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December 12, 2011 CONTENTS Volume 173 Number 44

AVIATION WEEK
& SPACE TECHNOLOGY

## DEPARTMENTS



## UP FRONT



## THE WORLD



## UNMANNED AIRCRAFT






## DEFENSE



## AEROSPACE BUSINESS



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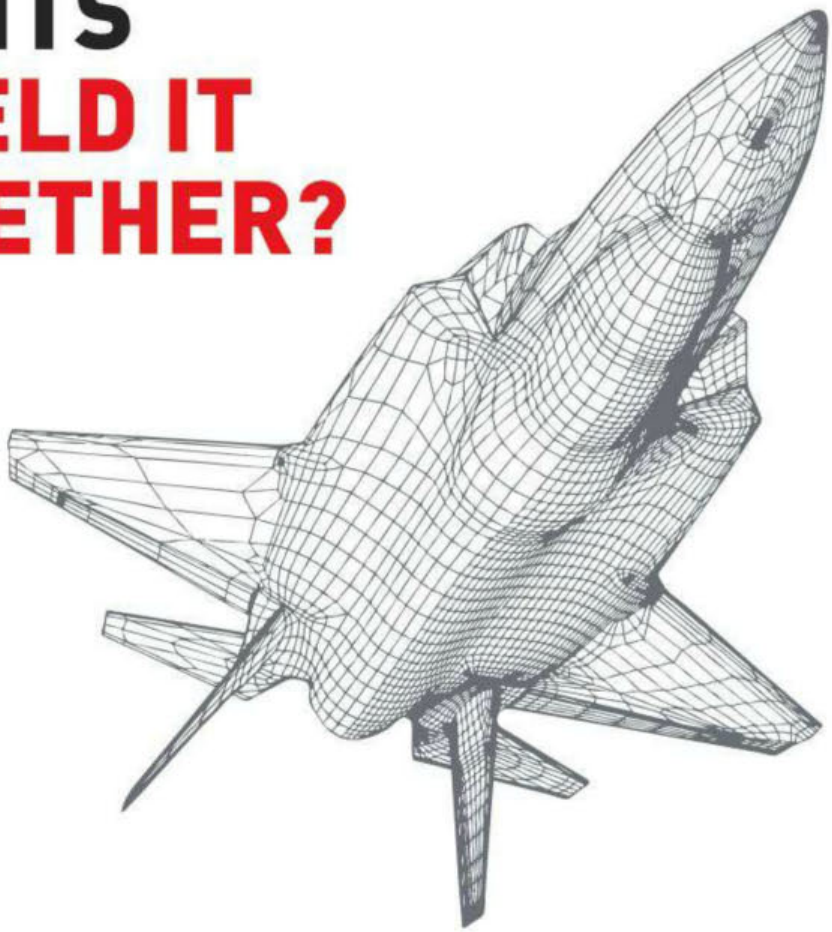

The F-35 brings together a staggering array of innovations and collaborators. We're proud to be among them. From the very start our structural bonding technologies enabled new design efficiencies. Since first flight, we've been in lockstep with our partners, bringing on board lessons learned. Now the ultimate test, production. An engineering marvel is ready for the hard realities of economic manufacture, each strike fighter held together by more than 50,000 Click Bond components. Our fastener products save over 5,000 manufacturing hours per aircraft while enhancing durability and airframe longevity, reducing life cycle cost. Congratulations on first delivery. Onward and upward.

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## BEHIND THE SCENES

*Singapore Bureau Chief Leithen Francis interviews Malaysian Defense Minister Ahmad Zahid Hamidi at the LIMA Airshow in Langkawi, Malaysia, last week. Ahmad discussed what the government is expecting from foreign defense companies in terms of offsets in return for Malaysia buying new fighters, airborne early warning aircraft and antisubmarine-warfare helicopters (see p. 23). That Malaysia is embarking on major defense procurements attracted more exhibitors than the previous show. Air chiefs from around the world attended, particularly those from the Asia-Pacific region and Middle East.*

# AviationWeek.com

*For the complete current issue, archives and more, go to:* **AviationWeek.com/awst** *Free to subscribers.*


### INSIDE THE F-35B

**After reading** our status check on the Joint Strike Fighter (p. 36), view an interactive presentation of components in the JSF's Stovl variant. See descriptions of the key systems in the vertical lift system and how they have been changed over time to address technical challenges. **AviationWeek.com/Check6**

### SNEAK PEEK

**Tired of waiting** for the mail? Subscribers to the Aviation Week Intelligence Network can view complete editions of *Aviation Week & Space Technology* up to three days before each publication date. Log in at **AviationWeek.com/awin** and click on the magazine link in the left column.

### SWISS FIGHTER REACTIONS

**Details continue to unfold** after Saab's big win with the Gripen NG in Switzerland's fighter competition. International Editor Robert Wall went to our **Ares** blog with confirmation of the fighter's engine and radar and detailed a push for a public referendum aimed at killing the order. See his posts at **http://tinyurl.com/85gzu7s** and **http://tinyurl.com/6w6fhnd**

### MISSING UAV

**The crash of a stealthy U.S. RQ-170** unmanned aircraft in Iran (p. 18) is revealing clues about U.S. intelligence monitoring there. See Senior Military Editor David A. Fulghum's initial assessment of the crash and Iran's claim it was a shootdown at:

CHINESE INTERNET

**http://tinyurl.com/6o6mjx3**, then scroll our **Ares** blog to read updates of the unfolding drama. **AviationWeek.com/ares**

### BABBITT'S MISTAKES

**Former FAA Administrator** Randy Babbitt's sudden departure from the agency was filled with drama—including his failure to tell his bosses in the Obama administration that he had been arrested on a charge of drunken driving before the news media broke the story. Read Transport Editor Andrew Compart's account in our **Things With Wings** blog. **http://tinyurl.com/83rblcu**

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## FEATURED SPEAKERS

**Steven Douglas, Manager Aircraft Maintenance Division, FAA**

**Tiymor Kalimat, Manager Aircraft Leasing, Royal Jordanian Airlines**

**Lida Mantzavinou, Consulting Analyst, Commercial Aviation, Frost & Sullivan**

**Harry Seeger, Director Lessors & Banks, Lufthansa Technik**

**Abdul Wahab Teffaha, Secretary General, AACO**

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## FROM THE WEB

Comments from readers on AviationWeek.com

U.S. AIR FORCE

***The article "Are There Alternatives to the F-35 Program?" engendered some heated give-and-take:***

*richardb writes:*

The costly, poorly managed F-35 is the canary in the coal mine. If it is canceled, it's because Obama allowed mindless cuts to core defense programs. Defense spending, as high as it is, isn't the reason the U.S. lost its AAA+ rating. Obama knows this sequestration will emasculate the armed forces, yet he threatens a veto if Congress tries to reverse course.

*gerardo009 responds:*

The F-35 management is catastrophic .... [and all military entities involved] promise things not in the realm of reality.

