ve scaled it up and tested various hole shapes using a plexiglass model for much more detailed results. Now we’re transitioning to direct measurements with an infrared camera,” Heidmann says. Testing is also underway of an “anti-vortex” film-cooling concept in

in cruise emissions. The problem is that the NOx emissions increase as overall pressure ratio increases, particularly above 50:1, so it is a tremendous challenge for us.”

Lee’s team is studying balanced combustor designs with General Electric and Pratt & Whitney, as well as a NASA configuration with an improved fuel-air mixer and a lean direct-injection combustion system. “Every time we improve fuel mixing, the NOx drops,” he observes. The plan is to progress from tests of a single injector flame tube to multi-injector sector combustor trials in 2012-13, with a full annular combustor test aimed at substantial NOx reductions of up to 80% by 2015.

The combustor group is focused on injector design, active combustion and advanced liners to improve emissions. Further refinement of existing air blast or atomizer injectors may be possible, they believe, with further characterization of combustion processes using alternate and regular jet fuel planned over the next two years. For example, fuel produced through



which a series of auxiliary holes produce counter-vorticity to promote jet attachment and reduce its velocity.

The ERA project includes studies with General Electric of a highly loaded three-stage axial compressor with swept rotors and stators at NASA Glenn Research Center's W7 turbine test site. The trials are aimed at building up a database of transonic performance as part of efforts to improve matching of highly loaded compressor blade rows to increase overall pressure ratios. Work is also under way with GE on a highly loaded high- and low-pressure turbine in the nearby

Noise-reduction tests of a G550 model in Langley's 14 X 22-ft. aeroacoustic tunnel will be followed by flight tests with Gulfstream.

W6 single-spool turbine facility. The HP turbine is a reduced shock design, while the LP turbine features a flow-controlled stator and a contoured endwall.

NASA is also experimenting with active-control plasma actuators as a potential way of improving the efficiency of LP turbines. The solid-state dielectric barrier discharge electrodes are mounted perpendicular to the flow and impart control via an oscillating wall jet, while others mounted parallel to the flow provide control by generating vortices. "We place them upstream or on a separation point on a blade. It produces velocity and forces close to the wall that give you more control authority than you'd expect," says Heidmann.

There are also two CMC-related experiments in ERA, one of which is an uncooled high-pressure turbine vane. Heidmann says the approach is to demonstrate different manufacturing techniques and explore design issues. A pre-preg lay-up of a CMC turbine vane made from a high-temperature resistant material called Hi-Nicalon SiC/SiC, and another using a hybrid approach involving chemical vapor-infiltration and melt-infiltration is planned in 2011. "Right now we're looking at a temperature capability of 2,400F for this generation, but next year we're looking at raising that to 2,700F."

NASA's ERA effort includes follow-on research into the next steps for ultra-high-bypass (UHB) ratio engines, including potential derivatives of Pratt & Whitney's PW1000G geared turbofan (GTF), now in development for service entry in 2013. "The GTF pushes the state of the art; but for the 2020 timeframe we need to push the state of the art even further," says Chris Hughes, UHB engine technology sub-element lead. A 22-in.-dia. scaled second-generation GTF is being investigated collaboratively by NASA and Pratt in Glenn's 9 X 15-ft. wind tunnel, and the two are expected to join with the FAA for an engine demonstration as part of the administration's Cleen (continuous lower energy, emissions and noise) program in 2014.

Work to integrate larger-diameter UHB engines on single-aisle aircraft such as the 737 successor has involved tests of a powered half-span model in the 11-ft. NASA Ames wind tunnel. The tests will help explore the performance tradeoffs of various engine-airframe combinations, allowing optimization of transonic wing-body shapes. These include nacelles beneath a high wing or over the wing nacelles, as well as designs incorporating boundary-layer ingestion. "As there are more issues the larger the nacelle gets, the wind-tunnel tests will be used to validate the shape we will come up with," says Steve Smith, vehicle systems integration element lead.

The baseline test model is based on a 737-800 with an 88-in.-dia. fan, versus the 61-in. diameter of the current CFM56-7B engine, with the pylon located at 34% span. The test assesses 161 design variables, including seven wing sections, says Smith.



NASA

"Initial optimization eliminated a double shock on the inboard leading edge, and a shock in the large 'trench' between the engine and fuselage," he adds. Although lift is transferring to the nacelle and offloading the wing, "[overall] for now it looks like it's going to work pretty well, and we're starting to build a semi-span model that will have a new 15-18 bypass ratio [powered] test engine," says Smith. "We will validate cruise performance in tests around November-December 2011," he adds.

Beyond GTF, the efficiency benefits of a direct-drive open rotor are being actively pursued under a cooperative research effort involving NASA, GE and CFM International. Testing is focused on validating blade designs that minimize noise from a set of counter-rotating unshrouded rotors while retaining the 25-27% fuel-burn advantage of the UHB ratio concept.

Baseline aerodynamic and acoustic testing has been completed in the 9 X 15-ft. low-speed wind tunnel at Glenn Research Center. This involved the blade design from GE's Unducted Fan engine to provide a database for evaluation of improved blades intended to reduce noise. Follow-on tests were conducted on a further set of five different GE blades (12 forward, 10 aft), all modified from the baseline "historic" design of the 1980s. The research effort is past the halfway point and is now testing at cruise Mach numbers in Glenn's 8 X 6-ft. high-speed tunnel, and will include both aerodynamic performance and near-field unsteady pressure measurements.

From May to October, a further phase will focus on a second-generation GE blade design.

Undertaken jointly by NASA, GE and the FAA as part of the Cleen program, the tests will use both Glenn's 8 X 6-ft. and 9 X 15-ft. tunnels. An intense phase will see aerodynamic and acoustic evaluation of the next-generation design at both high- and low-speed tunnels at takeoff, approach and cruise conditions. NASA says tests to date have demonstrated a 8-10% noise reduction relative to the 1980s design; confirmation of predicted cruise efficiency improvements is still pending.

