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Senior Editors Amy Butler, David A. Fulghum, Michael Mecham, Frank Morring, Jr., Guy Norris, Adrian Schofield, Graham Warwick
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DEFENSE, SPACE AND SECURITY
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Chief Aircraft Evaluation Editor Fred George

For individual e-mail addresses, telephone numbers and more, go to www.AviationWeek.com/editors

EDITORIAL OFFICES
2 Penn Plaza, 25th Floor, New York, N.Y. 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
Bureau Chief Robert Wall

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) 626-5356; Fax: +7 (495) 933-0297
Contributing Editor Maxim Pyadushkin

NEW DELHI
Flat #223, Samachar Apartments,
Mayur Vihar—Phase-I (ext.)
New Delhi 110091, India
Phone: +91 (98) 1154-7145
Contributing Editor Jay Menon

PARIS
40 rue Courcelles, 75008 Paris, France
+33 (06) 72-27-05-49
Bureau Chief Amy Svitak
Contributing Editor Pierre Sparaco
pierre.sparaco@orange.fr

SAN FRANCISCO
310 Brandon Court, Pleasant Hill, Calif. 94523
Phone: +1 (925) 934-6813
Bureau Chief Michael Mecham

SINGAPORE
30 Cecil Street, Prudential Tower #13-01
Singapore 049712
Phone: +65 6530-6532
Bureau Chief Leithen Francis

WASHINGTON
1200 G St., N.W., 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

Finance Director Hing Lee

President/Publisher Gregory D. Hamilton
hamilton@aviationweek.com

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Iain Blackhall
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January 9, 2012

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AVIATION WEEK
& SPACE TECHNOLOGY

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UP FRONT

18 *Some of Boeing workers at the Wichita facility express their frustration after learning the company will close it and shift production to other plants around the U.S. as military spending contracts*

THE WORLD

DEFENSE SPENDING

MISSILE DEFENSE

DEFENSE

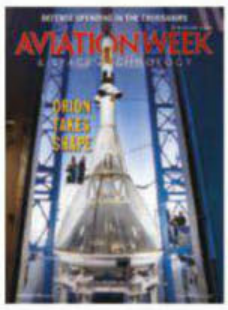
ELECTRONIC WARFARE

PROPULSION

SPACE

AIR TRANSPORT

LAUREATES 2012



COVER STORIES

40 *Lockheed Martin is putting NASA's first Orion multipurpose crew vehicle through ground test at its facility near Denver. Lockheed Martin photographer Patrick H. Corkery shot the ground test article in an acoustic chamber, with and without the ogive that would protect it from the plume of the launch abort system at the top if it is needed to pull the capsule off a failing launch vehicle. Then he digitally blended the two photos to get the see-through effect on the cover image. Next up will be system vibration testing on the crew module.*

21 *Shifting of the Pentagon's global military focus could breathe new life into plans for programs such as a new stealthy bomber.*

The Industrial Designers Society of America is world renowned for advancing the art and science of industrial design. We're honored that the Boeing 787 Dreamliner was recently designated "Best in Show" at the IDSA International Design Excellence Awards. In summary, the Dreamliner was cited for "improving the human experience," and "restoring the majesty of flight." We're proud to say, it's what we had in mind from the beginning.

BOEING

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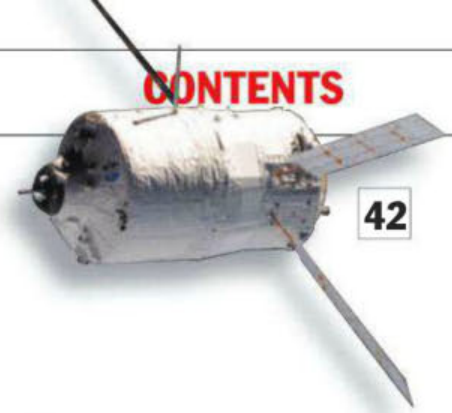

NASA'S ORION PROGRAM

AviationWeek.com

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CONDUCE GROUP

MRO TECH WATCH

The maintenance, repair and overhaul side of the aviation business is looking to the future and creating fanciful yet practical innovations to make repair easier, such as virtual worlds and augmented reality apps. Head over to **AviationWeek.com/om** to see the top 10 new MRO technologies to watch in 2012.

ADMISSION APPLICATION

Is India's Kingfisher really ready to join the Oneworld alliance, Online Editor Rupa Haria asks on our **Things With Wings** blog (**tinyurl.com/7rhunzu**). India's director general of civil aviation, Bharat Bhushan, has indicated the airline's operating certificate could be in doubt. For more on commercial aviation, go to **AviationWeek.com/wings**

FANNING THE FLAMES

A post on our **Ares** blog, "F-35 Proponents Say the Darnedest Things," received more than 150 responses. *Defense Technology International* Editor-in-Chief Bill Sweetman lists some of his favorite pro-JSF comments from December, along with his critique (**tinyurl.com/7ewug6f**). **AviationWeek.com/Ares**

BIRD-DOGGING GPS

Senior Space Editor Frank Morring, Jr., happened upon some bear hunters in the North Carolina mountains. He tied together hunting from a bygone era, William Faulkner's short story and the surprising role GPS can play in our day, in a Jan. 4 post (**tinyurl.com/7jljzme**). For more space blogs, go to **AviationWeek.com/onspace**

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PREMIUM CONTENT

Use the World Aerospace Database to find suppliers in thousands of product categories and subcategories. Its powerful advanced search allows you to find potential suppliers based on location, disadvantaged or minority-owned status, sales volume and more. **AviationWeek.com/awin**

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FROM THE WEB

Comments from readers on AviationWeek.com

U.S. AIR FORCE

The article "Hawker Sues USAF After Losing Protest" brought the following observations:

FM2436 says:

Just like the Air National Guard's C-27J—built by the Italian manufacturer Alenia—it appears that recently several U.S. military aircraft contracts have been awarded to foreign manufacturers. I believe the aircraft purposely built to have become the Light Support Aircraft was the Piper PA-48 Enforcer. It would have been exciting to have seen Piper introduce the PA-48 as a contender for the LSA program.

Warrant9 notes:

The AT-6B deserves another look. If it does not meet selection criteria, a specific explanation as to the deficiency is required. The AT-6(X) will be able to fly an A-10's air support mission delivering similar weapons. With a $1 billion contract hanging in the wings, it is unthinkable that USAF would eliminate the lower-cost, U.S. manufacturer from the competition.

In "Saudi, U.S. Finalize F-15SA Sale," Amy Butler reports that though the buy buoys Boeing's St. Louis production line, the company's hopes dim for selling a semi-stealthy version of the aircraft abroad.

BOEING

Warrant9 says:

A purchase of U.S. fourth-generation warplanes by its richest client state? It is a dog-bites-person snooze. Can't Europe keep its rich client states in line? Of course, if Saudi Arabia bought a Euro Canard it would mean much more than whether they were buying the "best warplane" or not.

Slowman opines:

Contrary to the article's suggestion, Japan's F-X contest outcome has virtually no impact on the South Korean F-X contest.

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

FEEDBACK

Aviation Week & Space Technology *welcomes the opinions of its readers on issues raised in the magazine. Address letters to the Managing Editor, Aviation Week & Space Technology, 1200 G St., Suite 922, Washington, D.C. 20005. Fax to (202) 383-2346 or send via e-mail to:* **awstletters@aviationweek.com**
Letters should be shorter than 200 words, and you must give a genuine identification, address and daytime telephone number. We will not print anonymous letters, but names will be withheld. We reserve the right to edit letters.

PREVAIL TO THE POCKETBOOK

William Garvey's "Problem Prop" (*AW&ST* Dec. 12, 2011, p. 14) talks about the Center for Environmental Health's (CEH) push to ban avgas. They have been lobbying for years to get this disparaging legislation passed.

Here is some more ammunition to fight CEH. As of 2006, Chevron's Riverside, Calif., refinery was producing large quantities of leaded motor fuel because the 1950s-vintage tractors in the state's agricultural belt need lead to protect their engines. The state gave the farmers approval to use leaded fuel and Chevron permission to refine it.

In that same vein, note that 90% of all agricultural spray aircraft run on low-lead avgas, and most are powered by radial engines, usually Pratt & Whitney R-1340 Wasps. There are more than 2,200 agricultural aircraft in the U.S. and another 1,200 de Havilland DHC-3 Otter and North American AT-6s.

Environmentalists should know that without aerial support, crops will be damaged and the cost of vegetables will soar if, thanks to CEH lobbying, farmers are required to buy new tractors.

William Coleman
LEES SUMMIT, MO.

T-38 ADVOCATES . . .

I agree with reader Todd Fredricks' comments about the T-38 (*AW&ST* Dec. 19/26, 2011, p. 8). A logical replacement for the trainer would be the supersonic F-5F, which is equipped with an internal M-39 20-mm cannon and two engines, and can expend a wide variety of air-to-air/air-to-ground ordnance. The F-5F also carries the AN/APQ-159 X-band air-to-air search, range and angle tracking radar with off boresight acquisition capability. Maintenance costs for the aircraft are similar. Years ago, Northrop prototyped composite components for the F-5—now mothballed. With a bit of effort, a glass cockpit could be incorporated into the aircraft and perhaps an active, electronically scanned array radar.

Significant numbers of F-5Fs are available via foreign governments that are considering replacing the type.

Anthony J. Tambini
SOUTH SAN FRANCISCO, CALIF.

. . . AND ISRAEL'S F-5 CONNECTION

Todd Fredricks' recent letter may cause some confusion. F-5s have never been part of the Israeli air force. The Israeli connection, however, is in the retrofit of updated electronics/avionics suites performed for a few foreign air forces by such top-notch Israeli companies as Elbit Systems and IAI.

Jacques Hammel
TIVON, ISRAEL

JEERS KEEP COMING

I have a jeer for your editorial "A&D in 2011: Cheers and Jeers" (*AW&ST* Dec. 19/26, 2011, p. 74). It is off-base regarding some of NASA's woes. Obama's administration should have been jeered for "hitting the restart button on human space exploration" through its predetermination of the findings of the contrived Review of Human Space Flight Plans Committee. Further jeers go to Congress for greeting the president's deconstruction of U.S. human spaceflight with nothing more than "sound and fury, signifying nothing."

George C. Mantis
HUNTSVILLE, ALA.

THE COMPOSITES COMPONENT

The viewpoint "What Next in Airline Safety?" (*AW&ST* Dec. 12, 2011, p. 50) failed to address some of the safety challenges that lie ahead.

We are entering the era of large composite airframes, which react to typical crash loads differently than ones made of metal.

Metal tends to absorb more energy in deformation, therefore composite airframes can be expected to transfer more energy into cabin fixtures such as seats (and their occupants), and probably in different ways. On the other hand, for a given impact the composite airframe should remain intact to a greater degree than a metal one, perhaps making a severe impact more survivable. The definition of a survivable accident for a composite airframe will be different than for a metal airframe.

To continue to make progress in airline safety, some fundamental research on crashworthiness characteristics of composite structure is needed now.

Fred Bearden
LAGUNA NIGUEL, CALIF.

WHO'S WHERE

Nick Whitney

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.*

Nick Whitney (see photo) has been appointed managing director of the Operational Support Services unit of *Marshall Aerospace*, Cambridge, England. He comes from AgustaWestland, where he handled all business with the U.K. Defense Ministry.

Steve Sear has been promoted to senior VP-global sales from VP at *Delta Air Lines*.

Bonnie S. Reitz has been named chairman of the *Airlines Reporting Corp.* board of directors, Arlington, Va. She succeeds **David Landuyt.**

Alan Hood (see photo) is the new managing director of Safran Group subsidiary *Aircelle Ltd.*, Burnley, England, succeeding **Andrew White.** Hood was finance director.

Tom Horton (see photo), American Airlines' chairman, president and CEO, also will be chairman of the New York-based *Oneworld* alliance, succeeding Gerard Arpey. Horton followed Arpey at the AMR helm in November.

E. Robert Lupone has been appointed executive VP, general counsel and secretary of Providence, R.I.-based *Textron*, succeeding **Terrence O'Donnell**, who is retiring. Lupone was senior VP and general counsel of Siemens Corp.

Kim Smith has been named VP-environment, health and safety for the Chicago-based *Boeing Co.* She succeeds **Mary Armstrong**, who will retire after 27 years with the company. Smith was Boeing Commercial Airplanes' director of supplier management at Spirit AeroSystems in Wichita.

Kent Renner (see photo) has been named senior VP-chief accounting officer of Buchanan, Mich.-based *XPO Logistics*. He was global controller with GE Energy Services.

Giorgio Vismara will join Zurich-based advanced composites manufacturer *Gurit* as general manager-marine, effective Jan. 17. He is general manager for Vismara Marine.

John Grunsfeld has been named associate administrator for *NASA*'s Science Mission Directorate in Washington, succeeding **Ed Weiler**, who retired in September. Grunsfeld, a physicist and former astronaut, was deputy director of the Space Telescope Science Institute in Baltimore.

David Smith has become senior manager of financial planning and analysis and **Richard Squire-Tibbs** controller at The McGraw-Hill Companies' *Aviation Week*. Smith was manager of accounts receivable and credit analysis in MGH's Financial Reporting department, and Squire-Tibbs was controller in the MGH Business Services Center. Both work in New York.

Stefan Gardefjord (see photo) will join the *Swedish Space Corp.* in Solna as CEO on May 1. He will succeed **Lars Persson**, who is moving on after five years in the role. Gardefjord is CEO of Logica Sweden.

Lance Bush has been named president and CEO and **Steven Kussmann** chief operating officer of the *Challenger Center for Space Science Education*, Alexandria, Va. Bush was chief strategic officer and head of the Washington office of Paragon Space Development Corp., and Kussmann was the Challenger Center's director of operations.

Hilliard C. Terry, 3rd, has joined Bermuda-based *Textainer Group Holdings* as executive VP and CFO, and **Daniel W. Cohen** is the new VP and general counsel. Terry was VP and treasurer at Agilent Technologies, and Cohen was corporate counsel at Sybase.

Wayne Pearce (see photo) has been appointed CEO of *Oman Air*. The Australian native was the head of strategy and planning at Etihad Airways. **Saleem Bin Amanullah Bin Abdul Hussain** has been appointed general manager-customer services. He was CEO-cargo for RAS-ENT in Toronto.

Danny Robayo has been promoted to assistant manager from director of training at *FlightSafety International*'s Teterboro, N.J., Learning Center.

Alan Hood

Tom Horton

Kent Renner

Stefan Gardefjord

Wayne Pearce

Pat Long

Andrew Gale has been named CEO and **Dennis Nolan** CFO at *Numet Machining Techniques*, Old Greenwich, Conn. Gale was CEO of Veridiam and Nolan was senior VP and general manager at Rockwood Services Corp.

USAF Brig. Gen. **Gary M. Batinich** has been nominated for promotion to major general and appointment as mobilization assistant to the commander of U.S. Air Forces Central Command, Southwest Asia. Brig. Gen. **Richard S. Haddad** has been nominated for promotion to major general and assignment as director of plans and programs of Air Force Reserve Command, Robins AFB, Ga. Col. **Richard M. Erikson** has been nominated for promotion to brigadier general and assignment as mobilization assistant to the USAF deputy chief of chaplains at the Pentagon.

HONORS AND ELECTIONS

Pat Long (see photo), vice chairman of Longistics, has been named a finalist for two *Stevie Awards for Women in Business*. Long's nominations are for Best Entrepreneur and Best Overall Company in the Service Business.

Alan M. Title, a physicist at the Lockheed Martin Space Systems Advanced Technology Center, Palo Alto, Calif., has received the 2011 John Adam Fleming Medal, given by the *American Geophysical Union*. The award honors an individual for "original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, space physics and related sciences."

BY JOSEPH C. ANSELMO

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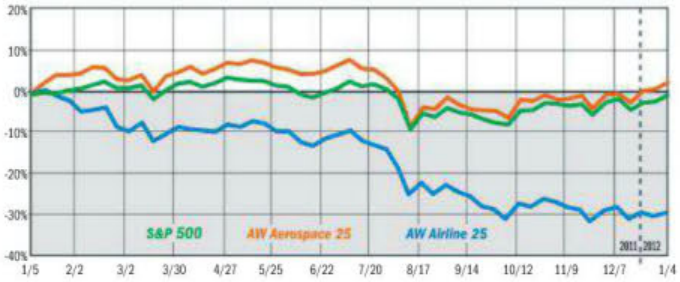
AW&ST/S&P Market Indices

(as of 1/4/2012) PERCENT CHANGE

MARKETS	INDEX VALUE	WEEK AGO	YEAR-TO-DATE	YEAR AGO
AW Aerospace 25	1378.4	2.2% ▲	1.1% ▲	1.6% ▲
AW Airline 25	778.0	1.9% ▲	1.3% ▲	-29.8% ▼
S&P 500	1277.3	2.2% ▲	1.6% ▲	-0.7% ▼



Weekly Market Performance

Closing Prices as of Jan. 4, 2012

Company Name	Current Week	Previous Week	Fwd. P/E	Tot. Ret. % 3 Yr.	Tot. Ret. % 1 Yr.	
AEROSPACE & DEFENSE						
AeroVironment Inc.	30.14	31.47	20.6	-23.5	2.4	▲
Allegheny Technologies Inc.	48.85	47.36	15.2	79.8	-12.3	▼
Alliant Techsystems Inc.	58.10	56.00	6.9	-32.0	-21.8	▼
BAE Systems plc	4.48	4.34	6.9	-15.3	-11.0	▼
Boeing Co.	74.33	73.26	16.1	75.6	12.8	▲
Bombardier Inc. 'B'	4.13	3.81	8.4	-6.8	-15.8	▼
Cobham plc	2.87	2.72	8.9	-3.9	-11.1	▼
Curtiss-Wright Corp.	36.05	35.10	12.7	5.8	8.1	▲
DigitalGlobe Inc.	15.83	16.38	25.0	....	-48.2	▼
EADS NV	31.76	30.55	17.2	87.7	34.9	▲
Eaton Corp.	45.48	43.30	10.4	93.0	-10.0	▼
Elbit Systems Ltd.	40.00	42.69	7.5	-5.7	-18.4	▼
Embraer-Empresa Brasil ADR	26.49	24.95	....	53.9	-7.5	▼
Esterline Technologies Corp.	57.71	54.00	10.8	47.6	-17.0	▼
Exelis, Inc	9.58	9.20	5.7	....	....	
Finmeccanica SpA.	3.77	3.59	-10.5	-70.7	-64.3	▼
FLIR Systems Inc.	25.47	25.25	15.4	-18.7	-12.7	▼
General Dynamics Corp.	68.12	65.95	9.1	23.4	-0.9	▼
General Electric Co.	18.56	17.83	12.7	24.8	3.0	▲
GKN plc	2.98	2.77	8.3	168.4	-10.3	▼
Harris Corp.	36.51	36.14	6.9	-1.8	-18.3	▼
Hexcel Corp.	24.53	24.61	18.4	219.8	33.6	▲
Honeywell International Inc.	55.53	53.98	13.0	76.1	4.8	▲
Kratos Defense	6.29	6.05	92.5	-50.1	-54.0	▼
L-3 Communications Hldgs. Inc.	67.46	66.70	7.9	-7.1	-4.8	▼
Lockheed Martin Corp.	80.91	80.94	10.7	7.6	17.3	▲
Moog 'A'	43.30	43.97	13.1	11.7	3.2	▲
Northrop Grumman Corp.	58.63	58.13	8.7	44.9	1.7	▲
Orbital Sciences Corp.	14.51	14.33	14.9	-23.8	-17.8	▼
Parker-Hannifin Corp.	78.50	76.03	10.5	82.9	-8.8	▼
Precision Castparts Corp.	168.94	163.56	17.9	158.2	18.9	▲
Raytheon Co.	48.59	48.63	9.5	1.7	5.6	▲
Rockwell Collins Inc.	56.45	54.84	12.6	45.3	-2.6	▼
Rolls-Royce Group plc	11.71	11.30	15.2	106.6	14.7	▲
Safran SA	29.65	29.05	11.7	131.3	-13.6	▼
SAIC Inc.	12.57	12.15	9.1	-36.8	-21.7	▼
SIFCO Industries Inc.	19.45	19.63	....	231.0	22.1	▲
Singapore Technologies Eng.	2.14	2.05	15.3	26.8	-14.5	▼
Spirit Aerosystems Holdings	21.21	20.55	9.8	87.5	2.4	▲
Textron Inc.	19.01	18.16	12.9	28.1	-21.4	▼
Thales	31.03	30.26	9.8	-17.8	-7.1	▼
TransDigm Group Inc.	93.13	95.34	16.6	214.5	23.1	▲
Triumph Group Inc.	59.27	58.94	12.1	197.0	26.5	▲
United Technologies Corp.	75.05	73.13	13.2	49.0	-3.1	▼

COMMENTARY

A Hit-Or-Miss Year For Aerospace Stocks

The past year has seen a lot of turbulence in the stock market, but there have been a few bright spots for investors in aerospace and defense companies. Shares in suppliers of aerospace components fared particularly well in 2011 as **Airbus** and **Boeing** ramped up output, and soaring order numbers added to the airframers' already bulging backlogs. Notable performers among suppliers include **Hexcel** (up 34%), **TransDigm Group** (33%), **Triumph Group** (31%), **Sifco Industries** (23%), **Rolls-Royce** (20%), **Precision Castparts** (18%), **Safran** (12%) and **Moog** (10%). Those yearly gains outpaced the Dow Jones Industrial Average, which was up 6%, and the S&P 500 index, which was essentially flat.