*Hardcore notes:*

Obama-bashing neither explains nor accomplishes anything. He is the president, not dictator. If the Congress and Senate fail hugely, you can't expect him alone to carry that burden.

*ELP suggests:*

The F-35 won't be survivable against high-end threats—that is the job of the F-22. And, the F-35 will be too expensive to procure and operate for second-tier strike-fighter work performed better by existing platforms like the Super Hornet and Strike Eagle.

***"Airbus Expects United To Place A380 Order" generated a lively exchange, including:***

*123xyz opining:*

Airbus desperately needs more A380 sales and must do everything possible to break even on the program. Surely package deals [will be made], even if it means jam-fitting it into an airline's fleet.

*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.*

### AIA CLARIFICATION

Your editorial "Debate Defense Spending Honestly" (*AW&ST* Nov. 14, p. 66) makes some critical points—defense spending is not unaffordable or high by historical standards, and those who call for more cuts must explain which missions and capabilities should be sacrificed on the budget altar.

But contrary to your suggestion, the Aerospace Industries Association (AIA) is not arguing to fund defense as a "jobs program." The need for a capable defense-industrial base to support our nation's military—which requires appropriate investment in research and modernization—is sufficient justification.

However, with the U.S. in the midst of a deepening jobs crisis, the stubborn fact remains that these cuts will cost a million citizens their jobs, and many of these workers possess unique skills whose loss would devastate our strategic industrial base. With each new assembly line, machine shop or research lab that closes, we lose design, engineering and manufacturing capabilities critical to our long-term national and economic security. If we turn these skilled Americans out of work, we will voluntarily destroy a national strategic asset that took decades to create and will take as long to rebuild.

The "Super Committee's" failure to come up with recommendations to reduce our deficit is especially worrisome. It is well-known that cuts to the defense budget will squarely hit procurement and R&D first. With uncertainty surrounding how sequestration will take effect, companies are already planning for drastically reduced budgets.

While political wrangling in Washington shows no sign of subsiding, continued layoffs and frozen R&D investments will start to reshape the industry. We need to rein in the budget, but not at the cost of weakening our long-term national security and economic strength.

*Marion C. Blakey, President/CEO*
*Aerospace Industries Association*
ARLINGTON, VA.

### NOTHING NEW UNDER THE SUN

"Electronic Attack" (*AW&ST* Nov. 21, p. 29) discusses the use of high-power microwaves to disable the enemy. I must remind you that directed-energy weapons are not a new concept. Though disputed by some historians, many agree that the concept was used in combat as far back as 212 B.C., when a Greek general, Hippocrates, used mirrors to intensify and direct the Sun's rays, as proposed by Archimedes. During the siege of Syracuse, the general ordered that the rays be focused on the sails of the Roman fleet, which resulted in a conflagration.

*James Petty*
SALT LAKE CITY, UTAH

### GRAVITATING TOWARD FIELDS

In regard to "Workforce Woes" (*AW&ST* Nov. 14, p. 51), why is it necessary to boost the number of females in A&D? Of course, anyone interested in a specific career must have as equal an opportunity as his/her contemporaries.

But, if it is true that females have a stronger nurturing quality than men, it explains why teaching and medical fields attract a high number of females.

Trying to fill quotas will lead to restless employees. Time and money would be better spent generating interest in math and science overall, and then letting students choose the path of most fulfillment.

*Roy Steele*
GEORGETOWN, TEXAS


### TOP AND BOTTOM REVIEW

There appears to be a discrepancy between a recent cover and its caption (*AW&ST* Nov. 28, p. 4). The aircraft identifications are inverted. The T-38 is on top; the RAF Hawk Mk 128 below.

*Ed Rainey*
HILTON HEAD, S.C.

*The reader is correct—Ed.*

# WHO'S WHERE

James B. Ream

John Jarrell

Rick Saggar

Chris Murvine

Randy Bolinger

Roy Ng

Raymond J. Juzaitis

*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.*

**James B. Ream** (see photo) has been named senior VP-operations at *American Airlines* in addition to his current role as VP-maintenance and engineering. He was president and CEO of Express Jet Airlines and before that chief operating officer of Continental Express Airlines. **Denise Lynn** will move to VP-employee relations from VP-flight services, and **Maya Leibman** has been promoted to senior VP and chief information officer from president of the AAdvantage program. **Beverly Goulet** has been appointed chief restructuring officer in addition to continuing her role as VP-corporate development and treasurer.

**Christoph Meyerrose** will become the new managing director of *Lufthansa Bombardier Aviation Services* at Schoenefeld Airport in Berlin. He succeeds **Andreas Kaden**, who will head Lufthansa Technical Training in Hamburg, where Meyerrose had been managing director.

**Bernard (Barry) McCullough** has been appointed VP-business strategy for Washington-based *Lockheed Martin's* Mission Systems & Sensors. He joins the company after a 36-year career in the U.S. Navy, from which he retired as a vice admiral.

**John Jarrell** (see photo) will head up Madrid-based *Amadeus's* airport information technology business. He was a general manager at EMS Technologies.

**Shri P.V. Deshmukh** has become officiating chairman of *Hindustan Aeronautics Ltd.*, Bangalore, India, in addition to his current post of managing director of its MiG complex.

**John Farenish** has joined Washington law firm *Venable's* government contracts practice. He was general counsel of the U.S. Defense Department's Defense Contract Audit Agency.

**Rick Saggar** (see photo) has been appointed country manager for the U.K. and Ireland at *Gulf Air*. He was director of the airline business group at Hahn Air.

**Nick Godwin** has been named managing director of London-based *Commsoft*. He was business development director and will retain that post's responsibilities. Commsoft founding co-director **Gary Pollack** will become chairman. Director **James Stock** will be technical director and director **David Puse** project director for the Oases product. **Julian Beames** will become business operations manager. He was a regional manager.

**Chris Murvine** (see photo) has joined *Phoenix Heliparts*, Mesa, Ariz., as lead inspector and director of training. He was senior maintenance instructor for MD Helicopters.

**Caglar Ozturk** has joined the cargo operations team at *Air Charter Service,* Dubai, United Arab Emirates. He comes from Turkish air cargo carrier MNG.

**Rick Crider** has been named airport general manager at *Kelly Field* in San Antonio. He was VP-airport development and management services at RW Armstrong, Austin, Texas.

**Randy Bolinger** (see photos) has been named director of marketing services at Savannah, Ga.-based *Gulfstream Aerospace*. He was president and creative director at AMPT Associates.

**Roy Ng** has been appointed a regional manager-international sales. He was director of business development at Metrojet Ltd. in Hong Kong.

**Bill Ashworth** has become president of *Aviation Partners Boeing* in Seattle. He was president of Goodrich Aviation Technical Services and had been manager of the FAA's Seattle Aircraft Certification Office.

**Raymond Veatch** has been appointed assistant general counsel at *Tampa (Fla.) International Airport*.

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

**Steven Schell** has joined Houston-based *Landmark Aviation* as general manager of its Norfolk (Va.) International Airport location. He was general manager for Atlantic Aviation's Burbank, Calif., facility, and also held roles at Raytheon Aircraft Services, United Beechcraft and Hangar One.