As early conclusions from ERA and other studies point to integrated airframe-propulsion concepts as being the only way to meet NASA's performance targets, an element of the program is focused on combined airframe-propulsion aeroacoustics. The goal of the effort is to reduce interaction effects directly, or to actively use integration of the engine and airframe to reduce net radiated noise.

System noise assessments have been made with an HWB and a 7:1 bypass ratio turbofan, as well as with an open rotor, with plans to complete the latter assessment by the end of 2011. Tests evaluated the effect of turbofan engines mounted from above on 777-like pylons versus ones mounted from below on “keel” pylons on an HWB. Different acoustic liner and chevron nozzle configurations were also evaluated. “We see a

strong technical path to meeting the -42-dB goal," says Russ Thomas, HWB community noise team leader. "It's the last 10 dB that's really tough," he says, noting that the target can only be achieved by applying acoustic liners to crown pylons, adding "quiet" landing-gear technology and having a reduced approach speed. Open rotor tests will take place later this year in Boeing's 9 X 12-ft. low-speed aeroacoustic facility.

The highest profile element of ERA is the preferred system concepts competition in which the winners will identify advanced integrated vehicle and component technology concepts that could ultimately be flight tested as a demonstrator. Boeing, Lockheed Martin and Northrop Grumman won contracts, and up to two finalists will be selected by year-end.

Boeing is proposing a blended wing-body powered either

Next Steps

Boeing studies 'art of the possible' for 737 successor versus re-engine decision

GUY NORRIS/LOS ANGELES

Despite reports to the contrary, Boeing says it has no plans to announce in June the launch of an all-new model to replace the 737 or a decision to re-engine its best-selling twinjet.

Instead, the company says those expecting a dramatic new program unveiling at this year's Paris air show will have to make do with "more clarity on which direction we are leaning." However, if the signs of the last nine months are anything to go by, the trend continues remorselessly toward an all-new 737 replacement aimed at entering service in 2019-20.

Two major factors continue to influence Boeing's thinking. The Airbus A320NEO (New Engine Option) has galvanized the market since its launch last December, attracting more than 330 commitments to date. Secondly, Boeing has publicly described the market response to last year's 737 re-engining survey as "underwhelming," strongly indicating an all-new design as airlines' preferred alternative.

Yet, for all that, Boeing is being very careful not to be viewed as neglecting its 737 cash cow, unfilled orders for which currently stand at 2,162 or around two-thirds of Boeing's entire undelivered backlog. Mike Bair, Advanced 737 product development vice president, de-



Business aviation EVS/SVS technology could be ripe for air transport use by 2020.

clares: "We have the ability to continue to improve and develop the [737] Next Generation and to consider the development of an additional plane that would complement the NG fleet." Describing the "what if" new-airplane product as "an additional opportunity," he adds that

this “would not come at the expense of continued development and improvement of the [737NG], which remains our highest priority.”

From Bair's perspective, the re-engine option with Pratt & Whitney's PW1000G geared turbopfans, CFM International's Leap-X or Rolls-Royce's Advance2 two-shaft design, "is a real, technically viable option. This option features in several of our product scenarios under investigation," he adds.

Pratt Engineering Senior Vice President Paul Adams says, "We've been working the installation with Boeing on both re-engine and Y1." Yellowstone 1 is Boeing Product Development's code for the broad umbrella studies under which the 737 replacement falls.

"The decision on a new airplane is based on whether there is real value to be offered to the industry, with a possible entry-into-service toward the back end of the decade. We are focused on understanding where the market [airlines and passengers] is going and when key technology matures—determining the art of the possible," says Adams.

But with this timing, what can Boeing offer with confidence from its technology toolkit?

Much of this, in turn, depends on how aggressive the performance targets are. Boeing will not confirm reported goals for the new airplane of a 10% and 20% improvement in cash operating costs and fuel burn, respectively, over today's 737, but these are thought to be in the ballpark based on the goals set for the former 737RS (replacement study). Whatever array Boeing chooses will compete not so much with the A320NEO but rather the all-new A30X, which Airbus now says will

by two GTFs or optionally by three General Electric/CFM Leap-X-based open rotors. Lockheed Martin's more radical-looking option is configured with a laminar flow, modified box-wing and tail-mounted engines. Northrop Grumman proposed a notional double-fuselage concept and says its final concept will "fall out of the study."

The coming year will focus on five main tasks, says ERA chief engineer Mark Mangelsdorf. The first will be to evaluate a full-scale concept, starting with studies of how the contenders could best fit into the FAA's NextGen airspace plan. Task 2 will focus on meeting the preferred performance requirements, which include a 50,000-lb. payload and an 8,000-nm range for the passenger version. The freighter is required to carry a 100,000-lb. payload over a range of 6,500 nm.

Task 3 will sketch out a detailed 15-year technology maturation road map, while Task 4 will focus on the "long poles," or the critical technology demonstrations for the second half of the ERA program in 2013-15. "We're also interested in technologies that apply to N+1—[these are] nearer term single-aisle concepts or retrofitable to current 737/regional jet-class models," Mangelsdorf says. Task 5 covers the conceptual design of a subscale test vehicle that, if built, will be large enough "to demonstrate noise, emissions and fuel-burn goals," he adds.

"In June we'll start seeing some refinement of the vehicle concept, and around September we'll have to get more maturity and start seeing the technology road maps that go with them," says Collier. Up to two concepts may be downselected in December. ☛

likely follow in 2030 rather than 2025 as originally planned.

Starting with the baseline aircraft layout, Boeing remains unwilling to stray from the conventional tube-and-wing configuration. Recent revelations about small dual-aisle "semi-widebody" designs are dismissed by some industry observers as "Sonic Cruiser-like smoke and mirrors." However, ongoing research at NASA indicates such alternate, highly integrated configurations hold great promise for more efficient designs in the 2030s and beyond.