The picture was more mixed when it came to the aircraft builders that are buying those components. Airbus parent **EADS** had a standout year, with shares up 38% as the re-engined A320NEO became a runaway sales success and losses from the A380 jet and A400M military transport aircraft began to subside. Boeing's shares rose a more modest 12%, and the stocks of the No. 3 and No. 4 aircraft builders, **Embraer** and **Bombardier**, declined 14% and 19%, respectively.

Defense stocks also turned in a mixed performance, as investors tried to make sense of whether a dysfunctional U.S. Congress would really allow $1 trillion in automatic cuts over 10 years to begin to take effect in January 2013. **Lockheed Martin** led the pack with a 16% increase, and shares at **Raytheon** (up 4%) and **Qinetiq Group** (2%) saw gains. But most defense stocks ended the year in negative territory, including **Huntington Ingalls Industries** (down 17%), **BAE Systems** (14%), **General Dynamics** (6%), **L-3 Communications** (5%) and **Northrop Grumman** (1%). In the space sector, **Orbital Sciences** shares declined 15% and **DigitalGlobe** 46%.

Looking ahead, 2012 may well turn out to be a tale of two industries. Last year's surge in commercial aircraft orders signals that demand for components should continue to rise for several years. And it's not just narrowbodies: Bank of America Merrill Lynch analyst Ronald J. Epstein forecasts a 97% increase in deliveries of widebody jets through 2015, underpinned by a 40% hike in Boeing 777 production rates and the arrival of the new 787 and Airbus A350.

Meanwhile, defense stocks remain a wild card. A plan unveiled Jan. 5 by U.S. President Barack Obama to shift the Pentagon's global military focus from Europe and the Middle East to the Asia-Pacific region appears on its face to benefit the Air Force and Navy at the expense of the Army (see p. 21). But not everyone is convinced. Analyst Byron Callan of Capital Alpha Partners notes that the Middle East was mentioned several times during a Pentagon briefing to unveil the new plan and in accompanying documents. That reinforced his belief that investors shouldn't assume all air and naval programs will fare well and ground programs poorly. "There will be puts and takes," says Callan.

As for airline stocks, it was a brutal year. More on that in next week's Up Front column.

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.

DEFENSE

Typhoons Stalled

Discussions over price escalation clauses remain the main sticking point in talks between Saudi Arabia and BAE Systems for a follow-on purchase of Eurofighter Typhoon combat aircraft. The two sides have been in talks about changing the terms of an initial deal, under which the first 24 aircraft would be assembled in the U.K. and production would then shift to Saudi Arabia. The plan now is for all to be assembled in Europe. In a statement, BAE Systems notes that the delay has an earnings-per-share impact on 2011 financial results, although it adds the effect is somewhat offset by offshore patrol vessel contractual activities. The company insists that the discussions with Saudi Arabia are progressing well and that the Saudi government has budgeted for the purchase of 48 more Typhoons, as well as upgrades to training systems.

JSF Commitment

The Turkish government has approved the acquisition of the country's first two F-35As as part of a series of modernization decisions. Turkey has long been an F-35 program partner, with plans to buy more than 100 of the stealth aircraft. The government also has approved the acquisition of ten Anka medium-altitude unmanned aircraft, effectively launching series production of the Turkish Aerospace Industries program.

Turkish Police Opt for Bell

Bell Helicopter has entered final negotiations for the sale of 15 429s to the Turkish National Police, the company reports. The 429 is a new entrant in the light twin-engine helicopter market and the company sees Turkey's selection "as a significant win in the European market."

Further Foxhounds

The Russian government plans to upgrade at least 60 more MiG-31s through 2020 to enhance their ability to intercept aircraft and cruise missiles. The so-called MiG-31BM program will allow pilots to detect targets at a range of 320 km (200 mi.) and engage them at a range of 280 km, the defense ministry says in announcing the modernization plan. Each fighter can track 10 targets and engage six at the same time. The ministry also has announced plans to bolster its air force flight-training capabilities, with 20 new flight simulators to be fielded, including those for Su-34 strike aircraft, Yak-130 trainers, and Ka-52 and Mi-28N helicopters. The effort follows a 20% year-on-year increase in flight hours for pilots and a 10% increase in exercises seen in 2011. The ministry also notes that last year it fielded six Su-34s, eight Su-2SMs and more than 20 attack helicopters.

Carrier Cooperation

The U.K. and U.S. defense secretaries have signed a deal to work together more closely on the development and operation of aircraft carriers. The Statement of Intent on Carrier Cooperation and Maritime Power Projection "will serve as the framework for increased cooperation and interoperability on the use of aircraft carriers, as well as provide the basis for the U.S. to assist the U.K. Royal Navy in developing its next generation of aircraft carriers," according to the Pentagon's press secretary, George Little. U.K. Defense Minister Phillip Hammond met with his U.S. counterpart Leon Panetta at the Pentagon on Jan. 5 during Hammond's first official visit to Washington. The two allies signed a defense trade treaty in 2007 that allows pre-certified defense acquisition communities to cooperate without most export licensing controls.

Protecting Poland

The Polish government is expanding its purchase of Kongsberg Naval Strike Missiles (NSM) used for coastal protection. The 400 million zloty ($116 million) deal will buy 38 of the stealthy anti-ship missiles, including two equipped

ORBITAL SCIENCES CORP.

Commercial Cargo Hardware Headed to the Space Station

The initial two service modules for the Orbital Sciences Corp. Cygnus commercial cargo carrier, which is scheduled to fly to the International Space Station this year, are nearing completion at the company's factory in Dulles, Va.

The module on the left is set to go first, in a demonstration flight to complete milestones under NASA's Commercial Orbital Transportation Services seed-money program. The one on the right is assigned to the first commercial cargo delivery in Orbital Sciences' eight-flight, $1.9 billion Commercial Resupply Services contract with the U.S. space agency.

Thales Alenia Space has delivered the first pressurized cargo module for Cygnus to the launch site at Wallops Island, Va., and has two more awaiting shipment in Turin, Italy. Orbital is integrating a third service module in a separate clean room.

Although the company intends to fly two missions to the station this year, ongoing inspection and certification issues with the new pad for its Antares (formerly Taurus II) launch vehicle remain the controlling factors in setting launch dates (*AW&ST* Aug. 15, 2011, p. 34). Aerojet has overcome a test-stand fire last year to deliver enough AJ26 rocket engines for the first two Antares flights, according to Orbital. The demonstration-mission service module is scheduled to enter thermal vacuum testing at Dulles next month, with mechanical environmental tests to follow a month later. Built in Orbital's satellite production facility, the service modules will provide power, propulsion and other utilities for the Cygnus.

with telemetry equipment. The first 14 missiles being acquired under the new contract are due for delivery next year, followed by a dozen missiles in each subsequent year. The defense ministry notes that in addition to its anti-ship capabilities, the weapon also provides a land-attack functionality. Improving its air defenses is one of the modernization priorities the ministry has set for 2012.

Third Operators

Elbit Systems has added its second export customer for the Hermes 900 unmanned aircraft. The company did not disclose which government is buying the system, only saying it is in the Americas. It is the second export deal for the unmanned aircraft. The new contract is valued at around $50 million, including the use of satellite communications, the Israeli defense company says.

AIR TRANSPORT

Chinese Nix Carbon Fees

Chinese airlines are refusing to pay EU charges on carbon dioxide emissions and say Beijing is planning unspecified countermeasures against the policy. The carriers are also considering legal action against the EU, says Chai Haibo, deputy secretary-general of the China Air Transport Association. Although dressed up as a move by commercial airlines acting through their association, their rejection of the EU policy and disclosure of possible retaliation has surely been determined and coordinated by the Chinese government, which has controlling shares in most of the carriers and closely manages the industry. Chinese state media has also hurled protests at EU's law, under which all airlines must buy carbon-emission permits for flights to or from the EU.

Wounded A380 Returning

The Qantas Airbus A380 that was badly damaged after an engine failure near Singapore in November 2010, VH-OQA, is due to return to service in March. Repairs began in May 2011, and are expected to cost AU$135 million ($139.75 million), Qantas says. The costs are covered by insurance. VH-OQA was forced to make an emergency landing in Singapore due to an uncontained failure in one of its Rolls-Royce Trent 900 engines, with flying debris causing significant structural damage. The engine failure was eventually traced to a Rolls-Royce manufacturing fault. The repairs are being carried out at a Singapore International Airlines Engineering Co. facility in Singapore. The aircraft required structural wing repairs and the full replacement of the other systems affected, including pneumatic, electrical and hydraulic systems. All of the original engines on VH-OQA have been replaced by Rolls-Royce.

Wing Cracks

Airbus says it has already developed a fix to wing cracking found on some A380s. The cracks, first reported by the *Sydney Morning Herald,* have been seen by at least Qantas and Singapore Airlines. Airbus confirms the cracking on "on some non-critical wing rib-skin attachments on a limited number of A380 aircraft." The aircraft maker adds that safe operation of the fleet is not affected, and no flight limitations are being put on the A380. Airbus says an inspection and repair process has been identified. The repair is being performed as part of four-year maintenance checks, it adds.

SPACE

Moon Rocket Research

The Chinese space community is building momentum for its objective of a manned lunar landing, with the central government approving research on a launcher rocket. Approval for work on the launcher in the 2011 China Space Activities white paper, presumably covering the five-year plan period to 2016, does not mean that the government has approved a mission to land astronauts on the Moon. But it does mean preliminary studies already conducted will now move on to more detailed investigations. The clearest indication that the Chinese space industry has long hoped for a lunar mission is the provision for 10-meter (32.8 ft.) rocket diameters, comparable with those of NASA's Saturn V, in the infrastructure at the Tianjin manufacturing base. Those plans were mentioned in 2007, even though the base's main task was building 5-meter-dia. Long March 5 rockets. More recently the industry has revealed that it is studying engines of 300 to 500 metric tons thrust (660,000-1.1 million lb.) and rockets with combined thrust at liftoff of 3,000 metric tons, close to that of the Saturn V.

Mission Reentering Soon

Satellite trackers predict Russia's Phobos-Grunt Mars mission will reenter the Earth's atmosphere on or about Jan. 15, with a more precise forecast possible as it winds down toward the atmosphere. Carrying a Chinese probe piggyback, the 13,200-kg (29,101-lb.) spacecraft was left stranded in low Earth orbit after its Nov. 8, 2011, launch on a Zenit 2-SB rocket. Most of the probe's liftoff mass was hypergolic fuel that may be frozen, and it carried a sample-return capsule that may survive reentry and reach Earth's surface.

Space Apps

The British government plans to set up a technology center to foster work on satellite applications. In a wide-ranging speech aimed at laying out the government's plans to improve science and technology, Science Minister David Willetts tells the Policy Exchange that the satellite effort "will provide business with access to in-orbit test facilities to develop and demonstrate new satellite technologies. It will also provide access to advanced systems for data capture and analysis, supporting the development of new services delivered by satellites. These could be in a wide range of areas such as distance learning and telemedicine, urban planning, precision agriculture, traffic management and meteorology."

MAINTENANCE

Shaking Up Shanghai

To strengthen its line maintenance services in China, Hong Kong Aircraft Engineering Co. (Haeco) and its subsidiary Taikoo (Xiamen) Aircraft Engineering Co. (Taeco), acquired a 49% stake in Shanghai SR Aircraft Technics. Haeco has renamed the company Shanghai Taikoo Aircraft Engineering Services Co. (STA). Together Taeco and STA serve 39 airlines at Shanghai Pudong International Airport.

Corrections: *An item in the Who's Where column last week (p. 12) incorrectly stated Tom Horton's job status. He remains chairman, president and CEO of the AMR Corp.*

The title of U.S. Senate Minority Leader Mitch McConnell (R-Ky.) was listed incorrectly in the Jan. 2 Up Front column (p. 14).

BY MARK CARREAU

Houston-based Correspondent Mark Carreau can be reached at:
mark.carreau@gmail.com

COMMENTARY

Life Quest

NASA space centers' health-maintenance technologies find applications on Earth

New approaches to life-support technologies, as much as powerful rockets and optimally configured spacecraft, promise to pace NASA's push into deep space with humans.

Frequently, advances in the space life-support realm—where the emphasis is on compact, reliable low-energy systems—can lead to improvements at a faster clip in more down-to-earth arenas, including public and personal health, and even environmental protection. Activities at NASA's Kennedy and Johnson space centers, as well as on the International Space Station, are bearing this out.

At Kennedy's Space Life Sciences Laboratory, new engineering services contractor Qinetiq North America is pursuing biological and traditional physical/chemical strategies for advanced space life support. Some of the efforts are paying small dividends by improving plant growth efficiencies and wastewater treatment systems on Earth.

At Johnson, engineers recently signed a licensing agreement with Meridian Health Systems of California for use of NASA-developed technologies in U.S. Food and Drug Administration (FDA) trials that could lead to new treatments for atherosclerosis, a form of cardiovascular disease, which has been the leading cause of death in the U.S. for decades.

Some of Qinetiq's most forward-leaning work is focused on the recycling of water. "Water is a very valuable commodity for human exploration, obviously, and it's something we have not done a very good job—up to now—of enabling recovery systems for," says Michael Roberts, Qinetiq's program scientist.

Necessary for sustaining life, water in quantity comes with a high mass and launch costs if it must be stowed on a spacecraft for a long mission far from Earth or regularly launched as a resupply item to a planetary outpost.

NASA

NASA astronaut Clay Anderson examines a small plant growth chamber on the International Space Station during a 2007 mission.

Aboard the International Space Station, astronauts already recycle their air and reclaim potable water from urine and condensate using physical/chemical approaches. The technologies are finding applications in water purification on remote areas of Earth, though the processing in weightlessness has not been as straightforward as hoped.

The calcium that leaches from the skeletal systems of astronauts during prolonged weightlessness fouled the distillation and filtration process. Hardy plant crops may offer an attractive alternative on long missions or as part of a base on the Moon or Mars by offering a source of fresh nutrients for astronauts, as well as a natural medium for recycling air and water.

One focus of Qinetiq's work in the Life Sciences Lab at Kennedy is the use of light-emitting diodes to foster more efficient plant growth to perform those functions on space missions.

On the physical/chemical front, Qinetiq scientists and engineers report progress with the use of hollow fiber membrane bioreactors in separating gas bubbles from fluids in compact prototype wastewater treatment systems for piloted missions. The gas separation issue is another challenge for processing fluids in conditions where there is no buoyancy. The same approach is finding utility in small-scale treatment systems in coastal areas and even with high water tables.

During the 1990s, engineers, scientists and medical researchers at Johnson teamed to develop an imaging device using millimeter-wave electromagnetic energy for astronauts who became ill or injured far from Earth. They were largely unsuccessful, and follow-on research found the use of portable ultrasound devices to be more promising diagnostic tools.

However, the Johnson team grew convinced that the use of microwave energy coupled with a directional antenna small enough to be inserted into the human body with a catheter could be used to remove plaque deposits on arteries. The transmissions appear to provide just enough thermal energy to remove the damage and restore elasticity to the vessels without inflicting damage. Meridian plans FDA trials to determine the prospects.

Meanwhile, researchers at Johnson are looking at other health-related applications for the microwave technology applications they patented in 2000-02—uses in both traditional health care settings and on distant spacecraft or planetary outposts, where astronauts would be months or years away from hands-on medical experts.

Those include use of microwave transmissions to destroy cancer cells prior to the surgical removal of tumors, reducing the chance of leaving diseased cells behind to regenerate. Others would destroy the bacteria responsible for dental caries, or cavities, and help in the curing process of composite fillings and implants. Another would treat persistent bacterial infections associated with some artificial bone joint transplants.

BY PIERRE SPARACO

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

COMMENTARY

Missed Opportunities

French air transport labor actions point to poor industry supervision by politicians

SNPL France ALPA, France's leading airline pilot union, says its members will not report to work Feb. 6-9 as part of a retaliatory initiative against a proposal to revise rules governing walkouts in the airline industry. Eric Diard, a right-wing member of parliament, is proposing that unions be required to give carriers notice 48 hr. before a walkout to make it easier for airlines to plan contingency flight schedules. The proposal also calls for alerting air passengers about cancellations no later than 24 hr. before departure dates. In addition, Diard says a "social alarm" system would be put in place to encourage and facilitate negotiations set to avoid strikes and establish a more peaceful context.

Diard's plan is tentatively scheduled to be discussed in parliament on Jan. 24. He acknowledges that rules governing surface transportation, such as the Paris transit authority, could not be applied to flight crews and aviation ground personnel because airline operations are not so-called "public service missions" requiring special rules to preserve minimum services. But Transport Minister Thierry Mariani says passengers should not be held hostage by labor conflicts and should retain the right to freely come and go.

The issue is serious. The pilots' initiative is perceived very negatively, considered by many to be an overreaction. This is hardly the first time France's highly unionized cockpit crews have taken advantage of their key role to express views on management. The planned walkout doesn't result from failed negotiations; it is just a disagreement in principle. Air France's top management and flight crew unions usually don't speak the same language, and their disputes can be rude. This time, however, pilots are taking issue with a political initiative linked to French travelers' irritation.

REUTERS/LANDOV

SNPL leaders assert that Diard's proposed rules would restrict striking "rights" in the French airline industry, indicating that the government of Prime Minister Francois Fillon disregards the need for consultation and social dialog. In its latest statement, the SNPL has adopted a threatening tone. It is hard to see how anything positive will develop from the growing difficulties. And the worst is yet to come, with Air France unable to restore profitability and working on a new cost-cutting plan that could prove unpopular.

Consumer groups and travelers anxiously monitoring the situation are increasingly disappointed by the government's inability to create a more productive atmosphere. The ongoing problems took shape in the aftermath of a 10-day walkout by security personnel at major airports last month. Operations were seriously disrupted and flight punctuality went from bad to worse, mainly at Paris Charles de Gaulle Airport, infuriating passengers just before the Christmas traffic peak. Police briefly replaced striking workers (see photo) and the walkout ended without a tenable solution.

The security personnel's action confirms the urgent need to update key rules governing the French airline industry. In the past several weeks, Mariani has looked detached, keeping a low profile and carefully avoiding crucial questions.

In sharp contrast with the U.S. Transportation Security Administration, France has privatized airport security. Contracts in this competitive environment are of course granted to the most economically attractive bidders, which have no other choice than to rely on low pay scales to acquire and retain market share. In such a context, worker complaints about compensation are to be expected.

The recent action by security workers provided a unique opportunity to re-evaluate the privatization of security, a decision that was taken hastily despite the diverse terrorist threats surrounding France. But the opportunity was missed, underscoring that French politicians are not good at supervising air transport and, moreover, seem oblivious to air passengers' growing annoyance and disappointment.

BOEING CONCEPT

BY LEE ANN TEGTMEIER
Managing Editor for Civil Aviation/MRO
Lee Ann Tegtmeier blogs at:
AviationWeek.com/mroblog
leeann_tegtmeier@aviationweek.com

COMMENTARY

Harmonizing Lease Transfers

Work is under way to decrease costs and ease transferring leased aircraft across borders

Eliminating duplicated maintenance required by different regulatory agencies could take billions of dollars out of maintenance and engineering work for leased aircraft when they transfer across borders. That's not a typo—it's billions.

Given that leased aircraft comprise about 40% of the world's total commercial fleet, and that figure continues to climb, these costs if not corrected will grow with the leased fleet.

Costs Due To Different Technical Regulatory Requirements*

	Per Transfer	Annual	20 Years
Direct Costs	$263,000	$251 million	$5.002 billion
Downtime Costs	123,000	118 million	2.284 billion
TOTAL	**386,000**	**369 million**	**7.286 billion**

*When aircraft transfer across borders

Source: Aviation Working Group

The industry spends $369 million per year on aircraft maintenance and modifications to satisfy the various aviation authority transfer requirements, according to a survey completed by SGI Aviation for the Aviation Working Group (AWG). That adds up to $7 billion over 20 years.

"That's a cost we believe neither the lessors nor the airlines should have to incur just from transferring an aircraft from one state to another," says Rich Poutier, International Lease Finance Corp.'s (ILFC) senior vice president of technical services. Poutier is a member of the AWG's technical subgroup.

The Aviation Working Group, which comprises lessors, financial institutions and manufacturers, uncovered that the majority (58%) of the $7 billion is spent meeting similar safety objectives and 20% involves maintenance duplication (for example recertifying off-wing engines and revalidating modifications due to the national systems' requirements that are not harmonized). Only 15% of the costs stem from non-safety differences, such as airspace requirements; 7% are associated with different safety objectives.

Besides the $5 billion in redundant maintenance costs, the work takes 11.47 more days of aircraft downtime, which adds $2.284 billion over 20 years. Given the increased aircraft utilization and efficiencies airlines seek, can anybody afford this extra time and money?

The Aviation Working Group's longer-term mission is to promote regulatory cooperation to eliminate the majority of extra maintenance costs associated with transferring leased aircraft across borders. It is working with entities including the International Civil Aviation Organization, International Air Transport Association, European Aviation Safety Agency, FAA and member states to reduce duplications. Achieving regulatory harmonization will take time.

However, a short-term task could be fairly easy: encourage airlines to use more digital recordkeeping and eliminate reams and reams of paperwork. "Many lessors already are talking about how to do that," and one of the lowest hanging fruits is scanning historical maintenance records, says Poutier.