**Jessica Kuney** has been named shows and expositions coordinator for *Helicopter Association International*, Alexandria, Va. She has a background in planning meetings for associations and small businesses, including the Georgetown University Law Center.

## HONORS AND ELECTIONS

**Douglas Kennett** has been selected to receive the 2011 Lauren D. Lyman Award for achievement in aerospace communications, given by the *Aerospace Industries Association*, Arlington, Va. He was a USAF public affairs officer for nearly 30 years and was spokesman for U.S. forces in the U.K., director of media relations for the U.S Air Force and director of Defense Information at the Pentagon.

**Raymond J. Juzaitis** (see photo) has been appointed president of the board of managers of the Las Vegas-based *National Security Technologies Board of Managers*, succeeding **Stephen M. Younger**, who retires in January. Juzaitis heads the department of nuclear engineering at Texas A&M University.

**Tay Tiang Guan**, deputy director-general of the Civil Aviation Authority of Singapore, has been elected to a three-year term on the board of governors of the *Flight Safety Foundation*.

BY JOSEPH C. ANSELMO

*Follow Senior Business Editor Joseph C. Anselmo on Twitter at:*
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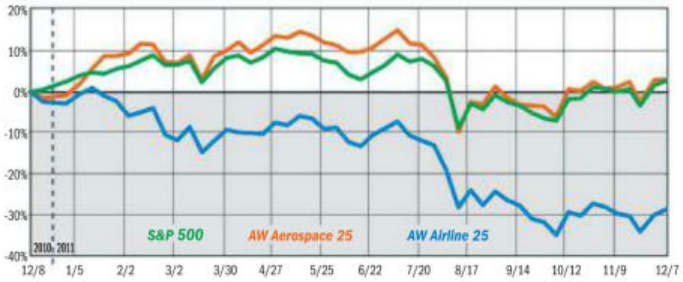
## AW&ST/S&P Market Indices

(as of 12/7/2011) PERCENT CHANGE

| MARKETS | INDEX VALUE | WEEK AGO | YEAR-TO-DATE | YEAR AGO |
|---|---|---|---|---|
| AW Aerospace 25 | 1324.7 | 0.2% ▲ | 3.6% ▲ | 3.0% ▲ |
| AW Airline 25 | 789.9 | 2.0% ▲ | -26.7% ▼ | -28.1% ▼ |
| S&P 500 | 1261.0 | 1.1% ▲ | 0.3% ▲ | 2.7% ▲ |




## Weekly Market Performance

*Closing Prices as of Dec. 7, 2011*

| Company Name | Current Week | Previous Week | Fwd. P/E | Tot. Ret. % 3 Yr. | Tot. Ret. % 1 Yr. |
|---|---|---|---|---|---|
| **AEROSPACE & DEFENSE** | | | | | |
| AeroVironment Inc. | 31.53 | 30.51 | 21.9 | -4.7 | 17.1 ▲ |
| Allegheny Technologies Inc. | 49.56 | 50.22 | 15.3 | 116.7 | -4.2 ▼ |
| Alliant Techsystems Inc. | 57.81 | 58.84 | 6.9 | -30.1 | -24.6 ▼ |
| BAE Systems plc | 4.39 | 4.31 | 6.8 | -9.5 | -8.6 ▼ |
| Boeing Co. | 70.60 | 68.69 | 15.3 | 79.7 | 11.0 ▲ |
| Bombardier Inc. 'B' | 3.69 | 3.72 | 7.8 | -4.8 | -17.1 ▼ |
| Cobham plc | 2.76 | 2.78 | 8.5 | 2.8 | -7.8 ▼ |
| Curtiss-Wright Corp. | 33.53 | 32.95 | 11.8 | 1.7 | 3.7 ▲ |
| DigitalGlobe Inc. | 16.08 | 14.90 | 25.4 | .... | -48.1 ▼ |
| EADS NV | 29.22 | 29.87 | 14.5 | 87.4 | 19.2 ▲ |
| Eaton Corp. | 45.59 | 44.91 | 10.4 | 118.2 | -5.9 ▼ |
| Elbit Systems Ltd. | 41.89 | 41.24 | 7.9 | 2.7 | -7.7 ▼ |
| Embraer-Empresa Brasil ADR | 25.20 | 25.52 | .... | 69.2 | -11.5 ▼ |
| Esterline Technologies Corp. | 53.15 | 53.87 | 10.2 | 43.8 | -18.0 ▼ |
| Exelis, Inc | 9.01 | 8.94 | 5.1 | .... | .... |
| Finmeccanica SpA. | 4.46 | 4.32 | -11.1 | -61.2 | -58.9 ▼ |
| FLIR Systems Inc. | 26.21 | 26.86 | 15.9 | -7.9 | -5.0 ▼ |
| General Dynamics Corp. | 65.66 | 66.06 | 8.8 | 31.0 | -1.5 ▼ |
| General Electric Co. | 16.74 | 15.91 | 11.5 | 0.1 | 1.5 ▲ |
| GKN plc | 2.98 | 3.06 | 8.2 | 290.3 | -5.1 ▼ |
| Harris Corp. | 35.91 | 35.60 | 6.8 | 9.6 | -19.5 ▼ |
| Hexcel Corp. | 24.45 | 24.92 | 18.4 | 200.7 | 35.2 ▲ |
| Honeywell International Inc. | 53.94 | 54.15 | 12.6 | 116.7 | 7.7 ▲ |
| Kratos Defense | 6.22 | 5.00 | 33.0 | -51.8 | -42.4 ▼ |
| L-3 Communications Hldgs. Inc. | 67.03 | 66.30 | 7.9 | 2.4 | -5.2 ▼ |
| Lockheed Martin Corp. | 77.57 | 78.15 | 10.2 | 5.9 | 17.7 ▲ |
| Moog 'A' | 41.57 | 41.82 | 12.6 | 25.0 | 5.5 ▲ |
| Northrop Grumman Corp. | 56.54 | 57.07 | 8.4 | 67.4 | 0.1 ▲ |
| Orbital Sciences Corp. | 14.51 | 14.85 | 14.9 | -3.7 | -17.7 ▼ |
| Parker-Hannifin Corp. | 81.90 | 82.78 | 10.9 | 121.9 | -2.0 ▼ |
| Precision Castparts Corp. | 163.07 | 164.75 | 17.3 | 194.3 | 15.7 ▲ |
| Raytheon Co. | 46.05 | 45.57 | 8.9 | -0.9 | 2.7 ▲ |
| Rockwell Collins Inc. | 54.50 | 54.90 | 12.1 | 65.3 | -4.8 ▼ |
| Rolls-Royce Group plc | 11.25 | 11.47 | 14.7 | 137.0 | 10.0 ▲ |
| Safran SA | 29.17 | 29.51 | 11.4 | 146.7 | -12.7 ▼ |
| SAIC Inc. | 12.95 | 12.05 | 9.4 | -29.7 | -20.1 ▼ |
| SIFCO Industries Inc. | 18.84 | 19.01 | .... | 273.0 | 26.9 ▲ |
| Singapore Technologies Eng. | 2.21 | 2.08 | 15.8 | 39.5 | -11.9 ▼ |
| Spirit Aerosystems Holdings | 19.82 | 19.51 | 9.2 | 112.9 | -3.1 ▼ |
| Textron Inc. | 18.76 | 19.43 | 12.6 | 25.2 | -18.4 ▼ |
| Thales | 31.12 | 31.53 | 9.5 | -16.0 | -16.4 ▼ |
| TransDigm Group Inc. | 95.02 | 96.42 | 16.9 | 231.5 | 35.5 ▲ |
| Triumph Group Inc. | 57.57 | 59.49 | 11.9 | 218.7 | 28.7 ▲ |
| United Technologies Corp. | 76.25 | 76.60 | 13.0 | 69.0 | 0.5 ▲ |