One possible glimpse into Boeing's thinking on Y1 may be taken from configurations developed by the company's Research and Technology branch for its 2010 subsonic ultra-green aircraft research (Sugar) study with NASA. Although aimed at meeting stringent

noise, emissions and fuel-burn targets by a 2030 timeline, the reference "Sugar Free" and "Refined Sugar" Model 765 concepts (against which more advanced models are compared) may come close to showing how a clean-sheet, next-generation tube-and-wing configuration might appear.

A more radical "Super Refined Sugar" configuration with a 160-ft. span, high-aspect-ratio wing (16 versus 11.6 on the more conventional design and 9.45 on the current 737) indicates how even standard designs can be optimized for better fuel burn. In the case of the extended wing, Boeing designers also came up with a wing-fold option, similar to that originally offered on the 777, to reduce span by 42 ft. at narrow gates.

Y1 also gives Boeing the first opportunity since 1964, when the 737 fuselage

was derived from that of the 707, to adopt a slightly wider, circular or ovoid cross section, with associated increases to the lower deck volume and increased capacity for containerized pallets. One key ground-handling advantage frequently cited for the 13-ft.-dia. cross section of the A320 is the capacity to take LD3-46-size containers in its lower hold.

Boeing says larger new twin-aisle concepts, such as the Light Twin study that emerged in early 2009, will likely not provide the basis for the cross section. Although much larger than the baseline 150-seat market needs of the 737RS, Boeing confirmed the Light Twin at the time was part of its single-aisle replacement work that broadened following the formal disbanding of the original 737RS project in April 2008.

Part of the reason the study was aban-



Technology studies range from active side stick and human-machine interface issues with advanced displays (above) to engines such as Gen 2 versions of Pratt & Whitney's geared turbofan (right).

ROCKWELL COLLINS



PRATT & WHITNEY

done was because the product development team could not meet the 20%-plus operating cost improvement targets. Now, three years on, with the launch of A320NEO, and Boeing "over the hump" on 787 development, the story seems to be different.

From the perspective of propulsion for Y1, Pratt is offering its "Gen 2" GTF, which will have a targeted overall pressure ratio of 50-55:1 against the 47-48:1 in development for A320NEO and on offer for the 737. Bypass ratio will also be in the 15-18:1 range versus 12:1 for the NEO engine. "We feel it will be achievable when we work it at a systems level,"

2013, while Boeing is developing hybrid laminar flow control for the empennage of the stretched 787-9. Active and laminar flow control are NASA's two main areas of investigation for reducing skin friction, which accounts for an estimated 48% of the drag on current airliner designs. Fewer fasteners, smaller and fewer flap fairings, and multi-function structures will also cut excrescence drag.

One of the key unknowns concerns the proportion of composite materials that will be used in the primary structure, either in the wing or fuselage. Despite Boeing's pioneering experience

variable-camber (TEVC) system developed to boost 787 cruise performance, as well as a maneuver-load-alleviation system similar to that used to reduce stress and enable a lighter wing structure on the 747-8.

The TEVC is a rudimentary morphing wing and uses slight adjustments of the moving surfaces on the trailing edge to optimize wing camber for better lift/drag ratios under changing flight conditions. A future version adds a dynamic adjustment-control module to the TEVC to provide command signals for optimum positioning of flaps, ailerons, and flaperons.

Although key suppliers such as Honeywell and Rockwell Collins decline to identify specific systems under review, they can discuss concepts applicable to the Y1 timescale. "We really look at the whole aircraft because of the portfolio we have," says Carl Esposito, Honeywell product

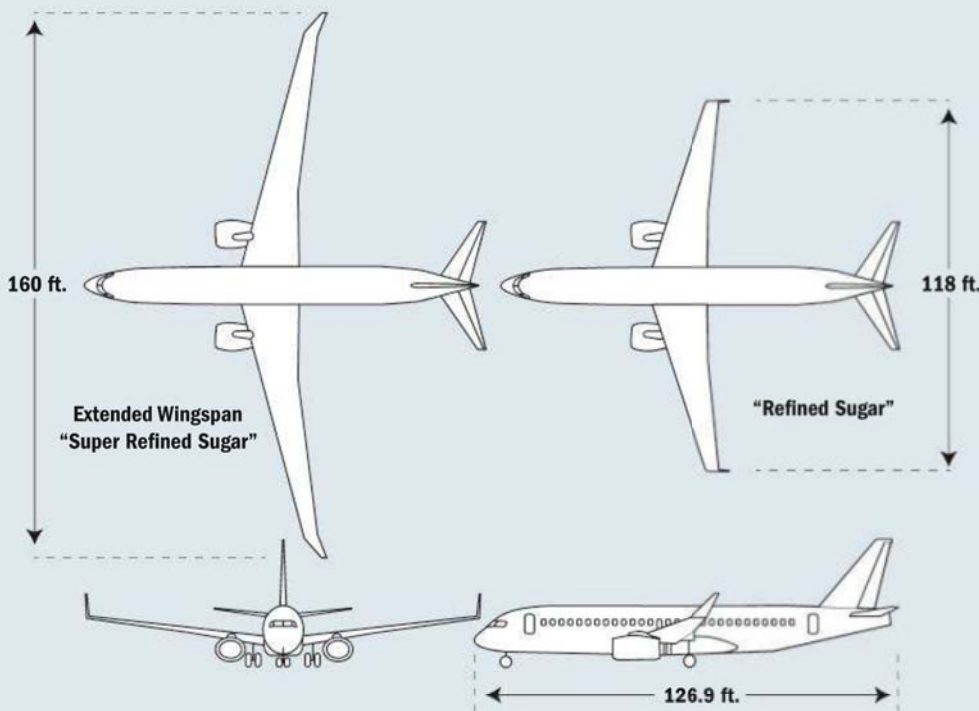
Y1 concepts may build on Boeing/NASA efficient airliner studies.

management vice president, who cites human factors, optimized "more-electric" hydraulic and pneumatic energy usage across the aircraft, and advanced predictive maintenance/health- and usage-monitoring systems as focus areas.