Southwest Airlines has been following that path since 1999. During audits or before a lease return, the airline scans an aircraft's maintenance records, secures the records storage and makes it accessible online. At the point of lease return, Southwest turns over three DVDs containing the records.

"In the past, when we acquired an aircraft from another operator, the records were delivered on paper and were usually stored in 20 boxes or more," says a Southwest executive. The airline had to store those boxes offsite—a far more costly and inefficient method than electronic document retention.

"The effort to go digital—it's time for the industry to get with it!" says Poutier.

It's hard to disagree.

BY FRANK MORRING, JR.

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

COMMENTARY

Lunar New Year

Strong educational element is a key part of Moon-orbiting spacecraft

NASA's twin Gravity Recovery And Interior Laboratory (Grail) spacecraft straddled the New Year as they eased into orbit around the Moon, where they will provide the most detailed gravity maps available and important clues to the origins of Earth's big satellite. Before the mission is over, the two spacecraft will also give thousands of middle-school students some hands-on experience in space research. After spending 3.5 months on a low-energy trajectory that started with a tandem launch Sept. 10, 2011, the first of the Grail orbiters braked into lunar orbit at 5 p.m. EST Dec. 31. The second followed 25 hr. later, trailing its twin almost directly over the Moon's South Pole before entering an 11.5-hr. elliptical orbit. The orbital periods of both spacecraft will be trimmed to a little less than 2 hr. over the next month as they reach near-polar, near-circular orbits independently. After that, their control at the Jet Propulsion Laboratory will be linked, with the second spacecraft to arrive—Grail B—orbiting ahead of Grail A, and they will begin making extremely precise measurements of the distances between themselves.

Those distances, reflecting the effects of the gravity field below the spacecraft, will range from 175-225 km (109-140 mi.), and Grail's measurements will be accurate to less than the diameter of a red blood cell. To achieve that accuracy and stay within the mission's $425 million cost cap, the program is using the same type of K_a-band ranging system that is orbiting Earth on the two Gravity Recovery and Climate Experiment (Grace) spacecraft. With the data generated during the 82-day basic science mission, which will see the Moon rotate three times under the Grail orbit, scientists expect to be able to resolve gravity shifts down to the level of crater rims, and to deduce the Moon's interior structure from the way the gravity changes (*AW&ST* Aug. 29, 2011, p. 78).

In addition to the extremely precise gravity-measuring instruments, both spacecraft also are carrying "cheapo cameras from the standpoint of state-of-the-art planetary imagers"—in the words of Principal Investigator Maria Zuber of the Massachusetts Institute of Technology. The cameras will allow middle-school students to order up photos of specific stretches of lunar terrain with their classroom computers. Zuber was able to add the mission's education-outreach component with the help of astronaut Sally Ride, who is heading the Grail MoonKam program.

The two Ecliptic Enterprises "rocket-cams," typically used to provide the dramatic video of stage and spacecraft separations during launches, have four heads each that are pointed forward, aft and directly below the orbiters. They can deliver 30 frames a second, and will be activated on a non-time-critical basis during the science mission.

"Engaging in real-world science is going to help, not just to help us develop scientifically literate citizens, but hopefully to encourage students to enter careers that have to do with science, technology, engineering and mathematics," says Leesa Hubbard, teacher in residence at Ride's organization.

Middle-school teachers can sign up to participate at https://moonkam.ucsd.edu/home

SECOND SOYUZ

Launch of France's first Pleiades Earth-imaging satellite plus a quartet of French military radar-mapping microsatellites atop the second Russian Soyuz flying from the European spaceport near Kourou, French Guiana, suggests that some cross-fertilization may be in order for the troubled Russian space program. The Dec. 16 mission marked the second flight of the Europeanized rocket from the new Soyuz pad at Sinnamary (see photo). The four-stage Russian rocket—which is optimized for the equatorial launch site with four first-stage boosters, a central core, a third stage and a restartable Fregat upper stage—placed a total payload of 2,191 kg (4,820 lb.) into 700-km orbits. Built by EADS Astrium and Thales Alenia Space, Pleiades 1A is the first of two new French Earth-imaging satellites; the second will be launched in the spring of 2013. The Soyuz also carried four Elisa microsatellites developed by the French military procurement agency (DGA) to demonstrate space-based mapping of radar transmitters. Also on board was SSOT, Chile's first operational Earth-observation bird. The launch came as top Russian officials rebuked Russian space agency Roscosmos following a string of failures, including loss of the delayed Phobos-Grunt Mars probe with a piggyback Chinese spacecraft. After a public tongue-lashing from President Dmitry Medvedev, Roscosmos chief Vladimir Popovkin banned overseas travel by space officials and workers with knowledge of Russian space secrets, according to *Izvestia*. Citing an internal Roscosmos directive, the Russian newspaper reported the ban extends to personnel of companies performing "sensitive" work under contract to the agency. It was not clear from the *Izvestia* report if the travel ban also extends to Russian personnel at the Sinnamary site, who appear to be doing something right.

ARIANESPACE

BY JAMES R. ASKER

Executive Editor
James R. Asker blogs at:
AviationWeek.com
jim_asker@aviationweek.com

COMMENTARY

Join the Club

Joint Chiefs welcome National Guard, sort of

Just in time to help carry out new defense priorities and changes that the White House and Pentagon announced last week, the four-star chief of the National Guard has taken his seat on the Joint Chiefs of Staff. The move marks the first significant change to the Joint Chiefs since the Goldwater-Nichols Act of 1986, and brings full and equal Joint Chiefs representation to a part-time element of the military that not only is not a free-standing armed service, but is also shared with state governors. The move caps a decade-long effort. After the Guard mobilized to fight terrorists and insurgents around the world, proponents sought to permanently address its hand-me-down equipment, short staffing and insufficient training by the institutional armed services. Opponents of the change, including current and former Joint Chiefs members, fear that it further muddies military authority, a cardinal sin to those in uniform. Meanwhile, the fifth armed service, the Coast Guard, remains both outside the Joint Chiefs and the Defense Department altogether, as it resides in the Department of Homeland Security.

AP/WIDE WORLD

'It's really a caricaturist's dream, isn't it?'

PHILIP HAMMOND

WHO NEEDS AIRPLANES?

Flanked by the newly enlarged Joint Chiefs, President Barack Obama made a rare appearance at the Pentagon to announce changes that, in part, will rely even more on the Guard and reserve troops to maintain strategic capabilities (see p. 21). Among programmatic ramifications of the new Pentagon road map is likely a reduction in the numbers of Joint Strike Fighter F-35s the U.S. will buy. That worries the U.K.'s new defense secretary, Philip Hammond. "We are concerned that any slippage in the program and any reduction in U.S. numbers could have an impact on availability and unit cost," Hammond told an Atlantic Council meeting here. "We're already under some pressure from public opinion in the U.K. over the fact that we are going to have built and launched carriers some years before we have aircraft to fly off them. It's really a caricaturist's dream, isn't it?"

REST STOP

The FAA's long-awaited crew-rest requirement immediately prompts cheers from many airline pilots. But the rule, published Dec. 21, has also prompted a legal filing from UPS flight crews, represented by the Independent Pilots Association, which blasts the FAA for exempting cargo pilots. The association has until Jan. 23 to file preliminary documents to the U.S. Court of Appeals for the D.C. Circuit outlining its challenge. "Factors that lead to fatigue are universal," the union maintains, and if anything, the nighttime operations crossing multiple time zones which characterize many cargo flights warrant more stringent standards than those for passenger carriers. The FAA included cargo carriers in its proposed rule in September 2010 but dropped them from the final version because "covering cargo carriers under the new rule would be too costly compared to the benefits generated in this portion of the industry." Meanwhile, UPS itself tells us: "Our current fatigue practices for pilots, such as flying many fewer hours per month and building special rest facilities, meet a much higher standard and far exceed the current U.S. rest regulations." But UPS also says it is "open to working with the FAA and other stakeholders on best practices."

LABOR PAINS

The president's appointment of three new members of the National Labor Relations Board (NLRB) could disrupt a delicate agreement on the FAA reauthorization bill. The current bill extending the agency's operating authority expires Jan. 31, and Congress has a limited number of days in session to pass an agreement this month. Congressional leaders have been negotiating a final deal that would allow the first full-fledged FAA bill since 2007 to finally pass, but labor issues have been key sticking points. Last week, Obama appointed Sharon Block, Terence Flynn and Richard Griffin to the NLRB. The appointments were made during what the White House argues is a de facto congressional recess, thus allowing them to serve temporarily without first obtaining Senate approval.

ENVELOPE EXPANSION

When Obama signed into law the defense authorization act, he also took a baby step toward expanding the use of UAVs inside the U.S. civil airspace. As part of the New Year's law, Congress directed the Pentagon, with help from the FAA and other agencies, to assess how fast the integration is taking place and look at the potential for creating test ranges to speed up the process.

Hunkering Down

Defense shrinkage likely to prompt others to follow Boeing's Wichita example

MICHAEL MECHAM/SAN FRANCISCO

Boeing's decision to lower costs and increase efficiency in its defense operations by shifting work at its huge Wichita facility to elsewhere in its network may well be the first of many plant closures this year as U.S. military spending dries up.

Boeing says it lacks sufficient work to justify retaining nearly 2 million sq. ft. of floor space and 97 buildings that comprise its Defense, Space & Security (BDS) facility in Wichita, so it will close all of them by the end of 2013. What viable work remains there will be shifted to company facilities in San Antonio, Oklahoma City and Seattle's Puget Sound region, says Vice President Mark Bass. How many of the factory's 2,160 jobs may be preserved by shifts to those locations is unclear.

"Despite our best efforts, ongoing cost reductions are simply not yielding enough savings to make our Wichita facility work competitive," says Bass, general manager of Boeing's maintenance, modifications and upgrades division in Wichita.

The closure underscores a distinction in the health of the industry between its commercial aviation and defense sectors; it is a case of the haves and the have-nots for job opportunities.

Boeing Commercial Airplanes' factories in Puget Sound have been so busy that the International Association of Machinists and Aerospace Workers (IAM) Local District 751 there has agreed since November 2009 to the temporary transfer of IAM-represented workers from Boeing Wichita to help keep commercial jets flowing off the Everett, Wash., 747 and 767 assembly lines. As of last week, 199 of IAM's Wichita machinists were on temporary assignment in the Seattle area, even as their colleagues in Kansas were hearing that their jobs will disappear over the next 24 months. The IAM represents 450 machinists in Wichita.

Simply put, says Deloitte LLP's aerospace and defense analyst Tom Captain, "The industry is facing an overcapacity of facilities." One out of every four defense workers is likely to feel the impact of ongoing defense cuts, starting with the $23.5 billion taken from the Obama administration's original fiscal 2012 budget request to the $50 billion likely to come from what the Pentagon will receive for fiscal 2013. Given that squeeze, "we expect to see a consolidation of the footprint of the industry," Captain says.

The consolidation will come not just in factories but in employment. It is "a sign of the times," says Bank of America analyst Ronald J. Epstein. "We expect today's news will be the first of many similar stories as defense contractors respond to a shrinking budget."

Those watching Wichita are likely to point to Boeing's decision in 2005 to sell its commercial operations there to Canada's Onex Corp. as the beginning of the end. Onex created Spirit AeroSystems,

BOEING

which has transformed itself into the industry's biggest independent airframe manufacturer by expanding its commercial customer base beyond Boeing. Although the latter still accounts for 85% of Spirit's contracts, its customers now include Airbus, Gulfstream and Sikorsky. While Spirit has grown in Wichita, Boeing has merely hung on.

And Wichita's political establishment was watching. Even within the last year, critics say the company's senior executives were promising better times as they sought support from the politicians to win the U.S. Air Force's $35 billion KC-46A tanker contract against the EADS/Airbus proposal to put a plant in Alabama. Boeing won, based on its stated intent to use 767-200LR airframes made in Everett and flown to Wichita to be outfitted with military systems. That they now will not has left the Kansas state congressional delegation bitter and disappointed.

"Boeing's chairman [James McNerney] sat in my office 22 months ago during that [tanker] battle and promised me, then-Sen. [Sam] Brownback and [Rep. Todd] Tiahrt that if we won the fight to get the tanker contract . . . Boeing would stay in Wichita," says Sen. Pat Roberts. "The chairman again promised the entire delegation [all Republicans] that the work would remain in Wichita just last February, when the tanker contract was settled in Boeing's favor."

Wichita's congressional representative, Mike Pompeo, vowed to "hold the company responsible" for those pledges.

TRAVIS HEYING/MCT/LANDOV

"Boeing, like every company, has the right to change its business plans and operate in the best interests of its stakeholders," he says. "What neither Boeing nor any other company has the right to do is make false statements, violate long-held commitments to communities or to receive federal contracts based on representations it knows are not accurate."

Asked how to explain the switch in the company's position, Bass answers, "Over the past 18 months, the military market has changed dramatically. We looked at the best use of our facilities for efficiency. Wichita is not competitive." He cites labor costs and the fact that more modern facilities exist elsewhere that are smaller and less costly to run as reasons why the city lost its edge.

In October, Boeing Wichita delivered the 12th C-40A troop and cargo transport to the U.S. Navy. Wichita's work will now be split between Oklahoma City and San Antonio.

The review of Wichita's cost base began last summer. On Dec. 30, Boeing concluded that it was time to shut the site down, Bass says.

Wichita's maintenance and modification work will be assigned to an underutilized defense factory in San Antonio that the company already has tapped to help it catch up on post-production modifications to its 787s. San Antonio will see 300-400 new jobs related to the move, Bass says.

Oklahoma City will benefit the most, taking over Wichita's engineering work for an additional 800 jobs. Like San Antonio, Oklahoma City is a non-union facility; Wichita's machinists and engineers are unionized.

The Wichita facility's tanker installation work will bring 200 jobs or so to Boeing's factories in Puget Sound.

It is unclear how many of the jobs created outside Kansas will be reserved for workers from Wichita. Bass says there will be "some relocations, some transfers and some [hiring] from local markets."

Boeing Wichita workers learned last week that their factory will close. How many of them will find work at the three plants to benefit from the closure is unclear.

With 93,925 employees, Washington is the second-largest employer of aerospace and defense workers in the country; California is the leader. Kansas ranks 10th with 36,860 workers, but is first in the nation in terms of its dependency on the A&D sector, according to Deloitte.

The loss to Wichita's economy is estimated at $1.5 billion over 10 years, says Jeremy Hill, director of Wichita State University's Center for Economic Development and Business Research. He bases this on both the loss of jobs and the impact the closing will have on the local supply chain. About half of Boeing Wichita's jobs are held by union members—585 in the Society of Professional Engineering Employees in Aerospace (Speea) and 450 in IAM.

The demographics of that workforce are difficult to pin down, but a consensus by those familiar with it is that most are older, experienced workers rather than new hires. Speea's records offers some insights; the average age of its engineering and technical worker membership in Wichita is just under 50, and they have held their jobs for nearly 21 years. The average salary of $100,015 shows why

their jobs are so valued. U.S. Census data pegs the average Wichita household income at $46,559.

The job losses are another blow to Wichita's aviation industry, which Captain characterizes as the capital of U.S. general aviation, just as Puget Sound wears that crown for commercial jets and Oklahoma City is increasingly recognized as tops for military transport maintenance and modifications.

The latter's rise was helped by Boeing two years ago when it shifted its C-130 Avionics Modernization Program and B-1 bomber modernization efforts to its Oklahoma City facility from Long Beach, Calif. That move leaves the C-17 as the last big fixed-wing aircraft manufactured in California. Its days may be numbered because USAF purchases are winding down, leaving Boeing dependent on foreign military sales.

BOEING

Systems integration on KC-767 tankers, such as this one for Italy, is among the work done at Boeing's Wichita Modification Center. This activity now shifts to Puget Sound.

Wichita, a city of 365,000, accounts for 21% of all manufacturing in Kansas. That role is dominated by aviation, not just at Boeing and Spirit but also at Cessna, Hawker Beechcraft and Bombardier's Learjet. Besides Boeing's own workers, Hill's research shows that the company's work is essential for 8,000 jobs among suppliers in the region.

Bass says Boeing spent more than $3.2 billion with some 475 Kansas suppliers in 2011 for defense and commercial accounts, including 24 on the tanker program. He says those 24 will remain on after work shifts to Puget Sound.

Still, Wichita's metropolitan area, with its 280,000 workers, has seen its aviation employees endure the industry's ups and downs, succumbing to the forces of factory modernization and globalization. A few decades ago, the region had 50,000 aviation workers, Hill notes.

In September 2008, on the cusp of the near-global financial crisis, the city's aircraft employers listed 9,000 openings for machinists, aircraft-certified welders, avionics electricians and aircraft sheet metal workers, an Aviation Week analysis revealed. But the drastic drop in demand for business jets hit Wichita hard. Within a year there were 11,000 layoffs, led by Cessna and Hawker. Layoffs have continued at Boeing and for business jet and general aviation workers, even as Spirit is expanding. This latest blow from Boeing comes as some business jet manufacturers have shifted work to lower-wage plants in Mexico.

Boeing came to Wichita in 1934, when it acquired Stearman Aircraft. Besides producing Stearman Kaydet open cockpit biplane trainers, Boeing's Wichita heritage includes making B-29s during World War II. Post-war, these factories were home to B-47 bomber production. Later, they shared production with Seattle of "tall tail" B-52s (D-F models) and all "short tail" Gs and Hs, says company historian Mike Lombardi. But the city's real future with Boeing began with parts for the 707 and boomed when it was selected to make fuselages for the 737 and 757 and major assemblies for all of the manufacturer's commercial jets.

All that changed in 2005 with the sale of commercial operations to Onex, leaving only BDS's military maintenance and specialized upgrade programs behind.

Correctly betting on a tanker victory, Boeing redesigned its 767 final assembly operations in Everett for simultaneous production of civil/military versions of the two-engine, mid-sized jet. Tanker production is not expected to begin until 2013.

The original plan was to fly green tankers to Wichita for installation of their military equipment. Wichita's closure means the work will be done in Puget Sound, reflecting a commitment Boeing made to the IAM in a four-year contract signing last month (*AW&ST* Dec. 19/26, 2011, p. 65).

But just where the tanker fitting work will be placed is uncertain. Boeing's widebody factory in Everett is undergoing production ramp-ups. The facility has been so crowded that Boeing has leased additional space at nearby Paine Field for completion work on 787s and some of them were sent to San Antonio.

The company was considering the possibility of establishing a new single-aisle factory for its 737 MAX reengining program away from the main 737 factory in Renton, south of Seattle. But Boeing pledged in the new IAM contract that the MAX jobs will stay in Renton, which consumes all of the capacity there.

So if Everett is busy and Renton is full, is the best candidate Boeing Field in Seattle? It fulfills the need to have adequate runway capacity for aircraft ferry flights. Executives are not commenting, but observers say one possibility is the Boeing Development Center there, which has been used for F-22 fighter contract work.

Boeing Field was where the company tapped one under-utilized facility, Building 1401, to localize another high-profile military program with a civil aircraft pedigree. The building was revamped to support installation of military systems for the U.S. Navy's P-8A maritime patrol aircraft, which uses a 737 airframe. In an earlier era, that work might have gone to Wichita, just as KC-46A tanker work was supposed to.

However, 1401 has no room to spare as P-8 production increases. The last P-8A test aircraft are due to leave shortly, followed by rollout of the first production unit to be flown to the Navy's Jacksonville, Fla., training center. Meanwhile, Boeing has won its second low-rate initial production contract.

And what will become of the Wichita buildings? Spirit AeroSystems is leasing space from Boeing Wichita for 787 assembly work. But Spirit does not need additional space for other contracts, says spokesman Kenneth Evans. That includes its production ramp-ups as Boeing's largest airframe supplier for the 737 and 737 MAX.

"Obviously both companies need to work together to ensure the 787 forward-fuselage production system is not affected," Evans says.

With Joseph C. Anselmo and Jen DiMascio in Washington.

Looking East

Pentagon shift to Asia-Pacific and Middle East bodes well for aviation and missile defense

AMY BUTLER and JEN DIMASCIO/WASHINGTON

President Barack Obama's changing of the Pentagon's global military focus from Europe to the Middle East and Asia-Pacific regions could breathe new life into dormant plans for a new stealthy bomber, and fuel the development of improved intelligence and surveillance aircraft and ballistic- and cruise-missile defenses around the globe.

Overall, the new military strategy is the White House's attempt to curb defense spending, which has ballooned since the terrorist attacks of 2001 and contributed to a massive federal deficit. "The growth will be slow, but [the budget] will still grow," Obama told reporters.

Congress has agreed to cut $487 billion from the military's budget over the next decade, though senior defense officials promised only to make reductions strategically. A law passed in August would mandate another $600 billion in defense cuts in January 2013 if legislators fail to reduce the federal deficit by $1.2 trillion.

REUTERS/LANDOV FILE PHOTO

U.S. Defense Secretary Leon Panetta and Gen. Martin Dempsey, chairman of the Joint Chiefs of Staff, are poised for a $487 billion cut over 10 years.

Though specific programmatic cuts will be outlined within the next month, the strategy calls for a reduction in the end strength for U.S. Army and Marine Corps ground forces and a likely commensurate cut in numbers for their equipment. Program terminations are also probable, as Obama said he wants to dispose of Cold War weapon systems.