COMMENTARY

# Winners and Losers In Changing Supply Chain

**Airbus, Boeing, Bombardier** and **Embraer** may get the lion's share of attention, but the airplanes they build are the sum of systems and parts that are procured from hundreds of suppliers around the globe. So it is not surprising that **United Technologies Corp.'s** $18.4 billion deal to acquire **Goodrich** is generating a lot of speculation about the future of the aerospace supply chain. Will others move to counter a new aircraft "super supplier" that will sell everything from **Pratt & Whitney** engines and **Hamilton Sundstrand** electronics to Goodrich brakes and landing gear? Could consolidation go so far that aircraft builders are forced to rely on sole-source suppliers that demand hefty prices?

Fortunately, a new assessment by consultancy ICF SH&E finds that "vigorous competition" remains in the top tier of most segments of the aerospace supply chain, despite recent consolidation. That is good news for the Pentagon, which is renewing its emphasis on competition, including expectations that prime contractors will push their suppliers to compete for the goods and services they buy from their vendors. According to ICF, the two largest players in aerostructures—**Spirit AeroSystems** and **Triumph Group**—account for less than 20% of the market. Other segments that offer an array of choices include flight controls, avionics and defense electronics, environmental control systems, wheels and brakes, electrical power and distribution, and nacelles and thrust reversers. "Supplier concentration is not excessive in most of the categories where Boeing and Airbus buy their components," says ICF Vice President Kevin Michaels, who unveiled his findings this month at the Credit Suisse-Aviation Week A&D Finance Conference in New York.

There are a few notable exceptions. **Honeywell** holds a commanding 80% share of auxiliary power unit sales. And Goodrich and **Messier-Dowty** account for all but a small slice of the landing gear market. But by and large, industry analysts believe there is room for more consolidation without harming competition. "We have not gotten . . . where scale reduces competition to the point where prices begin to rise," says Tom Captain, the leader of Deloitte's global A&D practice. "We won't see that for a long time."

But suppliers will have to up their game to remain viable. As aircraft builders continue their move to procure complete systems—instead of components they have to integrate on their own—Michaels believes the most successful mergers will be of companies that find ways to combine products to create systems. One example: **Meggit**t, the leading supplier of fire-detection equipment, paid $685 million this year to buy **Pacific Scientific**, the leader in fire-suppression equipment.

All this spells bad news for lower-tier suppliers that are still reliant on a "build-to-print" business model. They will need to find a buyer or partner—or risk going the way of phone booths, camera film and card catalogues.

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

## AIR TRANSPORT

### More Orders, Cancellations

With a few weeks to go, Airbus has formally topped its revised order intake target for 2011, with 1,521 booked in the first 11 months. But the aircraft maker also—again— added to its cancellation total for the year, with Kingfisher's dropping of two A340-500 orders bringing the total to 143 units. Airbus parent EADS had put the gross-order target at 1,500, although Airbus COO for customers, John Leahy, says the full year total could be 1,650-1,700. Airbus has already announced commitments to reach that level, although those contracts remain to be finalized. Net orders year-to-date stand at 1,378, with 477 aircraft delivered.

### Machinists Back Contract

Boeing and the leadership of the International Association of Machinists (IAM) are counting the 74% approval of a four-year contract by machinists in voting on Dec. 7 as a victory. The vote gives Boeing labor peace with its most militant union until September 2016. It assures machinists of jobs in Renton, Wash., building the 737 MAX.

### Smoother Path to China

The Europe-based air traffic management subsidiary Northrop Grumman Park Air Systems has received a temporary certification by the Civil Aviation Administration of China (CAAC) for its NOVA 9000 airport surface movement guidance and control system. The company is the only supplier of this system to obtain a CAAC certification—a prerequisite to site acceptance and operation at airports or en route into the country.


JAPAN AIRLINES CONCEPT

### Second Japanese Airline Plans its International 787 Routes

Japan Airlines has established the first four international routes for its Boeing 787s, although the carrier now expects first delivery of the aircraft will slip to February. While JAL is still discussing delivery dates with Boeing, airline President Masaru Onishi says the initial aircraft will likely arrive in mid-February. JAL had previously said this would occur in December. The carrier will be the first to take delivery of the GE-powered version of the 787. JAL was previously forecasting it would receive five 787s during its current fiscal year, which runs through the end of March, but has now lowered this projection to four aircraft.

The airline had already announced that it would use the 787 for a new Tokyo Narita-Boston route beginning April 22, although this may not be the first route the 787 flies. Onishi says the aircraft will also be used on three other existing international routes beginning in the spring: flights from Tokyo Narita to Moscow and New Delhi, and from Tokyo Haneda to Beijing.

Onishi says the additional three routes were chosen because they are of medium size in terms of demand, and have a higher percentage of business travelers than others. But the 787s will probably not completely take over from 777s on these routes.

Meanwhile, 787 launch customer All Nippon Airways is waiting to receive its third 787. This will be the first in long-haul configuration to be delivered to ANA. The carrier is expecting to receive a total of 11 787s through the end of March, including two in long-haul configuration. ANA also plans to operate one of its first 787s on the Tokyo Haneda-Beijing route.

Separately, Boeing has established two world speed and distance records for the 787's weight class. The sixth 787, ZA006, powered by GEnx engines, departed from Boeing Field in Seattle at 11:02 a.m. local time on Dec. 6 and set the distance record for its class (440,000-550,000 lb.) with a 10,710-nm eastbound flight to Dhaka, Bangladesh. This record previously had been held by the Airbus A330, based on a 9,127-nm flight in 2002.

Following an approximately 2-hr. stop for refueling in Dhaka, the airplane returned to Seattle on a 9,734-nm flight. The airplane landed at 5:29 a.m. on Dec. 8, setting a new record for speed around the world (eastbound) with a total trip time of 42 hr. and 27 min. There was no previous around-the-world speed record for this weight class.

The 787 carried six pilots, an observer for the National Aeronautic Association, and operations and other Boeing employees—13 passengers in total.