Following the lead taken by the 787 with dual head-up displays as standard, Esposito believes advanced flight-deck features such as enhanced and synthetic vision systems (EVS/SVS) will ultimately find air transport applications. New-generation flight-deck features such as Automatic Dependent Surveillance-Broadcast and controller-pilot data link communications "will become a baseline configuration for entry-into-service in the 2020 time-frame," says Bob Ellis, Rockwell Collins product systems marketing director.

From a controls perspective, Ellis believes development of active, jam-resistant side-stick controllers could give the flight deck a new look, while backup safety modes, such as the ability to fly with degraded or damaged control surfaces, could appear. The transition to electrical stabilizer actuation with the 787, A380 and A350, is also likely to continue onto future single-aisle designs, he says. ☉

Boeing Advanced Concept Model 765



BOEING

says Adams, who adds that goals include a lighter hybrid fan and nacelle, with a shorter inlet. "We may also [modify the] gear ratio to a point where it could change from a star to a planetary system, but my expectation is we'll probably stay with the current configuration and look at both."

Aerodynamic advances—particularly in potentially high-payoff areas such as passive, natural and active laminar flow control for drag reduction—are progressing toward practical application. NASA is planning to flight test a method of laminar flow control on swept wings with micron-size protuberances called discrete roughness elements around

on the 787, the company continues to warn that scaling factors do not always justify their use at the smaller single-aisle size. However, ongoing materials research suggests that lightweight ceramic matrix composites (CMC) may be sufficiently mature for wider application by 2020, and that out-of-autoclave composites could be used for secondary control surfaces.

Other structural technology advances that might be brought to bear could include adaptive structures for spanwise load control, lighter interiors and an integrated structural health management system with embedded sensors. Y1 could use future versions of the trailing-edge

Advancing Edge



Technologically, the U.S. Army's rotorcraft fleet has fallen behind, as illustrated by its most heavily used helicopter, the OH-58D Kiowa Warrior armed scout, based on a 1960s design.

U.S. Army next-generation rotorcraft plans raise questions about industry's ability to innovate

GRAHAM WARWICK/WASHINGTON

The U.S. Army is moving toward its first next-generation rotorcraft program in decades, but industry is concerned that a "business as usual" approach to technology demonstration could stifle the innovation it badly needs to rebuild its competitiveness.

While the Army prepares to award contracts next month to begin the Joint Multi-Role (JMR) rotorcraft technology demonstration program, an industry coalition continues to push for funding to perform rapid, incremental "pre-X-plane" demonstrations that would promote innovation.

The term "Joint Multi-Role" has been around for more than a decade, applied to the concept of a common rotorcraft that could replace the current U.S. fleet of attack and utility helicopters. Recently, JMR has been broadened to

encompass four classes of rotorcraft that would meet all of the U.S. military's vertical-lift requirements.

"JMR is not a specific aircraft, but weight classes: light, medium, heavy and ultra," says Layne Merritt, director for engineering and technology for the Army's Program Executive Office Aviation. The boundaries between weight classes are defined by major changes in aerodynamics and structures, and for the Army the four categories combine to cover the mission areas of reconnaissance, attack, utility and heavy lift.

JMR is aimed at developing technology for new—but still undefined—rotorcraft that would enter service in the 2025-30 timeframe. "All our current production lines go cold around 2018, plus or minus two years," Merritt says. "Minor upgrades will be required, so the configuration on the production line will

change, but, barring any major change, all the aircraft go cold in 2018."

This impending production cliff has motivated U.S. industry to press with increasing stridency for a new-start program. The Army's response is the JMR technology demonstration, which falls well short of launching a new acquisition program but sets the stage for development of a next-generation rotorcraft to begin around the end of this decade.

"The Army is struggling with the question of how to put together a future vision and make smart investments with its limited S&T [science and technology] funding," says Merritt. Although a new program may still be a decade away, "it takes time to develop and integrate technologies, and JMR signals the Army's determination to move ahead," he says.

In January, the Army's Aviation Applied Technology Directorate issued a broad agency announcement (BAA) soliciting proposals for JMR demonstrator configuration trades and analyses. These paper studies will identify essential technologies required to meet the broad performance, survivability and sustainability attributes outlined in the BAA. "They will help identify what we should invest in," says Merritt.

Configuration studies will be focused mainly on the JMR medium class—to replace today's AH-64D, UH-60M, AH-1Z and UH-1Y—with excursions into the light (OH-58D) and heavy (CH-47F) classes to identify technologies that are common across a range of rotorcraft, regardless of size. "We are not addressing ultra," he says, as work on the heavy-lift JMR ultra is being conducted under the U.S. Air Force-led Joint Future Theater Lift (JFTL) effort.

The Army studied concepts for ultra-large vertical-takeoff-and-landing (VTOL) aircraft under the Joint Heavy Lift project, which later was combined with the Air Force's emerging requirement for a C-130J replacement to create JFTL. But plans for a formal analysis of alternatives (AOA), as a step toward launching a program, were not approved because the Air Force would not commit to providing further S&T funding after completion of the analysis.

Instead, the AOA was converted to a \$4 million technology study with similar guidelines. A capability request for information (CRFI) released in October 2010 sought fixed-wing, tiltwing, rotorcraft and airship concepts for aircraft capable of vertical or short takeoff and landing car-

U.S. ARMY

rying a 20-36-ton payload and cruising at speeds and altitudes equal to or better than those of the C-130J.

The JFTL CRFI called for concepts with a technology readiness level of 6 by 2019, ready to begin development for service entry after 2024. The technology study is expected to be completed around the end of this year, in time to inform the fiscal 2014 budget planning cycle. But if JFTL does not produce the vertical-lift solution it seeks, the Army will revisit the JMR ultra concept, says an official close to the program.

In May, the Army plans to award three to five contracts, each worth \$3-4 million, for JMR configuration trades and analyses lasting 24-30 months. Although restricted to paper studies, "the trades should be very detailed and the analyses very defensible," Merritt says. The goal is to identify those key technologies that must be integrated and tested in flight demonstrators to be mature enough to use in an operational JMR.