By contrast, a boost is expected in the longer-range strategic forces capable of conducting campaigns in anti-access environments such as China, Iran and North Korea. The strategy specifically calls for a new stealthy bomber, which has been an on-again, off-again project led by the U.S. Air Force, though it does not provide a fielding date. Also specifically referenced in the strategy are improvements to missile defenses, likely building off of the nascent Phased Adaptive Approach being fielded to protect Europe and the Eastern U.S. from both regional and intercontinental ballistic missiles. Improved "resiliency and effectiveness" of space-based capabilities is also specifically mentioned.

While ground forces associated with the counterinsurgency (COIN) operations will be reduced, the aircraft designed to assist them will not lose support, says Deputy Defense Secretary Ashton Carter. "A lot of what we have learned in the COIN business transcends the COIN business," says Adm. James Winnefeld, vice chairman of the Joint Chiefs of Staff. This points to longevity in such fleets as the Air Force's MC-12W Project Liberty intelligence, surveillance and reconnaissance aircraft, designed specifically to support COIN and anti-improvised explosive device operations in Iraq and Afghanistan. It is unclear, however, whether new projects in these areas, such as expanding the Army's Enhanced Medium-Altitude Reconnaissance and Surveillance System, will be funded.

Defense Secretary Leon Panetta underscored continued support for ISR systems as well as space capabilities, unmanned aircraft and cybersystems.

Underlying the need for such equipment is a shift in the Pentagon's global footprint. The new Obama military strategy includes a significant decrease in U.S. military presence in Europe and a focus on countering threats in Asia and the Middle East. "Most European countries are now producers of security rather than consumers of it," allowing for a "strategic opportunity" to rebalance the U.S. military in Europe, the strategy says. Washington is pursuing a "smart defense" approach to pooling resources with European allies rather than simply basing large numbers of U.S. forces on the continent.

In Latin America and in Africa, where some insurgent and Al Qaeda affiliates operate, the Pentagon sees "innovative methods" of maintaining a U.S. presence, according to the strategy. This could include small special operations units outfitted to train local security forces or partnerships tailored for a specific region, says Michele Flournoy, deputy undersecretary of defense for policy.

Though end strength, especially in the ground forces, will come down, the Pentagon is embracing a policy of what it calls "reversibility." That would allow for reconstitution of such forces and their equipment if a surge is needed for a particular mission. "Reversibility is the concept that we have used to remind ourselves that we want to act in such a way . . . that we preserve options for the future," despite near-term cuts, Carter says. The cuts "are causing us—out of necessity—to have to stop certain things,

pause certain things and slow down certain things, and in each case we want, to the extent that we can do so, to preserve the ability to change course."

Reversibility is also applicable to the industrial base, he adds. "As we make program changes, we want to make sure that 10-15 years from now we still have an industrial base that supports our key weapons systems even if we are not able to buy in those areas at the rates or in the volumes that we had planned before we were handed this $487 billion cut."

Furthermore, Carter says Pentagon leaders are taking measures to protect the science and technology budget, which is where innovations are fostered. "We want to make sure we don't eat the seed corn," Carter says.

While no specific mention of potential F-35 cuts was made, the $380 billion program could emerge with all three variants intact, though production numbers will likely decrease in the next five years. According to Reuters, that decrease could be as many as 120 fighters.

Anti-access technologies are included in the strategy among those critical for future defense forces. Carter noted only that "we want it. We want it to succeed [and] that is why we are working so intensely on it managerially."

Japan and Israel are pushing their F-35 buys starting in 2014 for delivery in 2016. That will relieve some pressure on the U.S., but the international buy is far smaller than the projected U.S. cut.

Although the program has picked up new customers, the economic crisis and pressure on budgets abroad is forcing Lockheed Martin to fight for every sale, even in countries that have signed up as partners. The fighter's fate is in question, for example, in Italy, a key partner (see article below).

Panetta said that as budget details emerge, some members of Congress may oppose specific decisions. But he is "confident Congress will support what we're trying to do." Reaction from Capitol Hill has been mixed.

Rep. Buck McKeon (R-Calif.), chairman of the House Armed Services Committee, is casting the new strategy as a move that would weaken security. "This is a lead-from-behind strategy for a left-behind America. The president has packaged our retreat from the world in the guise of a new strategy to mask his divestment of our military and national defense," McKeon said.

The top Democrat on the House Armed Services Committee, Rep. Adam Smith (Wash.), praised the strategy.

Sen. John McCain (Ariz.), the top Republican on the Senate Armed Services Committee, says he will closely examine the new strategy.

"I understand the need for reductions

Rome Faces Reality

Italy weighs industry, budget implications of radical F-35 procurement changes

ANDY NATIVI/ROME

The Italian government is ushering in a new round of defense cuts in which, for the first time, the fate of Rome's participation in the F-35 Joint Strike Fighter program will be seriously threatened.

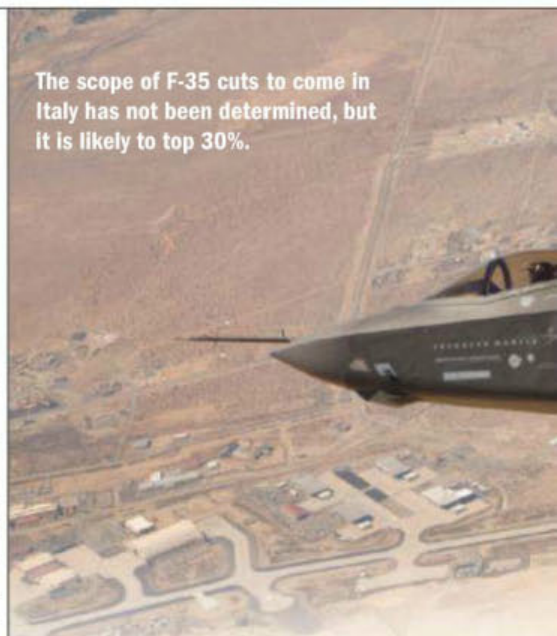
The newly launched defense review not only has sweeping implications for Italy's defense ambitions but also rings in a further belt-tightening in Europe among countries that are just beginning to come to grips with the scale of their budget and debt problems. Spain, where a new conservative government is grappling with greater-than-anticipated economic troubles, may follow with budget reductions. France is also expected to scale back defense spending after presidential elections in May.

In Italy, much of the work on the military review remains to be completed. Nevertheless, a sharp reduction in the number of F-35s Italy will buy is virtually certain, military officials say. At least a third of the 131 fighters slated for procurement will likely fall under the budget ax, with some minority parties arguing for an outright program termination.

Rome is one of the largest international buyers of the F-35—after the U.K. drastically cut its procurement objective in its 2010 spending review. Italy plans to spend €13 billion ($16.7 billion) to buy and sustain both the F-35A conventional-takeoff-and-landing and the F-35B short-takeoff-and-vertical-landing versions, though it has not ordered any aircraft yet.

Other major procurement projects are also under scrutiny, but the F-35 has received the lion's share of attention because of the size of the planned outlays.

Although Italy assessed its spending needs in 2010 in light of an era of fiscal austerity, the change late last year to a technocratic government, led by Mario Monti, specifically put in place to handle the country's financial problems more aggressively, has put military spending back in the crosshairs. The government, although not elected, enjoys broad support in the parliament to carry out sweeping reforms.



The scope of F-35 cuts to come in Italy has not been determined, but it is likely to top 30%.

Also potentially affecting the JSF debate is the fact that the government is very much focused on budget considerations rather than foreign policy ambitions. Cancelling the 22 navy F-35Bs would leave the service without fighters to put on its aircraft carrier after the AV-8B Harriers are retired. While that would crimp the ability to project forces, those considerations may not hold much sway with the Monti government. Such a move would likely cause the Italian air force also to drop plans to buy 40 F-35Bs and focus instead entirely on the F-35A.

On the other hand, working in the JSF's favor is that even at reduced num-

in defense spending, but we must also address the broader cultural problem plaguing our defense establishment: the waste, inefficiency, and ineffective programs that result from an overly consolidated military-industrial-congressional complex," McCain said in a statement. "We must eliminate the shameless cost overruns that characterize too many of our defense programs."

The strategy and comments by Pentagon officials hint at a reduction in the military's nuclear force, drawing the ire of Rep. Michael Turner (R-Ohio), chairman of the House Armed Services strategic forces subcommittee. "Deeper nuclear cuts will actually undermine the president's stated shift of focus to the Pacific," Turner said, adding that the strategy document shows no signs of plans that would "put national missile defense first."

The Missile Defense Agency is struggling to cut its annual budget, which is usually $9 billion, by up to $1.5 billion. At the same time, the agency is trying to fulfill the White House's 2009 mandate for an incremental, Phased Adaptive Approach (PAA) to fielding regional missile defenses in Europe. It is unclear whether the MDA will have enough money to develop a new high-speed interceptor as well as satellites needed for midcourse tracking of ballistic missile targets to make good on the PAA plan by 2020.

Flournoy also said the U.S. missile defense partnership with Japan—much of which is encompassed in the Raytheon SM-3 IIA interceptor program—will continue. But she stopped short of saying whether the U.S. will adapt the PAA construct in the Pacific region.

Defense officials underscore the need to continue efforts to reduce overhead costs inside the Defense Department and at its contractors. Some companies, such as Northrop Grumman and Lockheed Martin, have taken measures to reduce their workforces, and others, such as Boeing, are also closing facilities (see p. 18).

Along with cuts to investment accounts and overhead, Pentagon officials say they will trim personnel costs, which are a perennial problem. Health care and retirement cost growth has substantially outpaced the growth of the force, analysts say.

Former Lockheed Martin CEO Norman Augustine is famous for saying that in the year 2054, the Pentagon will be able to afford just one very expensive jet for all the services to share. That trend now applies to personnel, says Marine Corps Maj. Gen. (ret.) Arnold Punaro.

"We're heading in the exact same direction," he says, adding that the U.S. may produce the finest soldiers on Earth, "but four people aren't going to be able to meet all of our commitments."

LOCKHEED MARTIN

bers, the F-35 procurement would allow Italy to capitalize on the €2.5 billion it spent or pledged to the development and construction of a JSF final assembly and check out (FACO) facility at Cameri air force base. Work on the FACO is progressing quickly to be ready by 2014 to meet original JSF production schedules.

Italy committed $10 million in 1999 to the early phases of the F-35 program, with $1 billion put into the systems design and development phase in 2002, and another $900 million for the production sustainment and follow-on development phase. Another €700 million has gone for the FACO.

Factoring into budget discussions is not just the wasting of that money but also the potential loss of business for Italian companies, which is estimated at $11 billion over the life of the program, although Italian officials also bemoan that they have not secured more workshare.

The shifted political winds also may give Defense Minister Giampaolo Di Paola, a retired admiral who previously chaired the NATO military committee and served as the country's chief of staff, more leeway in adjusting the budget. When the Silvio Berlusconi government cut defense spending last year, it took €2 billion from modernization accounts but left personnel costs untouched, considering them sacrosanct, even though they represent 63% of defense spending.

Di Paola will have more options available, and he has already signaled an end-strength reduction from the authorized force level of 190,000 troops, which was set 10 years ago. The actual force level is down to 180,000, but Di Paola is reportedly looking at cutting this number to 150,000 or fewer, with civilian personnel levels also to be reduced by 5,000 from the current 30,000 positions.

The operations budget will probably remain constant, having been hit by cuts in prior years.

Di Paola has taken personal responsibility for the review of modernization plans, but he has not publicly weighed in on the F-35 debate.

As other countries' defense ministries have done, Di Paola will likely package the anticipated changes with a broad reform of acquisition practices. One probable area of interest is striking a new balance between buying off-the-shelf equipment and competing programs internationally to achieve a lower price. That could pose a threat to Finmeccanica, which has enjoyed a relatively protected home market in many cases.

The national aerospace and defense industry is anxiously awaiting the outcome of the review, even as the pressure on Di Paola to make decisive cuts on big-ticket programs is mounting. Spending cuts are likely to emerge this spring.

Grabbing Their Attention

Through struggles with procurement mishaps, Australia devises process for putting projects back on track

BRADLEY PERRETT/CANBERRA

Like its Western allies, Australia has had its share of troubled military procurement programs that missed cost and delivery targets. The Kaman Super Seasprite naval helicopter never entered service, for example, despite government expenditures of $1 billion. But Australia also deserves credit for innovations in program management that may hold lessons for other countries. While they offer no guarantee of success, they are worth a closer look.

In the 1990s, Australia began specifying the capabilities that it was seeking rather than the specific equipment and unit numbers that it wanted to buy. The same concept is being discussed more broadly now in the U.S., where pressure has been building to make draconian cuts in defense spending, even at the expense of some program modernization. In the Air 5428 program for fixed-wing flight training, for example, Australia has told bidders it needs so many pilots trained to certain standards each year; the bidders will work out how many aircraft and simulators are needed.

Australia also adopted a two-pass procedure for acquisitions in the last decade. In striving to meet a capability requirement, the defense department seeks first-pass approval by presenting the government with a range of choices, routinely including a low-risk option based on buying mature equipment from abroad. With the choices narrowed, the department then requests tenders and, eventually, second-pass approval—authorization to issue a contract.

Another Australian concept that emerged around 10 years ago and is increasingly looking like a good idea is the "projects of concern" list, in which Canberra formally identifies which procurement efforts are getting off-track, concentrating the minds of suppliers and officials. The process was ill-defined at first but has gradually been tightened up. Like capability requirements, the idea is attracting attention elsewhere and has been adopted by the U.K.

The latest example of an Australian project of concern, to the regret of Eurocopter and its partners in the NH Industries consortium, is the MRH90 transport helicopter, a version of the NH90 ordered in 2005 and 2006 for the Australian Army and Royal Australian Navy. Indeed, an aim of the projects of concern mechanism is that suppliers will fear for their reputations in being formally named and shamed. By the time it is listed, a program will have a remediation plan on which the contractor and defense department agree, including a timetable and specific targets. A contractor that fails to adhere to that plan can expect to be marked as a risky bidder in future programs. Failure to satisfactorily remediate "in extreme circumstances could result in exclusion from further tenders until the project is fixed," says Defense Minister Stephen Smith.

The MRH90, 46 of which have been ordered as part of a broad rotorcraft replacement program, is suffering from a range of faults of varying seriousness. Some problems are preventing its ap-

Australia has agreed to take delivery of three more MRH90s, including this one, but Eurocopter would like to hand over more.

AUSTRALIAN AEROSPACE

proval by the defense force's Airworthiness Board, keeping it out of operational service. The most serious issue is that compressor blades in the Rolls-Royce Turbomeca RTM322 turboshafts sometimes rub against the cases and cause engine failure.

Dissatisfied, Smith marked the MRH90 as a project of concern on Nov. 28, 2011. Eurocopter's local subsidiary, Australian Aerospace, had signed a deed a few days earlier setting out a remediation plan, following a program review.

"With the MRH on the projects of concern list, I now have their complete attention," says Rear Adm. Mark Campbell, head of the helicopter systems division at the department's Defense Material Organization.

According to Australian Aerospace, "the deed provides a key pathway for the aircraft to become ready for use in a battlefield environment."

There is potential for unfairness in the projects of concern process, because the defense minister makes the decision on the advice of his department, which could be responsible for the foul-up. But companies can appeal directly to the minister if they perceive unfair treatment.

Moreover, last year the government adopted tighter procedures for adding projects to and removing them from the list. Early indications of trouble initiate diagnostic reviews—assessments of what is wrong. Those reviews generate the remediation plans but not necessarily the listing as a project of concern. Companies are asked to help in that preliminary process and are warned that their project is at risk of being listed.

The process is most useful for ensuring that action is taken as things go wrong, but only if there is pressure from the top, says Andrew Davies of the Australian Strategic Policy Institute. "It does serve one very valuable purpose, and that is that if the minister is engaged, then it forces [project managers and company executives] to make decisions, whereas the easy thing to have done might have been to defer a decision," he says.

One sign that the process works is that the list is growing shorter. It was down to six projects in mid-December from 12 a year earlier. Still on the list are the Collins-class submarine, Boeing Wedgetail airborne early warning aircraft, Eurotorp MU90 advanced lightweight torpedo, Airbus A330 tanker-transport, an upgrade of electronic support measures in the AP-3C Orion maritime aircraft, and the MRH90. Projects taken off the list Dec. 13 included Australia's order for the Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (Jassm). There are only two ways off the list: remediation or cancellation. Jassm was remedied.

The MRH90 underwent a first diagnostic review last April and a second review that led to its listing as a project of concern. At the time of the first review, the government had taken delivery of 13 aircraft but declined to accept more, which meant that the contractor ceased receiving government funds. With the remediation plan agreed, the department accepted three more; unit 15 was handed over in mid-December. Eurocopter and Australian Aerospace have assembled about 22 helicopters in Brisbane using parts from NH Industries partners.

Initially, the MRH90 was supposed to be operational in 2010 to replace the navy's Sea King helicopters. The Sea Kings' lives were extended to the end of 2011, but Campbell does not expect the MRH90 to be operational until mid-2012. The army will use the aircraft to replace Sikorsky UH-60 Blackhawks. The helos for both services will be pooled and all painted in the army's camouflage pattern to simplify logistics—and, presumably, discourage naval modification.

The aircraft that have been accepted can be used only for testing and initial training. The compressor blade-rubbing is caused by slight bending of the engine spool due to uneven cooling after shutdown. This appears a few hours after a flight and lasts for some hours more, during which the aircraft cannot be safely flown. The current workaround is not to fly in that interval, which is hardly acceptable. Referring to the response of Rolls-Royce and Turbomeca, Campbell says: "I am impressed with the level of contractor engagement, but I am not impressed with the time it is taking."

Less serious faults include failure of transmission-oil cooler fans, which have been modified, and more frequent than expected cracking of the windscreen.

In addition, the inertial navigation system is taking too long to align and the floor of the helicopter has proved to be too weak to withstand the impact of soldiers' boots—a surprising fault for a battlefield transport.

It is clear that although the NH90 was regarded as a low-risk choice because it was out of the development phase, Australia ordered it a little too soon after the first unit was delivered to lead customer Germany. Since it turned out not to be ready for service with Germany and other European buyers, Australia found itself among the lead customers—just what it had wanted to avoid. European operators have visited and collected much information on what Australia has discovered about the aircraft.

This is the second time Australia has been in this situation—in the same decade and with the same supplier. The Eurocopter Tiger attack helicopter was also ordered with the intention of entering service in Australia soon after European operators began using it. In that program, too, delays soon made Australia a lead operator, sometimes discovering and working on problems ahead of the Europeans.

The Tiger is now out of the woods in Australia, says Campbell, whose division is also responsible for that program. The system that needed technical modification was the helmet-mounted sight, trials of which are going well. By the second half of this year, Campbell expects to be able to recommend the aircraft for deployment. The program manager wants improvements in performance of the Tiger sustainment contract and changes to the contract terms, however.

A lesson learned from the MRH90 is that the sustainment and delivery contracts must be linked. Under the current contract, Australia is paying for support of aircraft it has refused to accept into service. The sustainment contract also needs to stipulate what the user primarily needs from the helicopter, says Campbell. It currently does not. The aircraft are being bought for a fixed price, with incentives in the sustainment contract.

In buying Lockheed Martin MH-60R Seahawks, Australia is taking another approach. It will, in effect, establish the equivalent of two more squadrons of the U.S. Navy's MH-60R feet in Australia under Australian ownership, with the same contractors performing maintenance through the U.S. government's contract. Australia's Boeing CH-47D/F Chinooks and C-17 Globemasters are similarly supported under Foreign Military Sales arrangements.

Status Not So Quo

With GMD win, Boeing retains a foothold in missile defense

AMY BUTLER/WASHINGTON

When it comes to the U.S. missile defense market, nothing and everything have changed.

In the closing days of 2011, the U.S. Missile Defense Agency (MDA) announced that Boeing would retain its decade-long position as prime contractor for the Ground-Based Midcourse Defense (GMD) missile shield for another seven years. But if the $3.48 billion contract signifies a renewal of the partners' sometimes-rocky marriage, there now seems to be a change in the wedding vows.

MDA Director Lt. Gen. Patrick O'Reilly competed the development sustainment contract work owing to frustration over the costs associated with improving and operating the system under Boeing's earlier contract. That work is estimated to be worth up to as much as $10 billion in 10 years.

"The agency couldn't stand the terms and conditions of the lead systems integrator" deal under which Boeing previously worked, according to one executive in the missile defense industry. "They were raping the agency on cost."

Dennis Muilenburg, president and CEO of Boeing Defense, Space and Security, notes that the award is a result of "delivering innovative solutions and a cost-effective approach to program management and execution."

But Boeing had some major missteps over the years—including poor test performance due in part to inadequate quality control, especially early in the program. Even with its track record, both good and bad, the company has retained its position overseeing the massive GMD system, which includes Ground-Based Interceptors (GBIs) in Alaska and California as well as sensors around the globe. The GMD's mission is to protect the U.S. from ballistic missile attack using hit-to-kill interceptors. Though Boeing carried the weight of past missteps in its bid, it also had the benefits in the competition of being an incumbent, including some facilities and processes already in place.

The Boeing/Northrop Grumman team managed to beat Lockheed Martin/Raytheon for the $3.4 billion GMD development and sustainment contract, which covers an initial seven years of work.

Lockheed Martin was scheduled to receive its debriefing on the loss Jan. 6, after which the company has 10 days to protest. However, the company is too ensconced in its ongoing battle to keep the F-35 moving forward to launch a major protest over GMD, suggests the missile defense industry executive.

The contract with Boeing was signed on Dec. 30, and work is slated to continue through 2018.