Routing on the first segment of the journey took the 787 from Seattle across the U.S. to Nantucket, Mass. After crossing the Atlantic Ocean, the airplane entered European airspace at Santiago de Compostela, Spain, and proceeded east over the Mediterranean, across Egypt to Luxor, across the Middle East and over India to Bangladesh. On the second segment, the 787 flew over Singapore, the Philippines and Guam before entering U.S. airspace over Honolulu and returning to Seattle.

### Wind Tunnel Trials for Australia's Scramspace

The Australian Scramspace hypersonic demonstrator aimed at achieving speed of Mach 8 in 2013 is undergoing wind tunnel trials at the German aerospace center's facility in Gottingen. The 62-meter-long (203-ft.) wind tunnel can effectively simulate scramjet operations at an altitude of 30 km. (19 mi.) Scramspace—the 1.8 meter-long Scramjet-based Access-to-Space System—is due to be launched in March 2013 from the Woomera test range in Australia. Liftoff is expected to be on a two-stage rocket to loft the air vehicle to an altitude of 340 km, where it is due to separate and descend. The scramjet is programmed to ignite at an altitude of 32-27 km. Japanese and Italian researchers also are involved in the project.

DLR CONCEPT

## Mars Mission Revamping Underway

Science chiefs from the European Space Agency (ESA), NASA and the Russian space agency Roscosmos have begun laying the groundwork to revamp a two-pronged robotic Mars mission to accommodate participation by Russia.

The joint ESA-NASA ExoMars mission has been upended twice in the past year by uncertainty surrounding the U.S. space agency's ability to fund its commitments to the martian expedition.

On Dec. 7 in Paris, ESA's director of science and exploration, Alvaro Gimenez-Canete, met with acting Associate NASA Administrator for Science Charles Gay and Roscosmos deputy head Anatoli Shilov to establish a pair of trilateral working groups charged with redesigning ExoMars with full Russian participation in mind, in exchange for launching the 2016 leg of the campaign on a Russian Proton rocket. The two working groups—one charged with examining payload options, the other with considering the technical feasibility of a Proton launch—have until early February to report back to their respective science chiefs, ESA says.

NASA had offered to pay for an Atlas 5 launch that would send ESA's entry, descent and landing demonstrator and data relay satellite—equipped with a methane-sniffing sensor and other science instruments—to Mars in 2016. Under the original plan, that mission was to be followed two years later by a NASA-led campaign that would deliver a NASA rover and an ESA rover to drill and collect soil samples.

Last April, the U.S. space agency said budget cutbacks were threatening funding for ExoMars. After months of back-and-forth between NASA and ESA, during which NASA pulled the plug on its 2018 rover, NASA said in September it could not commit to launching the 2016 leg of the mission. As a result, ESA turned to Roscosmos for possible launch of its planned Mars orbiter in the 2016 window.

During the meeting, Russia agreed at least in principle to provide a Proton rocket, pending resolution of several outstanding issues, including space for Russian instruments or other technologies aboard the mission as well as rights to data collected by a proposed ESA-NASA ExoMars rover that could launch in 2018.

In a statement on Dec. 8, NASA said any decisions regarding ExoMars cooperation are not expected before President Barack Obama releases his fiscal 2013 budget request in early February, when the tri-agency technical teams are slated to complete their work.

"NASA is committed to a robust Mars exploration program, both robotic and human," the agency said, adding that the U.S. spends more on Mars exploration than any other nation and is the only country to land and operate a rover on the Martian surface. "And of course, we just launched the most sophisticated Mars rover ever built," a reference to the $2.5 billion Mars Science Laboratory en route to the red planet following its Nov. 25 launch from Cape Canaveral.

# DEFENSE

## F-16s for Iraq

The long-running saga over the sale of F-16s to Iraq came to an end on Dec 5 when Lockheed Martin was awarded a $835 million foreign military sales contract to provide 18 aircraft. The Defense Department contract covers 12 F-16C and six F-16D Block 52 aircraft, plus spares and support, and runs through to May 2018. The work is expected to keep the production line in Fort Worth running through 2015 and is the first firm F-16 order taken by Lockheed Martin for more than a year.

## Russians Order Yak-130s

The Russian defense ministry has ordered 55 Yakovlev Yak-130 advanced jet trainers from the Irkut Corp. The deliveries should start in 2012 and last through 2015. "The Yak-130 procurement by the air force will bring the pilots' training to the required level and prepare them to operate the new-generation combat aircraft," says defense minister Anatoly Serdyukov. The Yak-130 has a glass cockpit and a re-programmable fly-by-wire system that can replicate the characteristics of various Russian advanced fighters, including the Sukhoi T-50 fifth-generation aircraft.

## Spares Share

The Defense Logistics Agency has awarded Northrop Grumman a $76 million sole-source contract to deliver spare assets in support of the U.S. Air Force B-2 bomber.

## Reset for Hunter

Northrop Grumman has won two 12-month contractor logistics support contract modifications totaling $91.2 million for the U.S. Army's MQ-5B Hunter program for the tactical common data link (TCDL) Reset. The contracts cover resetting current C-Band systems with TCDL technology, as well as air vehicles, ground stations and data terminals.

# SPACE

## Medical Robotics Adapted

Engineers at Johns Hopkins University in Baltimore demonstrated a technique adapted from medicine that may help satellite controllers effect delicate repairs on operational spacecraft. Modifying a da Vinci medical console typically used by surgeons, graduate students Tian Xia and Jonathan Bohren were able to control an industrial robot 30 mi. away at Goddard Space Flight Center. The console included a 3-D eyepiece and motion feedback for "touch" sensitivity, and may lead to techniques for spacecraft repair and refueling.

## Component Testing Planned

Blue Origin, the secretive Seattle startup working on a commercial crew-delivery spacecraft under NASA's Commercial Crew Development seed-money effort, has signed an agreement with the agency to test a thrust chamber assembly at the Stennis Space Center in Mississippi. The BE-3 engine's combustion chamber and nozzle will be hot-fired at the center's E-1 test stand.

# PROPULSION

## Working Together

Safran's Sagem unit and MTU Aero Engines plan to set up a joint venture to work on safety-critical software and hardware for military and civil aircraft, including the TP400 turboprop powering the Airbus Military A400M airlifter. The operation should be up and running next year with aviation applications.