While increased speed and payload are on the wish list, they come with costs. "The studies will show the cost and weight sensitivity—for example, if

you have to increase the size of the aircraft to carry the last 2,000 lb.," he says. "Speed has been at the top of the list for a long time, but you have to balance it with low-air-speed operations. If you want to go very fast, you have to compromise. So you need to make trades and put speed into an operational and cost context."

The basic performance parameters outlined in the BAA will be fine-tuned based on the study results before the demonstrator program moves into its next phase. In parallel with the configuration studies, Army requirements officials will develop an initial capabilities document (ICD) for an operational JMR over the next year or so. It has not been decided whether this will be for the JMR medium or an overarching ICD with separate capability development documents (CDD) for each class, Merritt says. An ICD identifies the operational needs, while a CDD provides performance attributes and guides development of a new weapon system.

The next step will be the JMR technology capability demonstration—two flying demonstrators that will integrate and test key technologies emerging from

EADS NORTH AMERICA

Sikorsky is building prototypes of the coaxial-rotor X2 Raider (foreground), aimed at the Army's Armed Aerial Scout mission, and is likely to propose the technology for the JMR medium class (background).



the studies and ICD. The Army plans to award multiple demonstration contracts in the fiscal 2013 timeframe, and introduce more new technologies in fiscal 2015-16 as they mature. The program will address both the air vehicle and mission system, with demonstration of the mission equipment package beginning 18 months later.

"We are not saying the demonstrators will be brand new airframes," says Merritt. "If it's an airframe technology [being demonstrated], then it could be a new aircraft. If it's a drive train, then we could use an existing aircraft." The flight demonstrators will not be prototypes, he emphasizes, but the JMR technology capability demonstration phase would be folded into a formal acquisition program if and when it is established.

All of this will require more money than has been spent on rotorcraft science and technology (S&T) in recent years.

EADS offers the Army quicker access to newer technology through derivatives of its commercial helicopters, such as this EC145-based AAS-72X, a technology demonstrator for the Armed Aerial Scout program.

"The Army has an increased S&T budget in fiscal 2012," says Merritt, but funding will set the pace with which JMR moves from a demonstration to an acquisition program and is not the only reason why it will take so long. "Requirements have to be firmed up. [The Army] has to set clear requirements that will not change. We need to proceed in a very deliberate manner to keep the program on track."

JMR is part of the larger Future Vertical Lift (FVL) initiative, which has the broader scope of devising a plan for increased Defense Department invest-





ment in S&T. The Pentagon submitted an FVL strategic plan to Congress in 2010, identifying the capabilities required and providing road maps to acquire the technologies needed to develop next-generation vertical-lift aircraft.

The Defense Department is putting the final touches on a more specific FVL strategic plan that, when signed by senior leadership, will take on the authority of a directive. Any new vertical-lift program will have to align with the objectives of the strategic plan, and it will be a key step toward launching a next-generation rotorcraft program.

"Right now there is nothing that carries us toward a joint program of record," says a defense official familiar with the FVL initiative. "JMR is being stimulated by the technology community, but the acquisition community is not on board. The strategic plan will bring us closer to when a [new program] might actually occur."

As part of the congressionally directed FVL initiative, the Pentagon invited industry to form the Vertical Lift Consortium (VLC) with the goal of simulating innovation and speeding technology development. Bringing established manufacturers together with non-traditional suppliers and academia, the 97-member consortium signed an "other transactions agreement" (OTA) with the Defense Department intended to enable research projects to be undertaken more rapidly and less expensively.

In a blow to the consortium, the Army chose not to use the OTA as its contract vehicle for the JMR technology demonstration.

"The services have the right to contract in the way they choose. I'm disappointed the Army didn't take the opportunity to use the OTA, but I understand

why," says Stephen Mundt, VLC chairman and vice president of business development for EADS North America. He believes the timing of both the VLC and JMR and the structure of the OTA are reasons why the Army chose a more traditional route.

Despite the setback, Mundt says there is growing government interest in engaging with the consortium. "The idea that the whole definition of the VLC is based on the OTA is absurd. The VLC is a coalition of industry that has multiple responsibilities." One is to ensure that Congress understands the impact of near-term decisions on the future of the vertical-lift industry.

To that end, the consortium is going back to Congress in a bid to reenergize the rotorcraft caucus that mandated the FVL initiative and to lobby for an increase in science and technology funding. "We cannot continue to rob the seed-corn of S&T and expect to build revolutionary new platforms," Mundt says. "We intend to talk to Congress about resourcing some other opportunities, not necessarily through the Army's BAA."

Arguing there is too great a fixation on JMR, John Piasecki, VLC vice chairman and president/CEO of Piasecki Aircraft, says the FVL strategic plan outlines a full range of capability gaps and needed technologies. Industry came together more rapidly than expected to form the consortium and "there needs to be time for the services and the department to catch up," he says.

The VLC's mantra is that the cost of demonstrating technology is too high, and there is concern that the Army's approach to the JMR technology demonstration is "business as usual." Critics argue that several years of paper studies

leading to two flight demonstrators will not encourage the innovation and competition needed to reinvigorate the U.S. rotorcraft industry.

"Something has to be done to get back to rapid low-cost technology development to burn down risk before engineering and manufacturing development. The VLC can play an important role in that," Piasecki says. "Under normal [Defense Department] procedures, \$200 million gets you one flight demonstrator. A Skunk Works approach can do it for less than \$50 million," he says, citing Piasecki's X-49A compound-helicopter and Sikorsky's X2 coaxial-rotor demonstrators as examples.

Because the cost is high and the funds insufficient, the Pentagon moves from demonstration to development too early, argues Mundt. "They downselect too early, take competition out and leave innovations on the cutting room floor," he says. "When we have a strategic FVL plan, get buy-in by the services and [Defense Department] leadership, and apply a little money, they will be surprised how fast industry aligns its IR&D [independent research and development] spending, which dwarfs any investment the government makes" in S&T, Mundt says.