Boeing's edge was likely that it was willing to go "way lower than expected" on price, according to the industry executive. This is possible, in part, because of access to cash enhanced by Boeing Commercial Airplanes, the executive says. Lockheed Martin lacks a commercial business from which to draw extra resources if needed.

As with the Boeing KC-46A tanker award, the GMD contract signifies more than merely securing a revenue stream. Both wins were also critical as the company strove in 2011 to maintain legacy business—as the U.S. Air Force's

A GBI lifts off from Vandenberg AFB, Calif., in December 2008 for the last successful intercept of the GMD system.

MISSILE DEFENSE AGENCY

premier tanker manufacturer and the only company globally to oversee a missile defense program of such breadth.

The new GMD contract is a "hybrid" that includes both cost-plus and fixed-price elements, according to MDA spokesman Rick Lehner. Varying levels of incentives are included for staying on cost, or even underrunning, as well as for maintaining 30 healthy GBIs up to 95% of the time. There is also an award fee schedule for various performance periods. For the first period, the focus is on executing a successful FTG-06B flight trial, which will be the third attempt to pit a GBI from Vandenberg AFB, Calif., against a target from the Kwajalein Atoll in the Pacific Ocean. Two earlier efforts at this test failed, and GMD has not executed a three-stage GBI intercept since December 2008.

A nonintercept flight test of the system is slated for spring, followed by an intercept attempt in the fall.

The new contract is also designed to better align incentives with quality assurance and technical and engineering performance.

If Boeing's win is upheld, the balance of the U.S. industrial base in supporting its missile defense ambitions remains untouched. A Boeing loss would have put the company out of the business entirely, as Boeing's other main project, the Airborne Laser, was shelved late last year and the company is a supplier to its rivals on regional and terminal defense systems.

The Pentagon, meanwhile, broadcast Lockheed Martin's GMD loss in the same news release announcing its $1.9 billion sale of the Terminal High-Altitude Area Defense (Thaad) system to the United Arab Emirates, a deal under negotiation since 2007. Delivery schedules for the UAE have not been announced, and the contract negotiations are not yet final.

But company officials say the forthcoming contract for two Thaad batteries, including 96 missiles, will allow for a production-rate increase of 50-100% at the Troy, Ala., final assembly plant and, potentially, a per-unit price reduction. MDA officials say the per-unit price of a Thaad interceptor is $12.2 million.

Prior to announcing the UAE sale the interceptor ramp-up plan was "relatively conservative" to avoid overpromising and under-delivering, said Tom McGrath, Lockheed Martin's Thaad vice president. In addition to the battery purchase, the UAE is buying two AN/TPY-2 X-band radars from Raytheon.

Lockheed Martin expects to deliver its last Thaad interceptor to the U.S. this year for the first and second battery orders placed on contract in 2006; interceptor deliveries for the third and fourth batteries are slated to be complete in the summer of 2013, says McGrath. Negotiations are under way for the next two interceptor batteries.

Dennis Cavin, Lockheed Martin vice president of international air and missile defense, says the UAE system will provide the "same capability" as the U.S. configuration, but he did not specify whether there were differences in the configuration—software or hardware—for the equipment being sold abroad.

The Thaad system will enable the UAE to intercept missile targets in both the endo- and exoatmosphere, adding to the capability offered by the PAC-3 Patriot system purchased in 2008. PAC-3 is focused on shorter-range air and missile defenses and cannot operate in the exoatmosphere.

The UAE is the first foreign buyer of Thaad, but Cavin says demand for such defenses has "never been stronger" owing to the proliferation of threats.

Defensive Strategy

Helicopter makers rely on military deals as commercial demand falters

ROBERT WALL/LONDON

Combat operations have been a boon to helicopter manufacturers, especially at a time of anemic commercial orders. European companies in particular are counting on military demand to sustain them for at least another year.

The Polish government, for example, is preparing to acquire 26 medium, multirole helicopters, with the goal of fielding the equipment through 2017. The aim is to buy a single helicopter type that could fulfill different missions. The bulk of the fleet, 16 rotorcraft, would be used by the Polish army for troop transport. Another three would be for land-based search-and-rescue missions, with three more slated to be used for maritime SAR. A final four would be dedicated to maritime surveillance and anti-submarine warfare, the defense ministry says. First deliveries should take place as early as this year.

Eurocopter is now offering better-than-expected performance on the EC175

India also remains in the market for more military rotorcraft (see p. 28).

Moreover, the U.K. intends to order more helicopters. It plans to add four AgustaWestland AW159 Wildcats to its 62-rotorcraft commitment, according to Peter Luff, minister for defense equipment and support. The Anglo-Italian company is set to release the helicopter for service soon. The first AH-159 for the army is slated for delivery in April, and the first HMA-159 for the navy will follow a year later. The AH-159 is due to become operational in 2014.

Another source of activity could stem from some 2011 procurements that did not materialize owing to budget constraints, according to industry officials

"We will grow on the military side," Eurocopter CEO Lutz Bertling declares. Recent years had seen NH90 transport and Tiger attack helicopters helping to offset weak commercial demand, and the strong market success of the EC725 troop-transport helicopter has reinforced that situation during the past two years.

But Bertling says his company needs to protect its position as the second-largest military helicopter maker, especially since Sikorsky's strong position with the Pentagon keeps the U.S. manufacturer clearly in the top slot.

One important new arena of competition is Russia's resurgent rotorcraft industry—underscored by strong global sales of the Mi-171. Russian Helicopters, which is also making inroads in commercial markets, projected a more than 20% year-on-year increase in deliveries for 2011, to roughly 260 units.

Eurocopter will try to reclaim some of the market from its Russian rival. The EADS unit hopes to sign the first contracts soon for a low-cost Super Puma version. While the price remains above what the Russians can offer for the Mi-171, Bertling says that if Eurocopter's lift rotorcraft is used more than 1,200 hr. a year, it should pay for itself within two years.

The focus on military rotorcraft—in addition to the oil and gas sector, which has been the one commercial segment that remained resilient during the economic downturn—enabled Eurocopter to boost revenues in 2011 to more than €5 billion ($6.4 billion), up from €4.8 billion the year before, even as deliveries fell for the third year in a row; they reached roughly 500 units after peaking in 2008 at 588. However, there are signs that the business is stabilizing, with cancellations last year at the typical level of around 20 units.

But the market balance, now dominated in value by military sales, will shift in the coming years; parity is likely in terms of the size (in value) of the military and commercial sectors around 2025. Bertling notes that, particularly in the medium-twin category, his company needs to strengthen its offerings in the face of pressure from AgustaWestland. The AW139 has had a strong market presence, he adds, and AgustaWestland is further strengthening its products in that sector with the first flight of the AW189 late last year.

Eurocopter, meanwhile, intends to fight back, initially with the EC175 being codeveloped with China's Avic. Based on flight-test results, the company says it can offer better-than-expected performance, with the helicopter delivering a 135-nm radius-of-action with 16 passengers and 190 nm with 12 passengers,

Indian Summer

Years in the making, New Delhi is set to unveil a slew of aircraft awards

ASIA-PACIFIC STAFF/NEW DELHI

DASSAULT AVIATION

In value terms, 2012 is poised to be India's biggest year for aerospace contracting. The next 12 months will see a raft of large deals signed by the country's government for aircraft virtually across the board, but especially for long-awaited defense projects.

The first month of the year is expected to bring perhaps the most anticipated decision in current contracting activity—the lowest bidder, and therefore prospective winner, of the Indian air force's Medium Multi-Role Combat Aircraft (MMRCA) competition (*AW&ST* Nov. 14, 2011, p. 36). Dassault and EADS Cassidian are jockeying to supply either Rafales or Typhoons, respectively, with the winner expected to provide at least 126 aircraft.

A defense ministry officer said the team scrutinizing the MMRCA bids is expected to select the competitive bid in the third week of January; and if so, the government would attempt to award the contract by March. "It would take something disastrous for 2012 not to be the year of the MMRCA," he said.

The original request for proposals was released in 2007, and it was once expected to have been awarded by 2011. Still, by some accounts, this is the endgame of a competition that began almost a decade ago (*AW&ST* Feb. 7, 2011, p. 46).

Last April, India downselected the MMRCA contenders to Eurofighter's Typhoon and Dassault's Rafale (left).

Likewise, in the first days of 2012 India's Cabinet Committee on Security was expected to approve a crucial contract for 75 basic trainer aircraft, the result of a competition in which Swiss company Pilatus was declared the winner last year. But the committee instead approved a separate contract for 450 MBDA Mica missiles for the air force's upgraded Dassault Mirage 2000H/TH fighters. With huge pressure from the air force for an early conclusion, given the admittedly dire state of its training infrastructure, the $700 million basic trainer aircraft deal is likely to come up for final approval later this month.

EUROCOPTER

Eurocopter is trying to win back market share lost to the Mi-171 with a low-cost Super Puma offering.

representing a 30% improvement over the initial baseline. The company also is working on an 18-passenger configuration, which would have a 100-nm radius of action.

After discussion with potential customers, Bertling says, "we have incorporated certain adaptations that will further improve the helicopter's operational capability, placing it ahead of the competition from its entry into service." The EC175 is slated for delivery this year. The first two helicopters are now in assembly at Eurocopter's facility near Marseille, France. Flight testing has focused on two prototypes, which have logged more than 270 hr., and industrial activity is continuing.

The next major thrust to reclaim momentum in the medium-twin segment centers on the Dauphin and EC155 replacement program, the X4, which should come to market in late 2016.

With an improved cash position, Eurocopter also is seeking small-scale opportunities, with some deals possible in the near future, says Bertling. However, a larger move is unlikely, he adds. Instead, the focus will be on exploiting deals already made, in particular the acquisition of service company Vector Aerospace, which closed last year.

With continued speculation that a larger restructuring of the helicopter industry looms, Bertling remains skeptical about the ability of Eurocopter and AgustaWestland to act as consolidators because of likely anti-trust concerns. Still, he would not rule out the company playing a role if the opportunity arises.

By midyear, the Indian government is also expected to decide on its protracted $750 million light utility helicopter acquisition program. A choice is shortly to be made between the Eurocopter AS550C3 Fennec and Kamov Ka-226T Sergei to supply 197 helicopters (133 for the army and 64 for the air force) for high-altitude reconnaissance and surveillance.

After a disastrous abort of the deal just days ahead of an expected award to Eurocopter in November 2007, the government and army have played extra safe this time and decided to protect the contract from possible derailment again. Sources in the army's aviation corps say the government agreed to expunge certain performance requirements, including hover out of ground effect at certain high altitudes, to allow evaluations to be completed.

Late last year, the air force chose the Boeing AH-64D Apache Block III Longbow for its 22 attack-helicopter requirement. Negotiations for a U.S. foreign military sale contract are in motion, with a contract expected this year. A parallel decision on an effort to procure 12 heavy-lift helicopters could also come through this year, though the government has not declared a winner. Candidates include the Boeing CH-47 Chinook and new- generation Mil Mi-26T2.

With final touches remaining on paperwork, the Indian government will also shortly sign a $1.2 billion contract with the Pentagon for six follow-on Lockheed Martin C-130J Super Hercules special mission tactical transports. Delivery of the first six aircraft was completed last month when the sixth landed at Hindon Air Force Station near New Delhi.

Finally, another deal expected to emerge this year is a government contract for four additional Boeing P-8I Neptune long-range maritime reconnaissance jets to augment the eight already ordered by the Indian navy. Late last year, the Indian navy chief, Adm. Nirmal Verma, said his service required 12 more such aircraft. But he indicated that the navy had not yet decided on the aircraft type, although Boeing will probably pitch its P-8 platform for what it will see as a follow-on opportunity to double the Indian order.

Separately, a stripped-down variant of the P-8I will be offered by Boeing in response to a tender that the Indian navy is expected to float this year for 12 medium-range maritime patrol aircraft (MPA). Competitors are likely to include the Saab 2000 MPA, Dassault Falcon 900 MPA, Alenia Aeronautica ATR 72 MP and Airbus Military C295 MPA.

EUROFIGHTER

The Rafale and Typhoon (right) are vying for the 126-fighter MMRCA contract in India's biggest award this year.

Growler Debut

Libyan combat demonstrates new alternatives in Pentagon's electronic attack arsenal

DAVID FULGHUM/WASHINGTON

The conflict in Libya introduced to combat a new weapons system: the Boeing EA-18G Growler electronic attack aircraft. But that first exposure came without warning, and the spur-of-the-moment redeployment forced the U.S. Navy to demonstrate its operational and technological flexibility within NATO and U.S. Air Force frameworks.

Despite positive reviews during Libyan operations, even newer and better options for the F/A-18 Super Hornet and EA-18G Growler family are being developed that could be parlayed into long operational lives for both even on next-generation battlefields, where survival will be complicated by electronic attack, cyberintrusion and sophisticated, long-range air defenses.

If, for example, the next-generation surveillance and bomber program, now called Long Range Strike (LRS), survives the new wave of U.S. defense cuts, Growlers carrying the Next Generation Jammer (NGJ) "certainly could be one of the adjunct aircraft operating with the LRS platform," says Mike Gibbons, Boeing's vice-president for F/A-18 and EA-18 programs.

The commander of the first Growler squadron to see combat provided some details of how the new aircraft were employed, describing a much different scenario than operations involving the older, slower and less maneuverable EA-6B Prowler.

"We were watching what was happening in Libya on the news, but we were focused on Iraq," says Navy Commander Jay Matzko, who leads Electronic Attack Sqdn. 132 (VAQ-132), the first unit to deploy into combat with the EA-18G Growler. "It didn't cross our minds what might happen [in Libya] and, if it happened, that we would go."

Last March, the operational shakedown of the new unit and its aircraft took a drastic and intimidating new direction. VAQ-132 was four months into a six-month deployment to Al-Asad AB, Iraq, conducting battlefield electronic surveillance missions and squadron planners were paying little attention to the Libyan revolution. But within two days, the unit was flying combat strike and electronic-attack missions over the country.

U.S. NAVY PHOTOS

The U.S. Navy's VAQ-132 was the first EA-18G unit to see combat, after a no-notice shift from Iraq.

"We got the call to move to Aviano AB, Italy, and within 36 hours we had packed up the squadron," Matzko says. "Within 11 hours of landing in Aviano, we were flying missions over Libya."

The unit got some breaks. It went to war with two recent Red Flag exercises behind it in addition to experience gained in Iraq. There were no changes to software or equipment during that time, and the aircraft were brand new.

"There could have been a lot of bugs to shake out of the system," Matzko says. "That wasn't the case. When you have solid-state equipment, there's a definite improvement in maintenance. What we left with is what we used and it was effective. The way we trained, whether by design or accident, was exactly what we needed, because we had NATO partners there with us at the Red Flags. When we got to Italy and started flying in Libya, it felt like Red Flag."

Tactically, the aircraft were used in various combinations depending on the mission, and they ranged across nearly all of Libya. In many situations, the aircraft and crews were pulled off one mission to conduct another either on their own or in coordination with other NATO units.

"Every day that we went out was different," Matzko says. "There was no normal. We train as singles, in pairs or as four ships. In the four months we were there, we did all that."

The tactical formation could be dictated by geography, or target types and numbers. Aircrew and airframe flexibility were important, as were the Growler's payload options, its air-to-air radar and a range of weapons that included the Aim-120 Amraam and the high-speed antiradiation missiles (HARM) and jamming pods. Its HARMs were fired in support of suppression of enemy air defenses throughout the Libyan operations.

One area of interest to veteran aircrews was whether two crewmen in a Growler would be as effective as the four in the EA-6B Prowler it replaces. There

Joint Problems

DAVID FULGHUM/WASHINGTON and ROBERT WALL/LONDON

Complaints are just now being voiced by U.S. and allied participants in the NATO-led operations over Libya about the cobbled-together, understaffed and segmented joint command-and-control system. In particular, some early U.S. Navy missile attacks were launched without coordination with the Air Tasking Order, some allies did not have access to key information and personnel without the right skills were assigned to pivotal jobs.

Intelligence dissemination and sharing was a major issue. Air crews from Sweden, which is not a NATO member, had difficulty accessing NATO cryptography gear and the daily air tasking order, a Swedish military official says. And several non-U.S. military officials note that imagery collected during missions often could not be used easily because intelligence centers were not open to all participants.

Combat missions were hobbled by the inability to

were a number of influencing factors. Much electronic intelligence collection and analysis by submarines and special mission aircraft was done behind the scenes and doled out by mission planners.

Squadron officials say lessons learned in the Red Flag exercises and in Iraq and Libya validated the shift from four crewmen in the EA-6B to two in the EA-18G.

"Until you are actually doing it [in combat], and not in a simulator, you don't really know," Matzko says. "That's my biggest lesson learned. Two people can do the mission really effectively. The way we trained was so effective that we were ready to do something completely different from what we were doing in Iraq. Iraq was primarily electronic surveillance and Libya added kinetic [explosive] and non-kinetic [electronic] attack."

The Growlers' main missions were electronic attack of radars and communications networks. The Navy remains mum about real-time network and traffic communications analysis and whether they worked with non-government forces during the Libyan operation.

The EA-18G's air-to-air radar and varied weapons were key to operations over Libya.

"The tasking remained pretty level throughout the Libyan operation," Matzko says. "But the way we go after these [targets] is dynamic and different every time. We went wherever there was activity that [analysts] thought needed us. It was most of the battlespace. It was huge."

VAQ-132 was also involved in the rescue operation for the crew of a U.S. Air Force F-15E that crashed in Libya.

"It was a case that showed how flexible the aircraft was," Matzko says. "We had aircraft airborne and as soon as [the F-15] went down, our aircraft were pulled off a mission, moved to the [rescue operation] and it was successful. One would [refuel] while the other monitored the rescue. We didn't know what we were going into, so we were prepared for both [communications jamming and radar suppression]. We do train for [combat search and rescue], but it was absolutely something we didn't expect to do."

When the squadron arrived in Aviano, it had to find its place in the international operations and logistics complex. Navy officials worked with the U.S. Air Force fighter wing stationed there and the Combined Air Operations Center. Operators also had to do some missionary work in spreading the word about what the Growler can do.

"One of the things about bringing the Growler into the fight was that it was so new that nobody knew our capabilities either in Iraq or at Aviano," Matzko says. "Our wing did a lot of capabilities briefings so that people would know what we do and how they could use us. It took a long time for other military organizations, specifically the Air Force, to determine how best to use the Prowler. We're building on that success with the Growler by offering more in the way of different types of ordnance it can carry. It has air-to-air radar, so one of the things that makes it more attractive to the other services is that it [has capabilities] more like a fighter.

"The biggest advantage of having an air-to-air radar in the Growler [which the Prowler does not have] is situational awareness," he says. "In an aircraft without a radar, you're trying to understand where everybody is and what they are doing through listening. This is much more visual. It can be something as simple as finding a tanker quickly."

Nonetheless, Matzko says, "I don't think we're ever going to get rid of the spoken word in the Growler community. That's most of what goes on still. We do have digital capability, but there are so many things you can glean from a person's voice that it is still essential."

Advanced crew stations have bigger 11 X 19-in. glass panels which improve situational awareness by providing more on and off-board information.

In addition, Boeing specialists took data correlation algorithms that had been developed for kinetic warfare, increased the onboard correlation and fusion for the Growler, which has even more sensor information onboard, and focused it on the non-kinetic capabilities designed for the advanced, back-seat crew station. It also incorporates systems for airborne electronic attack, communications countermeasures, and interference cancellation as well as a new satellite receiver.

The new cockpit can display more algorithm-fused data. For example, it can provide a 3-D view of the battlefields, including enemy emitters (type and location), friendly sensors (fields of view), unmanned vehicles (type and location), air defense rings, and network analysis to enrich the electronic order of battle by identifying who is talking to whom. The next-generation cockpit is being developed as part of the advanced international road map options. The current EA-18G aft cockpit has an 8 X 10-in. center display that is decoupled from the front cockpit. Even though new displays can be larger, this one requires less weight, power cooling and space behind the screen, Gibbons says.

properly disseminate post-mission analysis, which slowed coalition response to some intelligence. Mission planning suffered from a lack of experienced targeteers.

"Mission planning has sometimes been disjointed," Air Chief Marshal Stephen Dalton, the U.K.'s chief of air staff noted during the operations.

Some U.S. officials are much more blunt. A former U.S. intelligence professional says he was appalled at the lack of intelligence coordination during the NATO-led air war.

"Operation Unified Protector was a disaster in its lack of a joint approach," he says. "All you have to do is look at the opening days when the Navy unilaterally targeted its [Tomahawk cruise missiles] irrespective and independent of the plan of the Joint Force Air Component Commander. That gets down to the issue of what that squadron commander experienced—a segregated intelligence venue. If you don't have the responsible organization taking an integrated, joint approach, you're only going to get information from a few sources.

"I'm not saying that the Navy and Air Forces had holes in their operational conduct of the conflict," he adds. "But the joint force commander was not acting very 'joint' nor integrating all the command-and-control elements to provide a joint and a unified approach."

Channel Surfing

Simple inlet concept could help pave way for combined-cycle space access

NASA PHOTOS

An F-15B testbed reached speeds up to Mach 1.74 to generate correct inlet conditions in the ventrally mounted test unit.