**Correction:** *One of the award recipients was identified incorrectly in the caption for lower-left photo on page S2 of the Nov. 14 issue. The caption should have read: Receiving the Program Excellence Award in the Sub-System Level Production Category were Kerry Bush (left), Boeing program manager for Joint Direct Attack Munitions; and Mark Lakner, integrated product team leader for precision guided munitions for the Naval Air Systems Command. Aviation Week Editor-in-Chief Anthony L. Velocci, Jr., looks on.*

BY MICHAEL MECHAM

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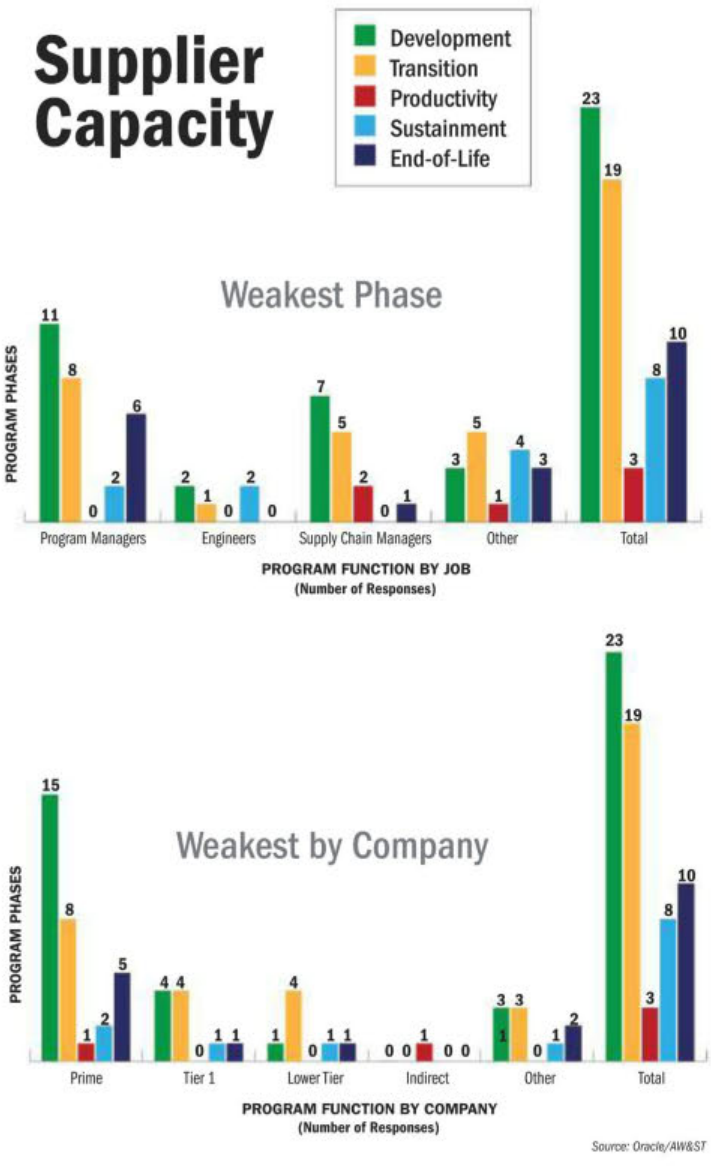
COMMENTARY

# Strengths and Weaknesses

## A snapshot of A&D supply chain concerns

An Aviation Week survey of senior aerospace and defense executives highlights concerns about the efficiency of the industry's supply chain, but also sees strengths in the collaboration, competence, compliance and supplier capabilities that are needed to make it work.




The poll was conducted at our annual A&D Programs Conference in October as part of our ongoing examination of issues critical to the U.S. defense industrial base. Eighty attendees responded, a third of them holding program management responsibilities. We claim no scientific rigor in the poll's results, but they track the conference's discussions.

Asked about supply chain performance, 30% said the supply chain was strongest in production-at-rate, an understandable response because that phase involves mature, standardized, repeatable manufacturing processes. Another 26% cited development, probably a reflection of the industry's many breakthroughs in innovation, says Oracle A&D program leader Ralph Carpenter, who formerly headed Raytheon's supply chain.

But when asked about its weaknesses, 32% chose development, likely reflecting increasingly rigorous Defense Department compliance requirements, complex program structures and performance-based contract models. "Lots of people are program managers on development programs, so they would be most concerned about that," says Carpenter, who reviewed written comments from respondents.

The supply chain's weakest capabilities are its efficiency, risk management, integration, visibility and strategic alignment, respondents concurred.

As a look at the accompanying charts will show, perceptions varied depending on respondents' professional perspectives. Program and supply chain managers ranked production as the strongest supply chain phase, outranking development by a two-to-one margin. But engineers see development as the strongest phase. And for lower-tier suppliers, development, which is primarily a top-tier concern, is only about half as important as production.

This may reflect the fact that contractors have a lot invested in enterprise resource-planning tools, which provide visibility and support best practices during the production phase, but that similar tools have not been employed in the earlier phases, Carpenter says.

While collaboration within the immediate A&D supply network is considered the chain's greatest strength for program and supply chain managers, the general consensus of the respondents is that collaboration among the Defense Department, academia and the private sector needs to be strengthened to drive continuous innovation, value creation and financial performance improvements.

Defense Secretary Leon Panetta has been warning Congress about the liabilities of across-the-board defense budget cuts. Carpenter colorfully refers to this as the "peanut-butter-spread approach," and notes that our respondents say it will undermine both supply chain efficiency and their alignment with strategic partners.

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COMMENTARY

# Growth Spurt

## In a time of industry contraction, there is a surprising engine of expansion

GENERAL AVIATION MANUFACTURERS ASSOCIATION

General aviation manufacturers are enduring one of the deepest and longest recessions in memory, resulting in massive layoffs, slowed production and cancelled new designs.

Excepting Gulfstream, Bombardier and Dassault—whose ultrajets still find favor among blue bloods, blue chips, movie stars and moguls—those who make, maintain or serve general and business aviation aircraft have been in a bad way since Lehman Brothers turned out the lights in 2008. And things are not expected to get appreciably better any time soon.

Even so, one general aviation entity is busier than ever, expanding globally and growing at a remarkable clip. Most remarkably, it is the General Aviation Manufacturers Association (GAMA).

When founded in 1970, GAMA's job was to promote and defend the interests of U.S. manufacturers comprising Cessna, Beechcraft, Lycoming and 14 others. Membership grew slowly, by less than one new member per year on average, until 2002's spurt, when it opened up to international companies. By 2005, the count was 52—a total of 35 new members in 35 years.

That same year, Pete Bunce (see photo) took over as president. A retired Air Force colonel, whose 26-year career included stints as an F-15 and A-10 pilot, unit commander and finally head of the service's Congressional office, Bunce understands aviation—he began flying light planes as a teen in Wisconsin—as well as organization and Washington's ways. His master's degree in international affairs and time as an international affairs fellow at Harvard provide him a good worldview, too.

Bunce's arrival came as the industry was soaring to dizzying heights . . . followed all too soon by the global economic meltdown. Compounding the fiscal misfortunes were unrelenting efforts in Washington to impose user fees and severe security restrictions—and politicians characterizing business aircraft users as irresponsible elitists.

Bunce's staff, along with the staffs of other general aviation alphabet groups, had their work cut out for them. That they have fought the good fight well is confirmed by GAMA's unprecedented period of growth—it gained 22 new members, a 40% increase, in the past six years, with more anticipated soon.

The character of membership is expanding as well. The criteria were recently altered to include rotorcraft, and Bell Helicopter opted in. Among the newest members is Chicago-based Jet Support Services Inc. (JSSI), which insures operators against unanticipated engine or airframe maintenance.