The Pentagon's new S&T strategy is to leverage the \$2.5 billion a year in IR&D spending it reimburses, but it worries that industry's independent research is no longer aligned with Pentagon needs and is focused on low-risk, near-term technologies. While proposed rulemaking to tighten reporting of IR&D spending will help, Mundt says industry cannot align its research if it does not know where the Pentagon is going. That is where the VLC comes in to play, he says. ☐

Talent Drain

Rocketdyne's talent pool is threatened by dithering over future launcher

GUY NORRIS and MICHAEL MECHAM/WEST PALM BEACH, FLA.

Pratt & Whitney Rocketdyne needs answers fast from NASA on the agency's direction in space exploration as it continues to consolidate facilities and staff in the wake of the Constellation and space shuttle terminations.

"We're really concerned about this lack of a decision," says PWR President Jim Maser, speaking to Aviation Week here at its rocket test headquarters recently. Earlier, he testified to Congress on the potentially damaging impact of the slow transition from Constellation to the planned follow-on Space Launch System (SLS).

"I don't know if it did any good, but at least being asked to testify shows we may be gaining a bit of traction," he says of his appearance before the House Science Committee's subcommittee on space and aeronautics (*AW&ST* April 4, p. 31). Maser testified in his capacity as chairman of the American Institute of Aeronautics and Astronautics' Corporate Membership Committee.

For PWR, some firm direction is better than none at all as it continues to rationalize its production workforce. "The shuttle ends in June, and J-2X [an engine originally in development for the now-canceled Ares launch vehicle under the Constellation program], is in a flat or declining budget," says Maser. "We believe it's got to be worked out by the fourth quarter this year. If things don't change, we know we will have to reduce numbers this summer. But what we'd like to do is speed up. I don't want guarantees, I just want to know what NASA plans to do."

In terms of workforce, "we're down year-over-year by 15%, and this year it's still up in the air. The last thing we want is to be under-staffed as we try to execute work we have on contract, or as we try to capture new work."

"From a fixed infrastructure standpoint, across Rocketdyne we have a two-to-one ratio in excess capacity in terms of footage, and we have a plan to [reduce that] by half over the next three years. That's a non-trivial activity," says Maser. He notes that the reduction process began in 2008 with Pratt's initial acquisition of the rocket engine manufacturer. Following the closure of the company's solid rocket facility in San Jose, Calif., PWR is consolidating work at its two Canoga Park sites near Los Angeles. The Canoga Avenue site—where the space shuttle main engines were built—will be closed. All its work is being transferred to the nearby, and more modern, DeSoto plant, which currently has responsibility for missile defense and related attitude control propulsion system work.

The company is also re-organizing its activities in Florida and

Mississippi. The site here will be used for the assembly and test of all "small" engines up to 50,000 lb. thrust. All larger engine test and development work will be focused at its Stennis Space Center in Mississippi.

The first J-2X engine is being assembled at Stennis now and will be tested in May. Despite the scrapping of Ares, Maser believes the J-2X development continues to be worthwhile.

"Constellation would really be a waste of money if the heavy-lift architecture doesn't use any of that, and I'd argue that this is unlikely. Even if we don't use any of it, [J-2X] has maintained the critical skills we need to maintain the baseline."

PWR also is poised to complete development of the RS-68A, the most powerful hydrogen-fueled engine made, and recently delivered the third flight-test engine for integration into a Delta IV launch vehicle.

"We're just wrapping up -68A and held a design certification review in California with United Launch Alliance (ULA) and the National Reconnaissance Office (NRO) on March 31," says Maser. "We've built and tested the first three flight engines, we've delivered two." Earlier in March, PWR completed a series of hardware acceptance reviews following tests on the first of three RS-68As that were then shipped to ULA's integration facility in Decatur, Ala.,

Rocketdyne is assembling the first J-2X at Stennis for testing in May. Despite the scrapping of Ares, its development is being used to maintain critical skills.



PRATT & WHITNEY ROCKETDYNE

for installation into the first stage of the Delta IV. The third, and final engine, 30005, was cleared for delivery after its acceptance review following hot-fire testing at Stennis.

"We're now negotiating the next lot buy of the engine to provide them through 2017. This will include a final batch of three more -68s as well as -68As. All we have to do is get back to steady-state production. We've been in a period of instability in terms of flow through our factories and test stand at Stennis," comments Maser.

The RS-68A is a liquid-hydrogen/liquid-oxygen booster engine designed to provide 705,000 lb. of liftoff thrust, or 42,000 lb. more than the basic RS-68. Although the NRO does not comment on specific missions, there is speculation that the engine could make its debut on NRO L-36, thought to be due for launch in 2012.

PWR continues work with Polaris on the Bantam low-cost, dual-use booster/launch abort system for Boeing's CST-100 spacecraft. Four of the variable-thrust engines would be used for orbital maneuvering. But should a launch abort be required, the Bantam engines could go from cold to full 50,000-lb.-thrust power in 80 milliseconds and sustain that output for 3 sec. in order to separate the crew capsule safely from the launcher.

The company also is developing an RL-10C upper-stage engine that converts RL-10Bs used for the Delta IV to an RL-10A configuration for the Atlas V. The development includes a smooth-walled combustion chamber that abandons the use of cooling tubes that climbed the walls of the chamber. ☛

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(212) 904-2628; matt_holdreith@aviationweek.com

Sales Manager, AviationWeek.com: Keith Gregory

(212) 904-4166; keith_gregory@aviationweek.com

Regional Account Manager: Lisa McCarty;

(202) 383-2391; lisa_mccarty@aviationweek.com

Defense Regional Account Manager: Sean Fitzgerald;

(202) 383-2417; sean_fitzgerald@aviationweek.com

Northeast U.S.: Russell E. Brody;

(732) 832-2977; russell.brody@verizon.net

Mid-Atlantic U.S.: Beth Wagner;

(202) 383-2467; beth_wagner@aviationweek.com

Southwest & Southeast U.S., Mexico, Latin America:

Tom Davis; (972) 731-6763; tom_davis@aviationweek.com

Midwest U.S.: John Specht;

(513) 459-6451; john_specht@aviationweek.com

Western U.S.: Tim Reed;

(949) 650-5383; tim_r_reed@aviationweek.com

Canada: Richard Brown;

(416) 259-9631; r.brown@vicbrownmedia.com

International Regional Sales Offices

Associate Publisher Civil: Iain Blackhall (U.K.);

+44 (20) 7176 6231; ian_blackhall@aviationweek.com

Germany, Switzerland: Robert Rottmeier (Switzerland);

+41 (21) 617-44-12; robert_rottmeier@aviationweek.com

France, Portugal, Spain, Benelux: Romaine Meyer (France);

+33 (1) 40-75-2501; romaine_meyer@aviationweek.com

Eastern Europe, India, Pakistan, Russia and the CIS, Middle East, Scandinavia, Africa, Mediterranean, Turkey and Asia

Vittorio Rossi Prudente (Italy); +39 0(49) 723548;

prudente@aviationweek.com

Sales Director Defences, EMEA, Italy: Andrea Prudente (Italy);

+39 0(49) 723548; andrea_prudente@aviationweek.com

United Kingdom, Ireland: Michael Elmes, Aerospace Media (U.K.);

+44 (125) 587-1070; mike.elmes@aerospacemedia.co.uk

Israel: Tamir Eshel, Eshel Dramit Ltd. (Israel);

+972 (9) 8911792; eshel_tamir@yahoo.com

Japan: Shigeru Kobayashi, Japan Advertising Communications

(Japan); +81 (3) 3261 4591; jac@media-jac.co.jp

Classified/Marketplace Advertising

U.S., Canada, South America: Elizabeth Meyer;

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Europe, Middle East, Africa: See Vittorio Rossi Prudente

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Aero Products & Services Advertising

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Miguel Ornelas; (818) 834-4232; mornelas@mindspring.com

Business/Production

Production Director: Laura Hoffman;

(212) 904-3489; laura_hoffman@aviationweek.com

Senior Production Manager: Anna Dariotis;

(212) 904-4360; anna_dariotis@aviationweek.com

Production Manager: Melissa Menelly;

(212) 904-4917; melissa_menelly@aviationweek.com

Advertising Services

For Media Kits and Promotions:

www.aviationweek.com/mediakits

or e-mail: elizabeth_sisk@aviationweek.com

For Custom Media: Greg Hamilton;

(212) 904-3259; hamilton@aviationweek.com

Market Research Manager: John Santospirito, PRC;

(212) 904-3084; santospirito@aviationweek.com

Advertising Operations Managers: Casey Carlson;

(610) 373-2099; casey_carlson@aviationweek.com;

Doug Walsh; (212) 904-3223; doug_walsh@aviationweek.com

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April 24-26—BCI Aerospace's Meetings. Matrade Exhibition & Convention Center, Kuala Lumpur, Malaysia. Call +33 (14) 186-4150 or see www.bciaerospace.com

April 27-29—Association of Aerospace Industries' Aerospace Supplier Exchange 2011. Sands Expo and Convention Center, Hall D, Marina Bay Sands, Singapore. Call +65 6517-6894 or see www.aerosupplierx.com/2011

May 2-5—Practical Aeronautics Short Courses: "Introduction to Aeronautics, A Practical Perspective." Wright-Patterson AFB, Ohio. At Ohio Aerospace Institute, Cleveland **May 9-12**—"Introduction to Aeronautics, A Practical Perspective" and **May 16-17**—"Introduction to Jet Engines, A Practical Perspective." See www.practicalaero.com

May 3-6—40th Annual National Aircraft Finance Association Conference. Harbor Beach Marriott Resort and Spa, Fort Lauderdale, Fla. Call +1 (410) 571-1740 or see www.nafa.aero

May 4-5—UBM Aviation's Airline Purchasing & Maintenance Conference. Olympia Grand Hall, London. Call +44 (207) 921-8039, fax +44 (207) 955-3949 or see www.apmexpo.com

May 5-6—Speednews' Ninth Annual Military Aviation Suppliers Conference. Jonathan Club Hotel, Los Angeles. See www.speednews.com/conferences

May 8-12—Aerospace Medical Association's 82nd Annual Scientific Meeting. Hilton Anchorage (Alaska) and Capt. Cook Hotels. Call +1 (703) 739-2240 ext. 106 or see www.asma.org

May 9-12—Naval Helicopter Association 2011: "Centennial of Naval Aviation" Symposium. Town & Country Resort and Conference Center, San Diego. Call +1 (619) 435-7139 or see www.navalhelicopterassn.org/2011-nha-symposium/

May 11—American Institute of Aeronautics and Astronautics' (AIAA) 2011 Aerospace Spotlight Awards Gala. Ronald Reagan Building and International Trade Center, Washington. Call +1 (703) 264-7511 or see www.aiaa.org

May 12—Northwest Chapter of Society of Experimental Test Pilots' Regional Symposium—"Flight Test Northwest. Future of Flight Aviation Center." Paine Field, Everett, Wash. Call +1 (661) 942-9574 or see www.setp.org

May 17-19—Technology Training Corp.'s Conference on Armed Unmanned Aerial Systems. Rio Hotel, Las Vegas. Call +1 (310) 563-1210, fax +1 (310) 563-1220 or see www.ttcus.com

May 17-20—Fatigue Concepts Short Course: "Fatigue, Fracture Mechanics and Damage Tolerance of Modern and Aging Aircraft Structures." Sheraton, Mid West City, Okla. Call +1 (916) 933-5000 or see www.fatcon.com

May 19—Society of Experimental Test Pilots' Great Lakes Symposium. Wright-Patterson AFB, Ohio. Call +1 (661) 942-9574, fax +1 (661) 940-0398 or see www.setp.org

May 25—Shephard Group's Electronic Warfare 2011. Estrel Convention Center, Berlin. Call +44 (175) 372-7001 or see www.shephard.co.uk/events/