GUY NORRIS/LOS ANGELES and GRAHAM WARWICK/WASHINGTON

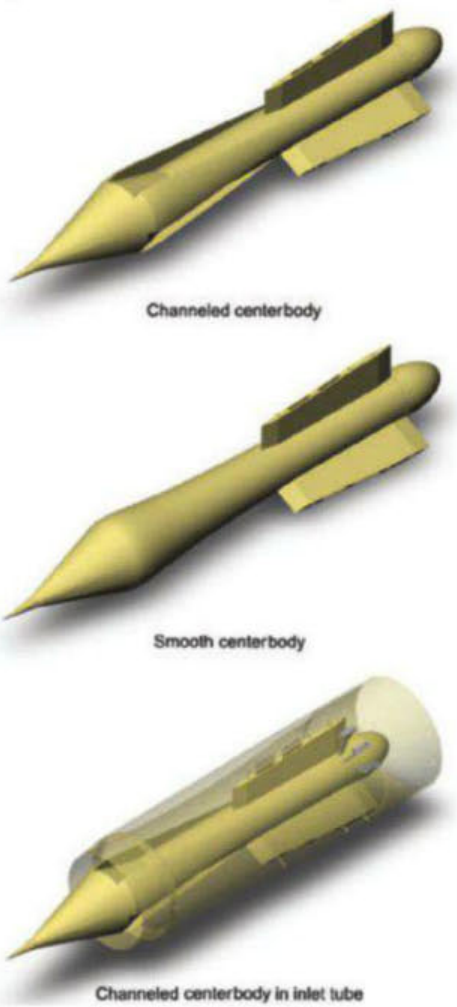
Fifty years after researchers tested a unique engine inlet design for Lockheed's Mach 3.2-capable A-12, a novel inlet concept is being evaluated that could lead to a new generation of simpler and lighter supersonic and hypersonic propulsion systems.

Detailed analysis of results from tests of the Channeled Centerbody Inlet Experiment, or CCIE, will begin this month following the final evaluation flight on NASA Dryden Flight Research Center's F-15B testbed aircraft on Jan. 5. The CCIE was flown on a pylon mounted under the F-15B over a series of eight flights, starting with initial tests in late August 2011.

The CCIE concept is being explored to address the problem of the changing mass-flow requirements for a supersonic inlet operating across different flight conditions. This is vital, because future supersonic and hypersonic vehicles, including air-breathing combined-cycle space launchers, must be capable of operating at low supersonic and transonic speeds as well as higher Mach numbers. The inlet will therefore be required to cope just as efficiently with a throat area and mass flow matched to cruise requirements as one configured for "off-design" transonic and low supersonic conditions.

Unlike typical supersonic, external-compression inlets designed to reduce the airflow to subsonic speed before it enters the engine, higher-speed supersonic and hypersonic combined-cycle designs are configured with mixed-compression inlets. These contain the terminal shock associated with the airflow inside the inlet instead of by the entrance to the inlet. In previous mixed-compression inlets like those used in the A-12 and its better-known SR-71 Blackbird-family stable mate, the position of the shock is controlled by moving the centerbody fore and aft.

However, the mechanisms for moving and controlling the centerbody are relatively complex and heavy, and NASA hopes the simpler, lighter CCIE can produce the same effect more efficiently. The CCIE has channels, or slots, in the inlet centerbody that increase the amount of air flowing into the engine, improving its performance over a wide range of Mach numbers. Although the CCIE is a fixed-geometry test unit, a fully operational inlet would have movable channels that would open and close to adjust throat area and vary mass flow into the engine, depending on conditions.



The CCIE is a version of the translating channel centerbody (TCCB) inlet patented by Ohio-based TechLand Research and originally intended to work with a now-shelved NASA-designed rocket-based combined-cycle (RBCC) engine. "The proof-of-concept test unit is relatively simple in configuration" and is being tested to "determine if a new design is worth pursuing," says CCIE principal investigator Clint St. John.

The main research objective was to define the airflow through the experimental jet engine inlet, then compare it to the flow through a standard inlet. Inside, airflow around two interchangeable centerbodies installed in an inlet tube was measured. One centerbody was channeled while the other had a conventional, smooth shape (see drawing).

First flights were undertaken with the channeled shape attached to a series of three nozzles to vary mass flow rates. Following these, the smooth centerbody was tested with the same three nozzles. Data from the smooth centerbody—including inlet mass airflow, internal surface pressure distribution and airflow distortion—were used to benchmark performance data for the channeled unit. The results will also be compared with computational fluid dynamics predictions.

Flights were aimed at capturing equivalent inlet performance at Mach 1.3 and 1.5 at 40,000 ft., which required the F-15B to fly at speeds up to Mach 1.74. The last flights, conducted in early January, repeated an earlier flight with a smooth centerbody and medium-flow-rate nozzle to gather additional data and perform further evaluation of the local flow field under the F-15B, says St. John. To avoid the worst of this, and to position the CCIE correctly for testing, "we angled it to a zero angle of attack when flying at Mach 1.5, which is the primary case," he adds.

Betting the Trifecta

Arianespace ups the ante with a trio of launch vehicle options in 2012

AMY SVITAK/PARIS

It's been two years since European launch consortium Arianespace turned a profit. Despite Europe's economic crisis, the market for commercial satellite communications is strong and conditions for launch providers are generally favorable, yet the Evry, France-based launch services company continues to rely on government subsidies.

Despite the success of its Ariane 5 rocket, which has not seen a launch failure since 2002, a second consecutive year of losses in 2010 led Arianespace's government backers to question how a reliable, high-performing rocket could be so costly to build, operate and maintain.

The answer, according to a 2011 audit that put the entire Ariane 5 system under a microscope, is politics.

"Building rockets in Europe is more expensive than building them in Russia or China," says Arianespace Chief Executive Jean-Yves Le Gall, referencing the premium governments pay to ensure a geographic return on investments in Ariane 5.

With the politics of European launch unlikely to change, Le Gall is shifting the company's focus, diversifying its product line in an effort to yield efficiencies, and tripling the number of vehicles available to commercial and government customers beginning this year.

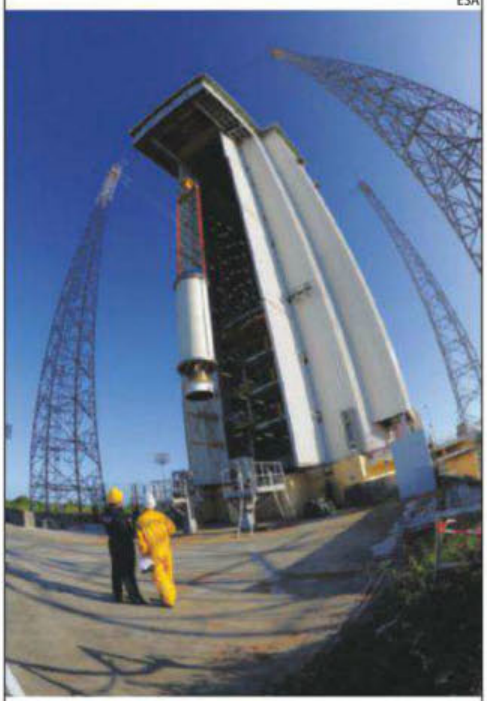
In October Arianespace inaugurated a Europeanized variant of Russia's Soyuz rocket, which launched two Galileo satellite navigation spacecraft from Europe's Guiana Space Center in Kourou, French Guiana. Coming on the heels of the audit, it was the first of two Soyuz missions to blast off from the South American spaceport last year, ending the year with nine launches.

Other Soyuz versions failed twice in 2011, however. Well before these launch failures, Arianespace was imposing strict quality-control measures in line with those applied to Ariane 5. Such practices are currently employed for Soyuz launches from the Baikonur Cosmodrome in Kazakhstan, where Arianespace's Starsem affiliate has conducted 24 missions without incident.

"[At times], we've refused to take delivery of a component or system because we thought there might have been a doubt about it," Le Gall says. This has resulted in some unpleasant meetings, he notes.

In addition to Soyuz, Arianespace is set to introduce Italy's small-class Vega rocket in February. Between the three launchers, the company expects to conduct 8-13 missions a year, nearly doubling its current manifest—a tempo not seen since the 1990s when the medium-lift Ariane 4 lofted 10-12 missions annually at a time when there were fewer entrants to the commercial launch market.

ESA



The Vega Zefir-23 second stage is hoisted at the Guiana Space Center in Kourou in preparation for the rocket's February launch debut.

Le Gall says the two new launch vehicles will afford a 20% reduction in the cost of an Ariane 5 launch by amortizing high fixed costs across a more robust launch manifest. But it is not clear whether such efficiencies will ultimately lead to lower launch prices, or eliminate the need for government financing.

The 19-member European Space Agency (ESA) has signed off on €217 million ($278 million) in government subsidies to be spread over 2011-12. But such government backing could be curtailed when the ESA council meets at the ministerial level in November to set the agency's multi-year budget. Although an annual payout is likely to continue, strings could be attached.

As a result of the 2011 audit, ESA member states now hold three rotating seats on Arianespace's board of directors, and therefore have greater visibility into the company's finances. But ESA ministers could go further by turning the commercial launch services provider into a government agency. Another option is to give ESA equity shares in the company.

In the meantime, Le Gall says Arianespace expects to eke out a slight profit and reach "financial equilibrium" in 2011 with €985 million in anticipated revenue.

The company signed 10 contracts last year and has 21 satellites in backlog for Ariane 5.

Another 15 contracts are on the books for Soyuz, including 13 to be conducted from Kourou and two from Baikonur, including the next tranche of six Globalstar second-generation communication satellites and Europe's Metop polar orbiting meteorological satellite.

Arianespace's order book now stands at €4.5 billion in backlog, including €2.5 for commercial Ariane 5 launches, €1 billion for government launches on Ariane 5 and €1 billion for Soyuz launches.

Le Gall credits Arianespace with orbiting half the 16 commercial geostationary satellites launched worldwide in 2011.

"It is good that we launched eight of the 16, but the bad news is there were only 16," he says, alluding to the tough competition Arianespace faces.

With 90% of its revenue coming from the commercial sector, Arianespace expects continued competition from International Launch Services, which markets Russia's Proton rocket; and Sea Launch, which returned to the market in 2011 after emerging from Chapter 11 bankruptcy protection.

Arianespace also faces fresh competition from China, which plans to launch five commercial missions atop its Long March rocket this year, and from India, which is about to enter the market.

In the U.S., Space Exploration Technologies (SpaceX) has yet to prove itself as a player in the launch business, though a demo of its Falcon 9 medium-lift rocket is set for Feb. 7. Last year, SpaceX announced plans to launch a heavy-lift variant of Falcon 9 as early as 2013.

BOEING CONCEPT

Boeing 737-900ERs will be the mainstays of Lion Air's fleet.

Lion's Share

Lion Air's president outlines strategy for market domination

LEITHEN FRANCIS/SINGAPORE

More than 20 scheduled carriers now vie for a share of Indonesia's commercial air transport market, with intense price competition and more regulatory requirements the order of the day. But such conditions will eventually force some airlines out, says Rusdi Kirana, head of Lion Air, the country's largest domestic airline.

He foresees a massive shakeout through mergers and business failures, leaving just four airline groups to serve the world's largest archipelago, within the next 6-7 years.

Of all the markets in Asia, market consolidation is most likely to occur in Indonesia due to the plethora of airlines there, many of which have failed to differentiate their offerings and are therefore unable to command a premium for their services.

Also, the Indonesian government is concerned about the inherent safety risks of having too many small—undercapitalized—airlines. In an effort to force market consolidation, new laws have been implemented. Scheduled commercial airlines this year must have a minimum of 10 aircraft, of which five must be owned. The government has passed laws requiring that airlines insure each passenger.

Rusdi says these new laws effectively increase the cost of running an airline and make it harder for startups. Airlines that lack strong financial backing will be forced to exit the market, he adds. A market consolidation, however, would be a boon for Lion, because it means it can capture market share and more readily add on the aircraft it has on order.

"The competition is very tough in Indonesia. "[You need to have] cheap tickets, but also good aircraft, a good frequency and good flight connections. Passengers are increasingly choosing airlines based on flight frequency, but it takes time to achieve that," says Rusdi.

Trying to expand frequency is complicated by the slot constraints at many of the country's busiest airports, he says.

Airlines, to remain competitive, must also have fuel-efficient aircraft. "But if you go to Airbus or Boeing to buy aircraft, you will see all the production slots are already taken up to 2015," says Rusdi, who signed a binding agreement in Bali, on Nov. 18 for 201 Boeing 737 MAX and 29 Boeing 737-900ERs. President Barack Obama, who was in Indonesia that week, witnessed the signing.

Prior to the deal for the additional 737s, Lion already had 114 -900ERs on order. Rusdi says he plans to still take delivery of the 114 aircraft. If one adds up all the aircraft on order and the new aircraft Lion has already received from Boeing, the total comes to 408 and "I hope we can get to a thousand," he says.

Rusdi, throughout the interview with Aviation Week, emphasized that 408 aircraft "is not that much" for Indonesia. He says the country's domestic airline industry is growing 15-20% per annum and is a huge market with 230 million people. Lion has 47% of the domestic market and will achieve 60% market share within the next two years, he predicts. This year the airline will transport up to 27 million passengers and reap revenues of $1 billion, he adds.

The new aircraft are mostly for future growth, but will also be used for replacements. Lion has already phased out all its MD-82s and will phase out the 737-300/-400s in the next 1-2 years. According to the Ascend database, Lion has nine -300/-400s. The 737 MAX aircraft on order have a delivery schedule that extends over many years, creating an opportunity for Lion to eventually start replacing the 737-900ERs, as the 737 MAX aircraft come in.

Rusdi also says he plans to order more narrowbody aircraft in time for the Singapore Airshow in February 2012, but declines to elaborate. The airline had 33 ATR 72-500s on order, of which 15 have been delivered so far, according to Ascend. Industry executives familiar with the situation say the upcoming order is for more ATR 72s.

The ATRs are associated with Lion's Wings Air brand, while the 737s operate under the Lion brand. Rusdi says Lion is in the process of preparing the paperwork for the air operator certificate (AOC) for the new full-service carrier, Space Jet.

There is a need for Space Jet because "Indonesia's economy is growing so fast. The passengers that have been flying

with us on Lion are moving up into the middle-classes and becoming rich. We don't want them to leave us." Space Jet is slated to start flying in 2013 using 737s, says Rusdi, adding that video-on-demand and Wi-Fi will be available.

On Dec. 15, 2011, Rusdi signed a contract for two Hawker 900XPs, which marks the first time his company has bought business jets. He says the first is scheduled to be delivered in May and will initially fly using the Lion AOC. But the aircraft will be used for business charters and eventually transition over to Space Jet.

The Indonesia-centric airline recently tried to establish a joint venture in Malaysia with the Berjaya Group, but the deal fell through. Rusdi says he is still interested in far-ranging joint ventures, but that due to the vast size of the Indonesian market, "it is not very important to us." Also, he notes that and open skies initiative across the Association of Southeast Asian Nations (Asean) is due in 2015. "I will be able to fly from Indonesia to any Asean country and then beyond to any country." As a consequence, "getting a new AOC in another Asean country is not really a must."

Late Surge

Boeing breaks 800 order mark, deliveries near-record pace

BY MICHAEL MECHAM/SAN FRANCISCO and GUY NORRIS/LOS ANGELES

A surge of customer interest in the 737 MAX and record orders for the 777 demonstrated Boeing's continued strength in both its single- and twin-aisle product offerings in 2011 as the company recorded 805 net orders.

The 777 was the constant star, setting a one-year order rate of 200 airplanes. The 300-365-seat aircraft solidified its role as the industry's dominant large twin-engine jet. The 1,000th unit is to be delivered in March.

Meanwhile, the 737 Next Generation family continued to attract orders, although it was overshadowed for much of the year by the Airbus A320NEO. Boeing's response to that reengining program—the 737 MAX—was slow off the block. But the new jet, which is to be delivered in 2017, finished the year on a high note with a firm commitment of 150 from Southwest Airlines.

JOE WALKER

Though contractually delivered in 2011, ANA's third 787 actually departed in January, as will the fourth aircraft.

Counting Southwest, MAX now has more than 1,000 orders and commitments from 15 customers and the company expects that number could reach 1,400-1,500 by the end of this year.

Altogether, Boeing accrued 921 orders. The 737NG series and the 787 suffered the most noteworthy attrition. Total orders for the 737 dropped from 625 to 551 once cancellations were accounted for.

The 787 gross order count rose by 45 during the year, but cancellations dropped the real gain to just 13 aircraft. The orders included four from Air Lease Corp., 10 from Etihad, six from Oman Air and 25 from an unidentified customer, which is thought to be Air France.

Some of the 787 cancellations were driven by ongoing delivery issues, but others reflected changes in strategy as carriers reconsidered whether a long-range 200-plus-seat airplane still met their needs. China Eastern fell into that category when it opted to swap 24 787s for 45 737-800s. The 747-8 lost one net order, while the 767 surged with 42.

Airbus has not released it 2011 figures, but is likely to record more than 1,600 gross orders. Its great strength came from NEO, which has passed the 1,200 firm order mark. Like Boeing, Airbus suffered its share of cancellations in an up-and-down year for airlines. But its net order intake is still likely to top 1,500. As for deliveries, the European company expects to top 530.

Boeing's commercial factories achieved 477 deliveries in 2011, four shy of 2009's mark, which was the best of the new century. At 477, Boeing did not quite achieve its goal of 480. That was revised down from a 485-495 target as factory reports in the third quarter made it clear that expectations for 747-8 and 787 deliveries were overly optimistic.

Early in the year, executives speculated that as many as 40 747 and 787s would be delivered, roughly split. But it became clear that the slow pace in achieving change modifications to 787-8s would make this expectation impossible to meet. A new mark of 15-20 deliveries—two-thirds from 747-8s—was set. Actually, nine 747-8s and three 787s were delivered.

Boeing squeaked the third 787 delivery, Line No. 31, onto the 2011 tally by recording it as "delivered" in documents signed Dec. 30. But All Nippon Airway's (ANA) pilots did not actually takeoff for Tokyo until Jan. 4.

The fourth ANA aircraft, Line No. 41, powered by the updated Rolls-Royce Trent 1000 Package B variant, is expected to be delivered within the next few days. Both No. 41 and Line No. 9 were to be delivered last year; the new schedule says mid-month.

Line No. 35, the production-standard airframe destined for completion of certification of the 787 with power from General Electric GEnx-1B engines, is slated to be tested in mid-January. The completion of that task will clear the way for delivery of the first GE-powered 787, Line No. 23, to Japan Air Lines, probably in late February.

Boeing CEO/Chairman James McNerney says the "vast majority" of 787 change-incorporation work involves the first 40-45 aircraft, but some could persist up to Line No. 60.

The Line No. 51 787 is now completing assembly in Everett, Wash. Counting deliveries already made and six test aircraft, 42 787s have left Boeing's factory doors and are awaiting modifications and testing prior to delivery.

AVIATIONWEEK
& SPACE TECHNOLOGY

2012 Laureate Award Nominees

55th Annual Honors

So rich is aviation, aerospace and defense in technological, operational and personal achievement year in and year out that many of the individuals who comprise these professional communities often say they cannot imagine plying their skills in any other lines of work. And an exceptional range of skills they are—from aircraft design to heroism, from leadership to harnessing the imagination. Aviation Week's Laureate awards represent our annual salute to the men and women, as well as the teams, who accomplish the extraordinary deeds that deserve recognition, not on a national or even regional scale, but globally.

The nominees and their achievements for 2012 are grouped in eight categories and listed on the following pages. While nominations were open to industry and government, editors selected all of the finalists independently. The winners will be announced at a black-tie ceremony in Washington on March 8, but recipients already have been selected in two special categories: Heroism and Lifetime Achievement.

AERONAUTICS/PROPULSION

■ **The AeroVironment Nano Air Vehicle Team** developed and unveiled a tiny remotely piloted air vehicle, the Nano Hummingbird. Looking and flying like a tiny bird, it is designed to record video with an onboard camera and send color video to a hand-held controller.

■ **The Boeing 787 Team** brought the first new commercial jet of the 21st century to market, forcing a response from its principal rival, Airbus. In the process, Boeing opened a new chapter in supplier relationships, as well as cooperative systems-testing and design in the production of commercials aircraft.

■ **The F-35 Stovl Propulsion Team** has created a path to address issues with the F-35 lift system that had delayed development flight-testing. On Oct. 3, 2011, the first of two test aircraft landed on the amphibious assault carrier USS Wasp to begin initial sea trials. This was the first time that an all-new Stovl aircraft landed on a U.S. Navy ship in 40 years.

BUSINESS/GENERAL AVIATION

■ **Pat Epps,** founder of Epps Aviation, led an 11-year quest to recover a Lockheed P-38 Lightning buried in the Greenland ice cap.

■ **Preston Henne,** senior vice president of programs, engineering and test at Gulfstream Aerospace Corp., headed the design, development and testing of the Gulfstream 650. He brought the aircraft to certification in 2011, as scheduled, despite its being set back by a fatal accident during critical performance trials, which temporarily grounded flight-testing.

■ **Tom Poberezny,** chairman emeritus of the Experimental Aircraft Association and co-founder of its AirVenture convention, was instrumental in working with the Young Eagles program to introduce millions of young people to aviation in 2011.

COMMERCIAL AIR TRANSPORT

■ **Filippo Bagnato,** chief executive officer of ATR, achieved multiple major milestones in 2011. Under his leadership, ATR generated a new wave of interest among airlines and lessors, and its record order intake and backlog make it a standout in a regional aircraft sector that is still struggling to recover from a severe downturn.