JSSI President Lou Seno says his company's admission to GAMA is noteworthy since, "we're the first member that doesn't manufacture anything."

While some challenge the precision of that statement (Avtrak, another member, is a maintenance tracking service), it does underscore GAMA's continuing outreach. Today, nine of its 17 airframers are either based outside the U.S. or foreign-owned. Further evidence: the creation in 2009 of a GAMA office in Brussels; last month's board meeting in Bordeaux, France, its first outside North America; and recent Chinese overtures to GAMA.

John Rosanvallon, president/CEO of Dassault Falcon Jet and immediate past GAMA chairman, says he's pleased with GAMA's expansion, since it provides more clout and revenue.

According to Bunce, credit goes to the staff, a dozen mostly young professionals, whose high energy was put to the test this past year, among the organization's busiest ever. But as the leader who oversaw GAMA's expansion in these grimmest of times, he should take a deep bow as well.

"He's a very good leader," Rosanvallon says of Bunce. "I think we are very lucky to have him."

### PROBLEM PROP

This past summer, the Center for Environmental Health (CEH) alleged that the sale of aviation gasoline violates California's Proposition 65, also known as the Safe Drinking Water and Toxic Enforcement Act, since avgas contains lead. The group wants to halt further distribution and use of avgas in the state and see the FBOs and other companies involved pay fines.

An industry coalition headed by the National Air Transportation Association (NATA) sought a federal injunction to block the CEH, but it was recently turned down without receiving any ruling on its contention that federal, rather than state, law prevails. And so the legal battle continues, expensively.


FRED GEORGE/AW&ST

Eric Byer, NATA's vice president of government and industry affairs, says the CEH is ignoring airports' and FBOs' legal obligations to supply avgas to operators. Furthermore, the denial of fuel would essentially ground nearly 18,000 avgas-burning aircraft in the state—including those used by police. NATA is also concerned that the CEH's effort "is getting legs" and could inspire similar actions elsewhere.

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**COMMENTARY**

# A History Of Misery

## Should solving tarmac delays be this hard?

Is it worse to forget history or to remember, but repeat it?

I ask because it has been nearly 13 years since a Northwest Airlines debacle in which the carrier left its passengers stranded in aircraft on the tarmac at Detroit Metropolitan Airport, grounded by a snowstorm for up to eight hours without food, drink or usable restrooms. Since then, airlines, airports, regulators, legislators and government officials seem to have talked ad nauseam about how to prevent recurrences. Yet just a couple of weeks ago, the Transportation Department and the FAA found themselves hosting a forum trying to come up with more solutions.

ZUMA/NEWSCOM FILE PHOTO

This is not a proud history.

A Transportation Department investigation of that tarmac incident in January 1999 faulted Northwest for inadequate planning and poor communications that included a failure to even ask other airlines if it could use their gates. U.S. airlines forestalled congressional calls for "passenger rights" legislation on airline service issues, including what came to be described as "tarmac delays," only by promising to tackle the issues voluntarily.

In December 2007, however, American Airlines passengers were stuck for up to 9 hr. on aircraft that were grounded in Austin, Texas, after several of the carrier's aircraft were diverted there due to severe thunderstorms across the state. The airline diverted 130 flights in total, just three fewer than it diverted on 9/11. Take heed of that number of flights, because it comes up often in this week's column.

On Feb. 14, 2008, JetBlue Airways passengers at New York John F. Kennedy International Airport were stuck on grounded planes for as long as 10 hr.; JetBlue admitted that inefficiencies in its response plans were partly to blame. American had problems again that April, when severe thunderstorms in the Dallas/Fort Worth area forced it to divert 129 flights, 13 of which were stuck on the ground with passengers unable to deplane for 4-8 hr.

Congress pondered passenger rights legislation again. The Transportation Department created a 35-member task force that in November 2008 issued guidelines for airlines, airports and government agencies to develop and refine contingency plans. In April 2010, the department began implementing a new rule under which airlines face hefty fines if they do not give passengers the option to get off the plane after 3 hr.

So how is it that on Oct. 29 diverted flights again contributed to numerous lengthy tarmac delays, and the Transportation Department, FAA, airlines and airports again are talking about how to prevent recurrences?

Yes, an unusually early winter-like storm dumped wet snow on the East Coast that day. But a big contributor to the delays, the FAA says, was that a confluence of circumstances, including the snowstorm, forced 134 flights to divert from their planned landings at the three major New York-area airports within a few hours. With each carrier making independent decisions about where to go, 28 diverted flights from various airlines ended up at Bradley International Airport in Windsor Locks, Conn., where the inclement weather began as rain but ended up as 20 in. of wet snow.

Even more frustrating, the aircraft probably could just have easily diverted to nearby T.F. Green International Airport, which had only rain to deal with and also can process international flights. Airlines diverted only five of their flights that day to Green, near Providence, R.I., but "we could have handled a lot more," says Kevin Dillon, the airport's president and CEO.

Give the regulatory agencies some credit for organizing—just a month after the Bradley incident—a well-attended forum on how to better handle flight diversions. Some valuable proposals were discussed, especially on how to include potential diversion airports in FAA-led inclement weather response plans, to let these airports know how many planes are heading their way, and for airports to let airlines know when they are overwhelmed. Customs and Border Patrol (CBP) personnel outlined why and how diversion airports need to plan for secure areas where international passengers can be unloaded to wait until CBP staff can get to the airport to process them.

But airports still complain that some airlines have created inadequate contingency plans and leave airports out of the loop. Airlines still accuse airports of not doing their part. The Customs problem has been noted for years. Coordinating diversions so a single airport is not overwhelmed is a good idea—but also a commonsense one that is long overdue.

Perhaps even more discouraging was an exchange at the forum in which Transportation Secretary Ray LaHood acknowledged that neither he nor the FAA administrator had even heard of the 2008 task force report, which LaHood says he now plans to read. That response is refreshing for its honesty, but disconcerting in its implication. Who is learning from the past?

BY FRANK MORRING, JR.

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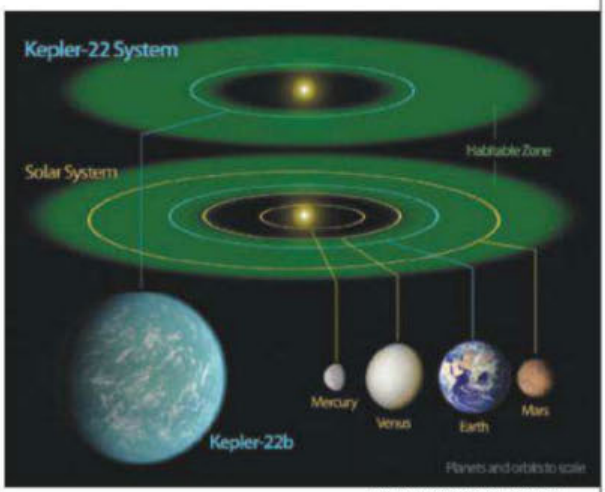
COMMENTARY

# Goldilocks Planet

## Kepler's extended mission in question as it confirms its first habitable planet

NASA's Kepler planet-finder has finally found a planet in the habitable zone around its Sun-like star that is neither too hot nor too cold, but just right for water to remain in the liquid state believed necessary to sustain life. Unfortunately, the orbiting probe's primary mission is drawing to a close just as its worldwide science team begins to narrow in on the best way to find the truly Earthlike extrasolar planets most likely to sustain life, and when funding for extended missions at the U.S. space agency is running dry.