June 2—AIAA's Executive Symposium: "Aerospace Today and Tomorrow." Kingsmill Resort and Spa, Williamsburg, Va. Call +1 (703) 264-7511 or see www.aiaa.org

June 2-3—Greater Los Angeles Chapter, Association of the U.S. Army Symposium: Enabling Army Operations: Global Employment. "Supporting the Warfighter with Space, C4 and Cyber Functionality." Long Beach Westin, Calif. See www.ausea.org/glac

June 9-11—5th Annual Cannes International General Aviation Air Show. Cannes-Mandelieu International Airport. Call +33 (49) 308-0177 or see www.cannesairshow.com/index.php?lang=en

June 14—University of Westminster Aviation Seminars—"Air Transport Marketing: Practical Techniques and Strategies." Also, **June 15-17**—"Regional and Low-Cost Air Transport: Opportunities and Challenges." London, U.K. Call +44 (20) 7911-5000 ext 3220, fax +44 (20) 7911-5171 or see www.westminster.ac.uk/aviation

June 14-16—2011 The Institute of Metal Finishing for Aerospace & Defense Industries. Royal Air Force Museum. Cosford, U.K. Call +44 (12) 1622-7387 or see www.instituteofmetalfinishing.org

June 15-16—Shephard Group's UV Europe/Air, Land & Sea 2011. Hotel Husa President Park. Brussels, Belgium. Call +44 (17) 5372-7001, fax +44 (17) 5372-7002 or see www.shephard.co.uk/events/

May 10-12—NextGen Ahead. Washington.

May 17-18—Affordability Requirements Forum. Washington.

May 24-25—A&D Cybersecurity Conference. Washington.

May 26-27—Inventory & Engine Asset Management Forum. Zurich.

Sept. 12—A&D Finance Europe. London.

Sept. 27-29—MRO Europe 2011. Madrid.

Sept. 28—MRO Military Europe. Madrid.

Oct. 20-21—MRO IT. Chicago.

Oct. 24-26—A&D Programs. Phoenix.

Nov. 8-10—MRO Asia. Beijing.

Mar. 13-14—Innovation Challenge Showcase. Orlando.

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Don't Take Aviation For Granted

U.S. Congress is slashing government spending to reduce the crushing \$14 trillion national debt and pare down this fiscal year's deficit of \$1.4 trillion, as estimated by the Congressional Budget Office. Funding for high-speed rail is getting the ax, but that project was always a pipe dream. Meanwhile, the mood on Capitol Hill is taking its toll at the Transportation Security Administration (TSA) and FAA. Unfortunately, these cuts—the latest are in the 11th-hour agreement reached to stave off a looming government shutdown—will translate into further setbacks for airports, airlines, the air cargo industry and travelers.

To put it bluntly, the Obama administration and Congress have failed miserably in their duty to support aviation adequately. The president and Congress had an opportunity under the economic stimulus program to make amends and fund FAA “shovel-ready” projects, jump-start the Next-Generation Air Traffic Control System (NextGen) and equip aircraft to use the 21st century air navigation system. However, the money was scattered to the winds, and aviation wound up occupying its overlooked stepchild status despite its over-arching importance.

Previous administrations and Congress have not done much better. Washington has long taken aviation for granted instead of treating it as a cornerstone of a vibrant, growing economy. When government does turn its attention to aviation, there seems to be little understanding of complex issues, often resulting simply in more regulations, higher taxes and scant or no contribution to safety, security or convenience.

A nation that relies on aviation deserves better than to merely endure as Congress dickers with agency appropriations. Unable to come to bipartisan agreement on FAA reauthorization, Congress has approved no fewer than 17 temporary extensions—the latest in December 2010. As a result, the agency and aviation have been kept in perpetual financial limbo. Still, the aviation sector limps along year after year, largely the object of neglect. This disreputable legacy comprises continually underfunded FAA budgets, over-taxed airlines and scorned travelers.

Understandably, the industry grows increasingly anxious over what the future holds. Even as fuel prices rise untenably, the U.S. offers non-U.S. airlines financial help to acquire aircraft. Regulatory requirements keep growing for such necessities as crew training. Passenger rights protections roll into a second phase when the first phase has barely been implemented.

The government can be a faceless bureaucracy, which routinely imposes superfluous regulations that override common sense. The irony is that government has an essential role to play in helping to make airways safe and to fund infrastructure improvements. Airports do not escape benign neglect, either. Environmental regulations and NIMBY complaints, short for “not in my back yard,” can make the process of adding capacity or building new airports excruciatingly long.

Obviously, the recent agreement on fiscal 2011 spending cuts will not be the downfall of the FAA, which is charged with over-



ERIK SIMONSEN

“Given aviation’s critical role as an economic linchpin, the latest cuts reflect the long history of inadequate funding as well as neglect in Congress and successive administrations, for which the U.S. will pay a steep price.”

seeing the nation’s civil aviation sector. As now proposed, \$220 million will be trimmed from facilities and equipment from the fiscal 2010 level, and \$254 million from the fiscal 2011 request. TSA gets a deeper cut: \$340 million from what was planned for aviation security.

Since Americans are loathe to raise taxes, there is little doubt that federal spending must be cut. Moreover, the FAA and TSA reductions are small compared to the \$40 billion in proposed cuts overall. However, given aviation’s critical role as an economic linchpin, the latest cuts reflect the long history of inadequate funding as well as neglect in Congress and successive administrations, for which the U.S. will pay a steep price.

Sadly, there seems to be a prevailing mind-set that the nation’s air transportation infrastructure is quite adequate, thank you very much, and there is nothing to be gained by substantial increases for civil aviation. Last week, yet another air-traffic controller was caught asleep on the job. But it is a deeper snooze that worries us. When it comes to civil aviation in the U.S., the leadership has been asleep for years and continues to be in a deep slumber. ☹



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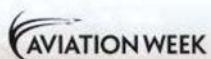
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