■ **John Borghetti,** chief executive officer of Virgin Australia, led one of the most dramatic transformations of any airline in 2011. Formerly known as Virgin Blue, the carrier vaulted from being primarily a low-cost operator in Australia and New Zealand to become a major player in international and corporate markets.

■ United Airlines managers **Gerry McGill** and **Guy Schroeder** were pivotal in developing and implementing line operation safety assessments for United's ramp and maintenance operations. The overall effort potentially saved tens of millions of dollars by reducing injuries and damage to equipment.

DEFENSE

■ **The Advanced Extremely High Frequency (AEHF) Satellite Recovery Team** rescued a wayward U.S. Air Force satellite valued at more than $2 billion after foreign object debris prevented even nominal operation of the liquid apogee engine.

■ NATO Secretary General **Anders Fogh Rasmussen** played a critical role in shepherding the alliance through policy and operational challenges in the Libya operation in 2011. It was dramatic evidence of his advocacy for a stronger, smarter and more modern NATO. He has also stressed the need to consider crucial capabilities such as cybersecurity and missile defense.

■ **Timothy Owings,** deputy unmanned aerial systems (UAS) project manager in the U.S. Army UAS Project Office, was key in refining and advancing Army UAS in 2011. This included proving the interoperability and system integration of AH-64D Apache and OH-58D/F Kiowa Warrior helicopters with Gray Eagle, Shadow, Hunter, Raven and Puma unmanned aircraft.

■ **The U.S. Navy and Northrop Grumman Fire Scout Team** were responsible for two important deployments in 2011: a seven-month stint on the guided-missile frigate USS Halyburton in support of anti-

piracy operations in the Gulf of Aden and a land-based deployment in northern Afghanistan, where Fire Scout provided 300 hr. a month of full-motion video coverage to coalition ground commanders.

■ **Samuel Young,** Insitu field service representative, and **U.S. Navy Lt. Nicholas Townsend** optimized the ScanEagle UAS in support of combat operations in Libya in 2011. Under their leadership, a team aboard the destroyer USS Mahan operated the ScanEagle cooperatively with U.S. and NATO forces, demonstrating how the UAS could be used more effectively.

IT/ELECTRONICS

■ **U.S. Navy Capt. John Feeney,** program manager, led a team effort to develop and deploy a low-cost, high-fidelity system that will bridge a critical antisubmarine-warfare training gap for P-3C aircrews in remote, forward-deployed locations.

■ **Henry Putek, Jr.,** Boeing 777 captain and Electronic Flight Bag Team leader was instrumental in enabling American Airlines to win FAA approval to operate Apple iPads in the cockpit during all phases of flight, with digital charts and manuals.

■ **Swedish air force team members,** in collaboration with **Danish military officials**, implemented a program to urgently integrate Link 16 on the single-engine Saab JAS 39 Gripen to support NATO combat operations in Libya. The program was compressed to two months from an initial projection of one year.

MAINTENANCE, REPAIR AND OVERHAUL

■ **The MD-10 VIA Improvement Team,** led by Patrick Doyle, Sr., avionics manager at FedEx, identified common causes of avionics failures. As a result of his work, FedEx was able to apply a hybrid methodology for the maintenance of avionics components, increasing the service life of older avionics systems.

■ **The DRS Technologies Inc. Mast-Mounted Sight (MMS) Team** updated a 30-year-old system that had become obsolete. In 2011, MMS teams in Iraq and Afghanistan returned 92% of items to service in five days on average, exceeding the U.S. Army's readiness standards.

■ **Kevin O'Connor,** vice director of the 76th Maintenance Wing at Tinker AFB, Okla., led a continuous improvement program that increased the volume of aircraft work by 24%, enabling Tinker to return 22 more KC-135, E-3, B-52 and B-1 aircraft to U.S. Air Force service.

■ **U.S. Navy Team Tomodachi,** led by Capt. Mike Kelly, aviation material officer for the Commander Naval Air Forces, was instrumental in sustaining safe relief operations for 257 Navy and Marine Corps aircraft in a radiological environment following the massive earthquake and tsunami that struck Japan in March 2011. The group established consistent protocols for measuring radiation and provided near-real-time information to support teams and logisticians.

SPACE

■ **The Kepler Mission Team** surveyed a 100-square-degree region of the Milky Way galaxy in search of Earth-size and smaller planets

orbiting in or near the habitable or Goldilocks zone of Sun-like stars. In 2011, the team used data collected from Kepler's first 134 days of operation and announced the discovery of 1,235 exoplanet candidates. Of those, 68 are similar in size to Earth.

■ **The Messenger Team** guided the seventh mission in NASA's Discovery program—Messenger—into an orbit around Mercury. The feat was accomplished through effective use of new thermal technologies, solar sailing, intricate mission design and disciplined program management.

■ **The X-37B Team** advanced the development of this all-composite spacecraft, which achieved the first autonomous landing of a U.S. unmanned vehicle following thousands of Earth orbits spanning 224 days. The X-37B uses new leading-edge tiles, insulation materials and electromechanical rather than hydraulic controls, and is set to fundamentally change the way the Air Force conducts low-Earth-orbit missions.

WORKFORCE

■ **Steve Carman,** director of the Program Operations/Space Systems Div. at Northrop Grumman Aerospace Systems, played a key role in the development of program leaders and engineering talent across the corporation and in sharing best practices in risk management with other industry professionals outside Northrop Grumman.

■ **The CyberPatriot Team,** sponsor of the National High School Cyber Defense Competition, used a highly innovative approach to attract young people to aerospace-related disciplines and teach them how to collaborate. The approach involved learning how to defend a computer network against unauthorized intrusions.

■ **Paul Graziani,** founder and CEO of Analytical Graphics Inc., demonstrated leadership in 2011 in introducing young people to the world of science, technology, engineering and math—including software licensing to educational institutions.

■ **The Wounded Warrior Project Team** made a significant contribution toward helping injured service personnel develop new skills to transition to the civilian workforce and pursue opportunities to become cybersecurity professionals.

LIFETIME ACHIEVEMENT

■ **Pete Rustan,** former deputy director for mission support at the U.S. National Reconnaissance Office.

HEROISM

■ **Ice 68,** comprised of members of the active-duty U.S. Air Force 62nd Airlift Wing and the Reserve Associate 446th Airlift Wing, Joint Base Lewis-McChord, Wash., responded to an urgent call from McMurdo Station, Antarctica, to rescue a seriously ill American contractor. The crews performed the time-critical, 9,100-nm mission using night-vision equipment during the middle of the Antarctic winter in high winds and a temperature of -40F, saving the contractor's life. This was the first C-17A mid-winter emergency evacuation from Antarctica.

DEEP SPACE

Hoping to avoid a repeat of Constellation overruns, NASA 'meters' Orion development to fit budget

The Orion crew vehicle, here without ogive that would protect it during ascent, is in ground testing at Lockheed Martin/Denver. Crews of four would spend as long as three weeks in the black capsule.

LOCKHEED MARTIN

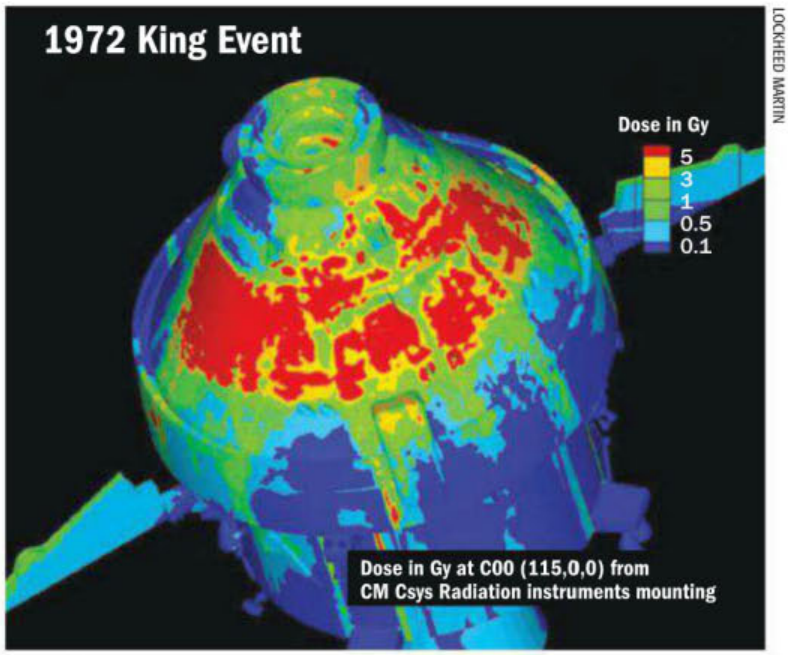
FRANK MORRING, JR./WASHINGTON

Developing the Orion multi-purpose crew vehicle will generate some smoke and fire fairly soon, even as the work is deliberately slowed to avoid the "unsustainable" cost growth that scuttled NASA's plans to use it to send astronauts to an outpost on the Moon.

One of the few surviving elements of NASA's Constellation program of human exploration spacecraft, Orion is now recast as a multi-destination deep-space crew vehicle with an asteroid tentatively tapped as its first target. The U.S. space agency already has spent more than $5 billion on the capsule, and is on track to run its first orbital flight test early in 2014.

If all goes as planned, a Delta IV heavy rocket will send a high-fidelity test article on a two-orbit mission designed to simulate loads the capsule will encounter returning from the Moon or points beyond, and to exercise techniques for recovering it at sea. That first "Exploration Flight Test" (EFT-1) will be followed by an ascent-abort test similar to the Little Joe tests of the Mercury and Apollo capsules.

"We don't have the money every year to do every system," says Mark Geyer, NASA's Orion program manager. "So EFT-1 is a great example. We decided to focus our money on the high-risk things, TPS [thermal protection system], crew module structure, parachutes, entry, navigation and guidance. So that's where we're putting our money in '11 and '12."



LOCKHEED MARTIN

The map shows radiation exposures calculated across the Orion capsule from a baseline solar flare that occurred in 1972.

Left for a later date will be detailed development of the service module that will fly behind the capsule until shortly before reentry, a task that may see the European Space Agency getting involved (see p. 42). Also on hold are the life-support systems for the crew who will spend up to three weeks in the capsule's cramped interior on early missions beyond low Earth orbit.

The nation's economic and political circumstances have left NASA facing at best a flat budget as of now, forcing the agency to "meter" development of Orion and the heavy-lift Space Launch System intended to carry it deeper into space than the space shuttle ever went (*AW&ST* Oct. 24, 2011, p. 40). But with $1.2 billion available in the fiscal year that ends Sept. 30, there is plenty of work going on.

Technicians at the Michoud Assembly Facility in New Orleans are putting the finishing touches on the second test capsule. This spring it will be shipped to the recycled Apollo-era Operations & Checkout Facility at Kennedy Space Center, where prime contractor Lockheed Martin will outfit it with subsystems for flight. Next fall, it will be powered up for the first time.

Meanwhile, the first test article is undergoing ground tests at Lockheed Martin's spacecraft facilities near Denver. It is destined for drop tests into water with a flight-version heat shield at a specialized Langley Research Center facility to gauge how well it handles impacts at different speeds and angles.

Depending on the trials' outcome, that capsule may be refurbished and reused in follow-on flight testing. The same could hold for the EFT-1 capsule as the program seeks ways to stretch funding, depending on the vehicle's condition after it returns to Earth.

"In the big picture, the intent is to reuse as much of the spacecraft as possible; always the goal of design considerations," says Lawrence A. Price, Orion deputy program manager at Lockheed Martin. "But as we learn more about it and run through tests, some tests [could involve] ultimate conditions where we could permanently deform the vehicle."

The program has access to a surplus Peacekeeper ICBM stage to use in its ascent abort test, which will validate the ability of the Orion's solid-fuel Launch Abort System (LAS) tower to pull the capsule off a failing launch vehicle and return it to the ground by parachute. Even though it will take longer to acquire and prepare a Delta IV heavy for the EFT-1 mission, NASA and its Orion prime contractor have decided to fly that one first.

"If we fly the orbital test first, we get more information," Price says. "There are more maturation items that we learn about during that test. And the other thing is that the environments are less rigorous during the orbital test, so it is more likely that the article could survive and be reused from an orbital test."

EFT-1 will carry aloft the flight-version capsule now at Michoud. Between the launch vehicle's upper stage and the capsule's heat shield will be a dummy service module equipped with test fairings. This will be dropped after the first stage is jettisoned to shed the mass needed for structural reasons at liftoff. That part of the flight will validate the shared load path to ensure the fairing design is stiff enough to help support the crew module and LAS during the highest load condition, Price says.

The Delta IV Heavy will put the vehicle into a 100 X 500-nm initial orbit, and on the second orbit its upper stage will raise the apogee to 3,000-5,000 nm, with the perigee dipping back into the atmosphere. The upper stage and service module will separate, and the capsule will plunge into the atmosphere at something like 84% of a lunar-return velocity. The Avcoat ablative heat shield will protect the capsule as it plunges through the upper atmosphere at more than 20,000 mph, using its reaction control system, slightly asymmetrical heat-shield shape and off-center center of gravity to steer as it slows to the point that its parachutes begin opening.

"We can turn the lift vector so we can fly down range or get a little bit of cross range to get to the landing point," says Price, adding that the technique—also used on Apollo and planned for the Mars Science Laboratory next summer—can

get the capsule to "within just a few miles" of the target for parachute deploy.

"Really all of the error in the landing point is due to drifting under the parachutes with the winds," he says.

Validating the chute deployment between 40,000 ft. and 20,000 ft. will be a key goal of EFT-1, and preliminary drop tests from a C-130 are under way at the Army's Yuma Proving Grounds in Arizona. After the parachute cover is separated from the top of the capsule at the end of the orbital test, a series of drogue, pilot and three main chutes will slow the crew from reentry velocity to "something like 20 mph," Price says.

The simulated return from deep space reflects NASA's new emphasis on using Orion to carry crews beyond low Earth orbit, with its original role as the first post-shuttle route to the International Space Station (ISS) shifted to private-sector crew vehicles. While it still will be able to carry out that mission as a backup in case there are problems with the commercial crew approach, the reconstituted program will focus on deep space.

So far, that hasn't required much of a change in the plans originally drafted for the Constellation version of Orion, according to Price, who says vehicle requirements for both missions are "mostly identical."

"A lot of the structure is designed to be able to get out of low Earth orbit and return," he says. "Micrometeoroid debris shielding is a little different, and radiation is a little different, but when the program began we were kitting those differences, so we could have a vehicle that was optimized for each, and if there were some pieces that weren't common, you could carry a kit that would accommodate that requirement."

Even before Constellation was canceled, NASA reduced the Orion crew size to four from six for the station mission to save money on adapting the vehicle for four-person deep-space flights. And Lockheed Martin designed distinctive circular solar arrays from the beginning for deep-space flights that will require the vehicle to function much longer than its look-alike predecessor, the Apollo command module.

"Apollo had fuel cells, and we went to solar arrays because it's easier to manage a solar array," Price says. "You don't need to keep it running all the time, and we wanted to be quiescent for long periods, whether we're sitting at space station, originally, or sitting in low orbit over the Moon or someplace."

The capsule was designed to sustain a crew for 21 days on its own, and to be able to survive for 210 days on orbit in a quiescent state. Those requirements drove the size of the environmental control and life-support system (ECLSS) needed to keep a crew alive, and the techniques for using the interior layout to shield them against radiation. Beyond that, a habitation module or other spacecraft would be required, depending on the mission.

"If we were going to go do missions that were a year long, you wouldn't want to stay in a small capsule anyway," says Price. "You'd want to use it for up and down and have it with you if there was an emergency."

Since a human flight with Orion is not planned until 2021, ECLSS work under prime contractor Hamilton Sundstrand and subcontractor Paragon Space Development Corp. has been slowed. The basic concept uses bottled oxygen and an amine swing bed to remove carbon dioxide and water vapor from the cabin atmosphere.

Current plans call for completing work on the capsule de-

Possible Partner

NASA and the European Space Agency consider sharing Orion costs

FRANK MORRING, JR./WASHINGTON

ESA/NASA

Europe's Automated Transfer Vehicle Johannes Kepler approaches the International Space Station. NASA and ESA may use a derivative of the ATV as the Orion service module.

To work as an exploration vehicle, Orion will need more than a pressurized capsule for crews. As NASA struggles to stay within its human-spaceflight budget, its managers have opened talks that could lead to a European contribution to the vehicle's service module.

NASA and the European Space Agency are studying a possible deal that would bring ESA into a partnership on Orion, using existing facilities and skills to build service-module structure and systems for the U.S. human spacecraft. European industry already has extensive human-spaceflight experience, and the two agencies are figuring out if it makes sense to apply that experience to the utility closet for the propulsion, power and life-support systems that would permit Orion crews to explore beyond low Earth orbit.

Europeans have built more than half of the pressurized modules that make up the International Space Station at the Thales Alenia Space factory in Turin, Italy, that also builds the Automated Transfer Vehicle. The ATV—an unmanned cargo vehicle that can deliver about six metric tons of cargo to the

velopment next year, and then moving on to the other components that will be needed for the early flight tests. That includes the service module, which will carry radiators under the fairings for thermal control; a main engine derived from the 6,000-lb.-thrust space shuttle orbital maneuvering system engine; and tanks for the bipropellant fuel that will power the main engine and the four reaction control systems thrusters.

"[The four engines] are large enough that they could be used as backups to the orbital adjust engine," says Price.

Phasing work on the service module should prove effective because the more complex systems tend to be housed in the capsule itself and thus will be flight-tested first in EFT-1. The service module subsystems are "more straightforward" and can be left for later, Price says. They are also heavier, which helps with the capsule weight.

"What we've done is move as much as possible out of the crew module into the service module to lighten up [the former] as much as possible," says Price. "So the whole vehicle is designed to be as light and efficient as it can and [in] the breakdown between the two, the lighter you can make the crew module, the smaller the parachutes are because they don't have to decelerate as much mass, and the smaller the heat shield can be because it's not decelerating as high as mass. The smaller and lighter those pieces are, the less mass you have to take to Mars and back."

As was the case when Orion won the Constellation competition for a crew exploration vehicle that could take humans to Mars, the latest variant will have a number of interim destinations before striking out for the red planet at some undefined future date. Possibilities range from a repurposed ISS module positioned in a halo orbit around one of the Earth-Moon Lagrange points, to an asteroid, to one of the Martian moons (see p. 44). The exact sequence remains dependent on the funding available for launchers, habitats, landers and other spacecraft that will be used to accomplish the missions.

NASA Program Manager Geyer says the push to hold down development costs goes beyond phasing the work to fit the funding profile, and includes attempts by NASA to mimic private-sector management practices.

"Sometimes [sincere, dedicated] people act as if affordability is for the other guy"

"We're trying to increase our efficiency in oversight," he says. "[We're also] really trying to reduce the reporting products .... There's a lot of stuff that drives costs for taxpayers that derives from financial reporting—values, [work breakdown structure] levels, institutional requirements and how stuff is reported. It can be a very large overhead, so we are working with headquarters on streamlining that and reducing the number of unique formats and reports that are generated that frankly, in my mind, don't necessarily really help us manage the program."

Not surprisingly, the Orion program has met with some resistance to its cost-cutting efforts inside NASA. "It takes time to convince them as to why there's another way to do this, Geyer says. "It's not some evil intent, some evil brat who just wants to slow things up. [Sincere, dedicated] workers believe their piece is critical, and sometimes people act as if affordability is for the other guy."

ISS—has many of the attributes that would go into a service module for the Orion capsule.

"We're looking to see if there's a way that they could do something along the lines of what they've already done with ATV, and could they take those kinds of systems and turn them into a service module that we could potentially use with Orion," says William Gerstenmaier, associate administrator for human exploration and operations. "We're kind of talking about that at a high level. We're probably a couple of years away from actually implementing something along those lines."

Gerstenmaier stresses that the talks are "really preliminary," and conceded that "it's politically a hot topic here, if it appears we're taking work away from U.S. companies." The idea, he says, is to determine if it is feasible to use European participation to free up funds for other development work in the U.S. Ultimately, the service module probably would be produced in the U.S., he adds. "If this doesn't cost too much in terms of either money or integration overhead, then this is a way to advance the Orion capabilities at a faster pace, but it means no less money going to U.S. companies."

Lockheed Martin remains under contract to build the service module, along with the rest of Orion. But at NASA's request the company is helping ESA as it goes through its examination of what it would take to have the service module work done in Europe.

"We all believe that when we do exploration of the Solar System, we're going to do it internationally; it won't just be the United States," says Lawrence Price, Lockheed Martin's deputy Orion program manager. "So the sooner we can get all of the international parties with all of their expertise involved in the program, the better off we'll be."

As currently envisioned, ESA would provide service module elements to NASA under the same sort of barter arrangements that the ISS partners use among themselves. NASA in turn would pass them on to Lockheed Martin as government-furnished equipment to integrate with the Orion capsule.

"There's a good reason to do it, and we're trying to help them assess what the best approach is," says Price.

At present, the two programs are studying whether ESA can use its ATV heritage to build service-module gear that will work with the U.S. vehicle in "the most weight-efficient way," Price says, noting that his company is providing tradeoff data to support that decision. There will be a systems-requirement review for the concept at the end of January, and a mid-point assessment of the concept in February. If that is positive, ESA will work out a detailed plan to present for approval at its ministerial conference in October, Price says.

"The United States would like to have a total capability of their Earth-to-orbit and return, so they wouldn't be dependent on economies and budgets and political determinations," he says. "And the Europeans have a certain amount of funding that they could apply to it, which is associated with the space station arrangement."

In the concept's broad terms, ESA would provide two service modules to NASA for integration into early Orion capsules. That could cover the first two flight tests of full-up Orion vehicles, now scheduled in 2017 and 2021. "Beyond that it's like our own budgetary process; no one knows what the budget numbers will be," Price says.

Proximity Ops

A flash-lidar sensor tested at the space station may guide Orion to noncooperative targets

FRANK MORRING, JR./WASHINGTON

Astronauts on the space shuttle Endeavour's final flight tested an optical navigation device that may help the Orion capsule make its first approach to a target in space, whether it is the International Space Station (ISS), an asteroid or another celestial body.

In the Sensor Test for Orion Relative Navigation Risk Mitigation (Storrm) maneuver last May 30, STS-134 Commander Mark Kelly flew back toward the ISS after undocking, following an approach like the one that Orion would use if it ever needs to dock with the station. Tucked into the payload bay was an advanced flash lidar that illuminated the looming station 30 times a second with an eye-safe burst of laser light. The lidar was part of a Vision Navigation Sensor (VNS) that resolved features on the station at ranges of 5.7 km (3.5 mi.) down to 7 meters (23 ft.) from the reflected laser light, and provide data that can be used to guide Orion or another spacecraft toward a target.

"It basically provides you a 3-D image of the target, so you'll see, for example, the particulars on the actual docking mechanism itself on station," says Howard Hu, manager of Orion system performance and analysis at Johnson Space Center. "It's not like a picture, but it gives you a 3-D image, and it's fantastic in how it can replicate, because it gives you that surface differentiation."

Storrm was conceived and developed under the old Constellation program, when Orion's first flights were to be to the space station. With the crew-transport role for the ISS shifted to commercial vehicles, and Orion's managers aiming at targets beyond low Earth orbit, the flash-lidar approach remains relevant because the target does not need to be rigged with special reflectors or be cooperative in other ways for the system to work.

Instead, the VNS generates a sort of 3-D image of a target for its algorithms to digest, based on the varying strengths of the reflections returning from different points on it. That means it can work with pretty much anything, whether manmade or natural.

"We're looking at hazard avoidance for lunar landing," says Hu. "If you want to avoid a particular bad spot as you get closer on the surface of the Moon, the lander can flash that lidar, and it gives you an image, and it can discern big boulders, big craters, things like that, and that allows you to steer yourself kind of like a target vehicle, to the surface and land safely."

For Orion itself, that could mean an asteroid. President Barack Obama has set a goal of reaching an unspecified near-Earth asteroid with Orion by 2025, and ongoing work with the Storrm package at Lockheed Martin's Space Operations Simulation Center is aimed in part at that potential mission. There the sensor is "flown" on a robotic platform toward mockups of a planetary surface, with craters and boulders, as well as toward an ISS docking port (see photo).

Hu's team continues to analyze the 500 gigabytes of data generated by the Storrm test, which also "shadowed" Endeavour's navigation system as it flew a standard shuttle approach to the ISS at the beginning of its mission. That work will not be finished until the summer, more than a year after the data were generated, because of the need to pace Orion development in line with tight budgets.

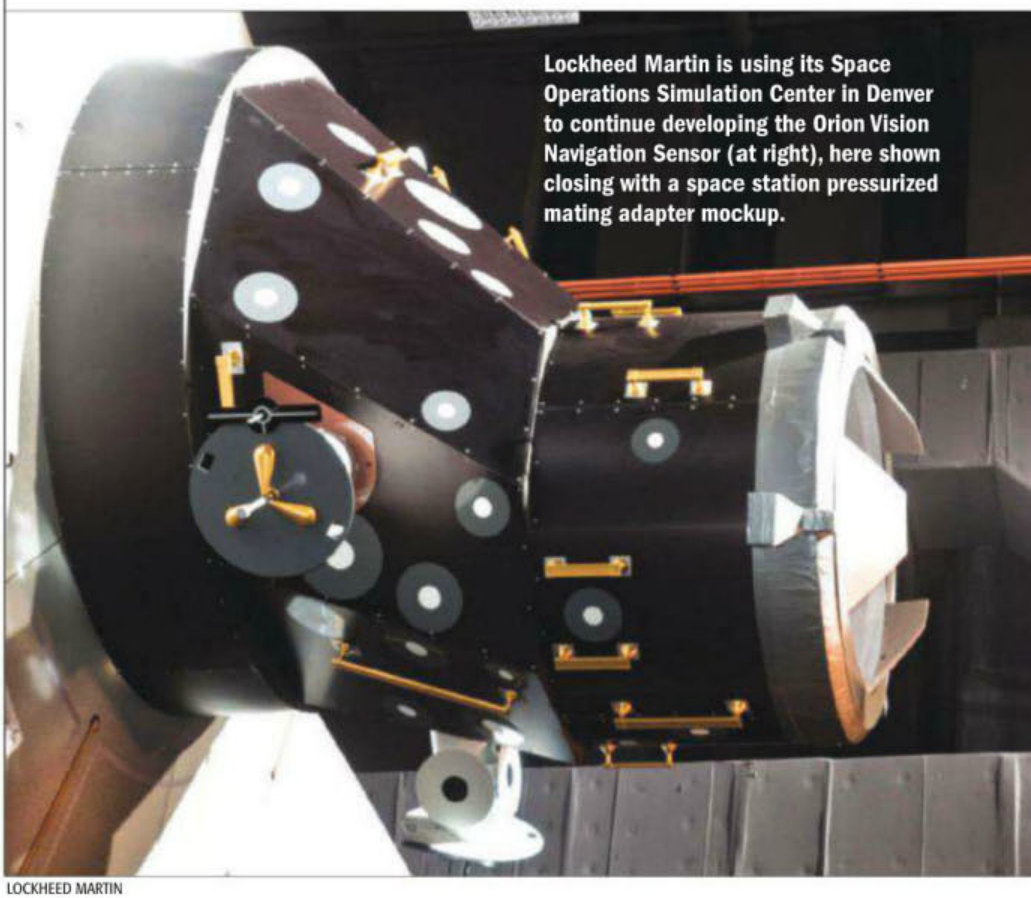
"It'll be phased to when we need to be rendezvous-and-docking with something," says Mark Geyer, NASA's Orion program manager. "The great thing about that lidar system and why we picked it so many years ago [is that] it can also be used for landing, for determining landing clearances and stuff."

In an operational system, the software that Johnson Space Center is running on the ground will be included in the sensor package in space, generating navigation solutions on board an Orion or any other spacecraft using it.

"We're fleshing it out," says Geyer. "It actually feeds forward to many exploration plans. It could be used on a lander; it could be used on other things, too."

While the lander application is in the future, NASA is already developing a common docking mechanism for Orion and any commercial vehicles that need it, working with the international docking standard published by the ISS partnership in 2010.

The new system would combine el-



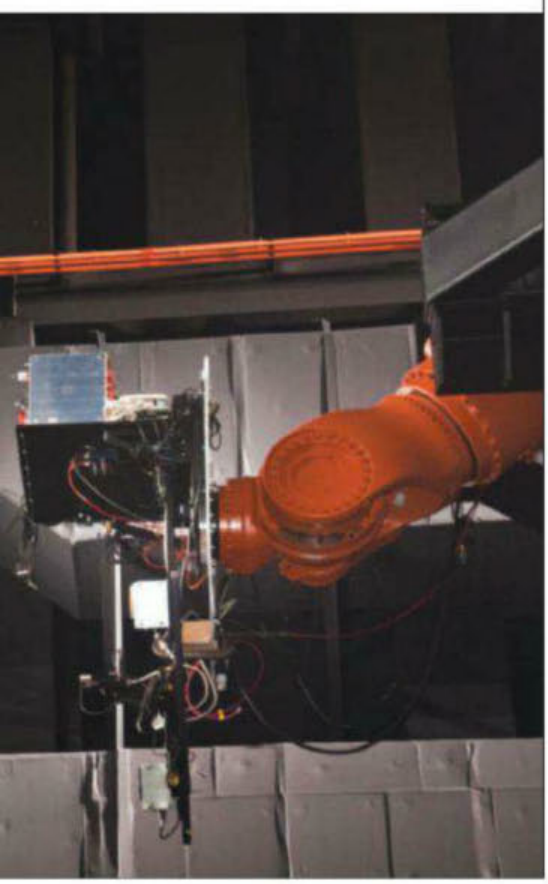
Lockheed Martin is using its Space Operations Simulation Center in Denver to continue developing the Orion Vision Navigation Sensor (at right), here shown closing with a space station pressurized mating adapter mockup.

LOCKHEED MARTIN

ements of NASA's electromechanical Low Impact Docking System (LIDS) and Russia's Androgynous Peripheral Attach System (APAS), with standard diameters and docking functions. The idea is to have a standard docking interface, including the "capture envelope" that governs rate of approach and the force needed to make a connection.

"We're building to the standard that we put out, and we're seeing if we missed anything in the standard," says William Gerstenmaier, associate administrator for human exploration and operations. "It's not a set of build-to requirements. It's not a specification in the typical way we specify hardware. It's like a USB interface. It says, 'here's where the pins are; here's what kind of signals can go across those pins,' but we don't specify much more than that."

Plans call for a flight test of the system before the commercial crew vehicles begin flying to the ISS in 2017. The system could also be used on Orion, which retains its role as a backup station crew transport in case the commercial companies do not deliver. Gerstenmaier says NASA could either provide docking mechanisms like the one on Orion as government-furnished equipment to private companies that need them, or let the companies build their own to the international standards.



Stepping-Stones

Designed for ISS and the Moon, Orion's new targets remain open

FRANK MORRING, JR./WASHINGTON

Applications close at the end of the month for a new group of astronauts to fly the Orion capsule beyond the space station to the Moon, Mars and points in between.

So far more than 1,300 would-be space travelers have applied for the job, hoping that Orion will become the ultimate enabling technology for deep-space human exploration. The figure is comparable to the response NASA received from its calls for space shuttle crews.

Like everyone who has flown in space, the Orion applicants are risk-takers, willing to gamble their lives for a plunge into the unknown. And at this point, the unknown includes specific target destinations for the craft that NASA engineers call the "multi-purpose crew vehicle, or MPCV." While President Barack Obama has set a goal of sending humans to an asteroid by 2025, that is only one possible destination for Orion.

> **"We're looking at a capability that can support multiple destinations"**

John Shannon, the last space shuttle program manager at NASA, has been on special assignment reviewing architectures for future human exploration for the past few months, and has started internal briefings on the options. Under the present state of play in U.S. space policy, Orion is almost certain to be the crew-transport element in any of them.

"If you step back and think of what we're doing, we're looking at a capability—both SLS [the heavy-lift Space Launch System] and MPCV/Orion—that can support multiple destinations," says William Gerstenmaier, associate administrator for human exploration and operations. "So instead of optimizing or building a vehicle that just supports one particular mission, we're trying to look at a vehicle that has enough flexibility without carrying a huge penalty for that flexibility, that can support multiple missions and multiple destinations."

Inside NASA, Gerstenmaier and other top managers are giving serious consideration to pulling modules from the International Space Station (ISS) when it is retired after 2020 and moving them to one of the Earth-Moon Lagrange points or to lunar orbit as an early destination for Orion. The idea has some international support as the ISS partnership begins to consider post-station human spaceflight (*AW&ST* Oct. 10, 2011, p. 46).

The first Orion flight on an SLS—tentatively set for 2017—probably will go around the Moon, and the first flight with a crew—in 2021 under current plans—may follow suit. It is also possible that the capsule will dock with the ISS, as a backup crew-transport vehicle to the private spacecraft under development.

Lockheed Martin, selected as the prime contractor on Orion in 2006, has been working on possible human missions with the capsule since 2007 and is looking for things to do with it on top of the original "back-to-the-Moon" plan.

"We basically were looking for other useful, productive ways to use Orion to explore that wouldn't cost a lot," says Josh Hopkins, Lockheed Martin's space exploration architect, who helped draft a "stepping-stones" concept growing out of that work.

Among productive human missions that could be enabled by Orion is a 35-day trip to the Moon's far side, where the capsule would go into a halo orbit around the L2 Lagrange point. Aside from giving crews longer-duration experience beyond low Earth orbit, a far-side flight could perform useful science by serving as a platform for deploying a low-frequency radio telescope on the surface, or for operating rovers to retrieve samples from the ancient Aitken Basin. The latter would guide development of similar techniques for exploration at Mars, while the former would take advantage of the radio silence on the other side of the Moon to peer into the "cosmic dark ages" after the Big Bang.

"If you could put a low-frequency radio telescope on the far side of the Moon, you'd be able to observe the structure of

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One possible target for the Orion crew capsule (here with a hab module attached) is a halo orbit at the Earth-Moon L2 Lagrange point, where the crew could operate robots in the Aitken Basin and unfurl a huge radio telescope on the surface.

the hydrogen gas in the universe before the stars lit up, so you could understand how it was that this relatively uniform Big Bang ended up resulting in this non-uniform distribution of clumps of matter in galaxies and stars," Hopkins says. "So it's a pretty interesting question for cosmologists, that as far as they can tell can only be answered by building a radio telescope on the far side."

As crews accumulate time at L2, NASA could begin interspersing longer missions to asteroids. Lockheed Martin has identified a 195-day mission to the asteroid 2008 EA9, about 12 million km (7.5 million mi.) from Earth, and a 450-day mission to 2000 SG334, at a distance of 8 million km. NASA could also conduct experiments with artificial gravity for eventual flights deeper into space, spinning an Orion tethered to a counterweight to keep the crew healthy.

For those longer-duration missions, NASA would "definitely" need a habitat module that the crew could reach through the docking port at the top of Orion. Shorter missions, like those to the Moon, could be accommodated in the capsule's 21-day baseline by shrinking the crew size to three or even two from four.

While Mars is considered the ultimate goal, Hopkins says an intermediate mission to Deimos could be another important step along the way.

Measuring only 15 X 12.2 X 10.4 km, and more distant from the planet than the larger moon Phobos, Deimos is easier to reach from Earth and has a couple of spots at the equivalent of its north and south arctic circles that receive 10 months of continuous sunlight for solar power.

"[Deimos] has very little gravity; it has some, but I think something like 5 meters/sec. is the escape velocity, so you could land a spacecraft and take off again using the equivalent of RCS [reaction control system] thrusters," says Hopkins. "So we've debated, do we call it a lander, or is it just a habitat that happens to be able to land? You do have to have footpads and anchors, and you have to have thrusters in the right place, and you have to design it to interact with the dust on the surface, but it's not a lander in the sense that we normally think of."

In a notional 900-day mission, a crew would land at the southern site for four months, then go into orbit for 50 days, and then land at the northern site for a 10-month stay before returning to Earth. While at the tiny moon, they could operate rovers on the planet's surface, perhaps to collect samples. Hopkins and his colleague William Pratt calculate that a good time for the mission would be 2033-35, which coincides with a planetary alignment that offers the most protection from galactic cosmic rays.

"We don't look at these first missions as going to a Lagrange point to get your passport stamped," Hopkins says. "There are some really interesting fundamental science questions about the formation of the Solar System or the universe that you can accomplish."

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Feb. 22-23—MIU Events/Exhibitions India Group's Indian Business Aviation Expo 2012. Manekshaw Center. New Delhi. Call +44 (124) 351-3606 or see www.miuevents.com/ibae2012
Feb. 23-24—Fifth Society of Experimental Test Pilots' Annual Southeast Symposium. Ramada Plaza Beach Resort, Fort Walton Beach, Fla. See www.setp.org/table/southeast
Feb. 27-29—Defense Maintenance Sustainment Summit. Hilton Torrey Pines, La Jolla, Calif. See www.wbresearch.com/dms/
March 5—Speednews' Second Annual Aerospace Raw Materials & Manufacturers Supply Chain Conference. Also, **March 5-7**—26th Annual Commercial Aviation Industry Suppliers Conference. Both at Beverly (Hills) Wilshire Hotel, Calif. See www.speednews.com/conferences
March 9-11—Valiant Air Command's 2012 Tico Warbird Air Show. Titusville, Fla., Space Coast Regional Airport. See www.vacwarbirds.org
March 19-21—International Academy of Astronautics/American Astronautical Society's Conference on Dynamics & Control of Space Systems. Hotel Ipanema, Porto, Portugal. See www.astrodynamics.org.pt/
March 19-22—Practical Aeronautics Short Course: "Introduction to Aeronautics—A Practical Perspective." National Institute of Aerospace, Hampton, Va. Call (970) 887-3155 or see www.practicalaero.com
March 21-22—Avionics Europe 2012 Conference & Exhibition. MOC Event Center. Munich. Call +44 (199) 265-6619 or see www.avionics-event.com
March 27-29—Asian Business Aviation Conference and Exhibition. Shanghai Hawker Pacific Business Aviation Service Center. See www.abace.aero/2012

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Feb. 14-16— Defense Technology and Affordability Requirements. Arlington, Va.
March 7—55th Annual Laureate Awards. Washington.
March 13-14—Innovation Supply Chain Showcase. Orlando, Fla.
April 3-5—MRO Americas 2012. Dallas.
April 3-5—MRO Military Conference & Exhibition. Dallas.
April 3-6—Aircraft Electronics Association's 55th Annual International Convention & Trade Show. National Harbor, Md.
April 23-25—NextGen Ahead: Air Transportation Modernization. Washington.
May 8-9—Civil Aviation Manufacturing. Charlotte, N.C.
May 23-24—MRO Regional—Eastern Europe, Baltics and Russia. Vilnius, Lithuania.
Sept. 19-21—MRO IT Conference & Showcase. Miami.
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June 11-15—Eurosatory. Paris.
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Oct. 9-14—Japan Aerospace. Nagoya.
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Budget Process A Major Liability

If the U.S. defense budgeting process could be any more disconnected from reality, it's hard to imagine how—which is precisely what comes to mind as we reflect on efforts by the Obama administration and Congress to reconcile the national security strategy the U.S. needs in a world of rapidly evolving threats with the spending it can afford.

A dispassionate observer might posit that it all comes down to dollars and cents, and resisting the temptation to try to acquire more than is absolutely essential. If only defense planning were that simple. But it is not, which brings us back to the process of how the country budgets for national security.

Imagine a federal law requiring a family to publicly detail its spending plans for the next five years—everything from health care and fuel costs to goods and services—while meeting whatever other mandates were legally required. To start, the family would make educated guesses about future expenses, factoring in such variables as inflation. It also would need to accurately assess what it already owns and how much it costs to maintain those items, as well as the prices of what must be purchased in the future. As part of this budgeting process, each family member would have a say in shaping the final plan.

Now consider that the employer of the family's wage-earners gets the last word on not just the family's income but on its spending plans. There might be unspent money left over from previous years, but under this system the employer gets to take that back. Moreover, each salary is determined by a committee of committees, whose membership is constantly changing and has no particular expertise in the family's needs.

Not surprisingly, this family never gets as much funding as it thinks it needs, but family members do get a lot of stringent advice on how to spend it. Even though Dad thinks his son can walk to school, the experts direct that the family buy him a car. Oh, one other thing: The family can expect to endure this process every year, effectively rendering each five-year plan all but meaningless.

Obviously, the family is the Defense Department and the committees of experts comprise Congress. But the Defense Department and the aerospace industry are not blameless. Together they are often responsible for gold-plated procurement programs that deliver weapons systems years late and way over budget. The Pentagon cannot resist writing requirements and then changing them in midstream, and effective program management continues to elude much of industry, inviting the attention of those who would target modernization programs that otherwise are in the nation's long-term interests. And as all this happens, the world of threats and adversaries can change dramatically. It is as if the family buying that car budgets for a Fiat, orders a BMW and then has to wait for 10 years for it to be delivered,

Welcome to modern national defense budgeting and weapons procurement.

Much has been written about the bureaucratic mess that Washington has brought on itself, and most of it has focused on the personalities who have the most control over the purse strings. Noticeably absent has been substantive debate on how to fix the process. There is no shortage of ideas—even good ones. Most shameful is the paucity of willpower and courage to make the changes that are so desperately needed.

If we have learned anything from all the discussions about the national debt, the failed "super committee," the repeated brinksmanship over government shutdowns, the rampant use of continuing resolutions to fund federal operations, and the general breakdown of responsible governing at the federal level, it is this: People will come and go; it is the budget process that needs fixing.

> "Most shameful is the paucity of willpower and courage to make the changes that are so desperately needed"

It won't be easy, of course, in part because the U.S. Constitution gives Congress and its current 535 elected members the final authority in federal appropriations. Nonetheless, there are achievable changes worth making—all the more worth doing in light of the fact that Congress, only twice since 1980, has completed the annual appropriations process before the start of each fiscal year.

One such potential change has been proposed by Sens. Jeanne Shaheen (D-N.H.) and Johnny Isakson (R-Ga.). Their idea: biennial budgeting, with one year devoted to passing spending bills and the next year devoted to scrutinizing federal programs. Another proposal addresses the inherent mismatch between the military's legal responsibility to staff, train and equip forces, and Pentagon civilians' authority to decide budgets and set programs.

The detriment of clinging to the status quo no longer can be ignored. With Americans openly debating entitlement programs and the role of the federal government, the time has come to make fundamental changes in the defense budgeting system. If the legislative and executive branches of the U.S. government continue to sidestep the urgent need to change how defense spending is budgeted, they will do so at the country's peril.

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