NASA AMES/NASA JPL-CALTECH

"What we see are 48 object, planetary candidates, in the habitable zone between 185 and 303K," says Bill Borucki of Ames Research Center, the Kepler principal investigator. "It's conceivable that any, or many, of these planetary candidates, and their moons, could have life."

But Borucki and his Kepler colleagues are facing a review in February by the senior agency managers who decide if funding will be available to continue the work. And those managers must find ways to fund a seriously over-budget James Webb Space Telescope by cutting spending in other programs.

Extended missions, and everything else in NASA's $5.09 billion science budget, are up for grabs as the money crunch begins. While $5 billion is a lot of money, the science mission directorate has a lot of expensive projects on its plate, including the $2.5 billion Mars Science Laboratory. MSL was just launched to begin an indefinite nuclear-fueled exploration in a equatorial crater rich in sedimentary rock that holds clues to the planet's habitability over time (*AW&ST* Dec. 5, p. 30).

The planetary-science division already has a plan to look at research and analysis (R&A) in the aggregate, according to planetary-science director Jim Green. That could mean cutting funds for analysis of data streaming back from such heroic missions as the Cassini Saturn probe, Opportunity Mars Exploration Rover, the Mars and Lunar Reconnaissance Orbiters (MRO and LRO) and the Mars Odyssey orbiter. Also exposed to potential cuts are the Gravity Recovery and Interior Laboratory (Grail) mission launched on Sept. 10, the extended Deep Impact mission and NASA-funded science on Europe's Mars Express and Venus Express probes. "Everyone of course is vying for the same budget," says Green.

Kepler's 48 candidate planets in the "Goldilocks zone" that is "just right" for liquid water are extremely promising. But winnowing them from 150,000 stars observed since 2009 has been difficult, and the Kepler team will ask for about three more years to gather data.

"We're putting together a very good proposal, pointing out that the stars we are measuring—G stars like the Sun—turn out to be quite a bit more variable than anyone expected," says Green. "That makes it much more difficult to find small planets, which are of most interest to us, particularly small planets in the habitable zone."

Designated Kepler 22b, the mission's first confirmed habitable-zone planet lies in the direction of the constellations Lyra and Cygnus, circling a star that is only slightly smaller than the Sun and about 25% less luminous. The Kepler probe, lofted March 7, 2009, detects extrasolar planets by measuring the dimming of light from a star as a planet passes in front of it.

Based on three observed transits—the first of them only three days after the spacecraft was declared operational—Kepler 22b orbits its star every 289.9 Earth days, crossing in front of it for 7 hr. 4 min., says Borucki. The relatively limited data do not allow a definitive characterization of the planet, including whether it is rocky, gaseous or has a liquid surface, and the nature of its atmosphere, if any. Its temperature, if there is an atmosphere, would be a pleasant 72F.

The mass of the planet is not yet known, but next summer, when the planet's star is high in Earth's sky, astronomers will have a better chance to measure its mass with large ground-based telescopes.

That possibility has raised the interest of the SETI Institute, which uses radio astronomy to scan the heavens for possible signals from extraterrestrial intelligence. Jill Tarter, director of the institute's Center for SETI Research, says private funding has enabled reactivation of the Allen Telescope Array, which shut down in April for lack of funding. The array's 42 6-meter antennas have just resumed scanning Kepler 22b and other potential planets identified by the orbiting probe for "techno-signatures" that would confirm extraterrestrial intelligence, she says.

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COMMENTARY

# Babbitt at Rest

## NextGen proponents are anxious about effects of FAA administrator's resignation

The NextGen air traffic modernization initiative loses a powerful cheerleader with the departure of FAA Administrator Randy Babbitt, who resigned last week after he was charged with driving while intoxicated in a Virginia suburb of Washington. NextGen backers in Congress say Michael Huerta, Babbitt's deputy and the new acting administrator, will continue advocating strongly for the big-ticket program despite a tough budget environment. That is good news, since insiders expect the Obama administration—faced with the likelihood that the Senate will not confirm a Babbitt successor before next November's elections—will leave Huerta in charge of the FAA through 2012. Still, the loss of Babbitt, a veteran pilot who was liked by both airlines and their unions, leaves a sense of unease. "It just couldn't come at a more difficult time for the agency," says Rep. John Mica (R-Fla.), chairman of the House Transportation and Infrastructure Committee. "It leaves it somewhat in limbo. I won't get into all of it, but I'm concerned."

ZUMA/NEWSCOM

**Babbitt's resignation "couldn't come at a more difficult time"**

Lawmakers, meanwhile, are still trying to pass a new FAA reauthorization bill by the end of the calendar year—if only their party leaders would agree. The issues have been largely whittled down to a contentious union-rules matter and the number of flights allowed to and from Ronald Reagan Washington National Airport. Yet the fate of the bill, which has already been extended 22 times, is now in the hands of Senate Majority Leader Harry Reid (D-Nev.) and House Speaker John Boehner (R-Ohio), who are preoccupied with passing year-end spending bills and tax measures. Officially, they have until Jan. 31 to extend authorization again or pass a new bill. But some lawmakers, such as the House Transportation aviation subcommittee's chairman, see a deal on the horizon. "It's more encouraging than it's been in the past year," says Rep. Tom Petrie (R-Wis.).

### DEADLINE LOOMS

Speaking of must-pass spending bills, Congress has to arrive at enough agreement to cover nine appropriations measures—including a $518 billion baseline defense measure—by the time the current "continuing resolution" (CR) expires Dec. 16. Potential pitfalls include differences between the House and Senate over how to fund labor issues, as well as House Republican policy provisions that could alienate liberal Democrats. Still, lawmakers are not worried about a deal on the defense bill, which could move on its own if agreements cannot be reached for other agencies. They would likely fall under another CR extension, which would maintain prior fiscal year spending and authority but disallow new efforts or changes. "We don't want to let the American people down," says Rep. Norm Dicks (Wash.), the top Democrat on the House Appropriations Committee. "We're the last bastion of getting something done around here."

### ROTO ROOTERS

With major questions looming over the future of many military rotorcraft efforts, Reps. Mo Brooks (R-Ala.) and Mark Critz (D-Pa.) are forming a Congressional Army Aviation Caucus. It has close to 30 members already. Brooks, whose district includes the Army Aviation and Missile Life Cycle Management Command, says the caucus will make sure Congress "stays focused" on resetting war-torn equipment after Afghanistan and Iraq. "Additionally, we need to continue funding for the new armed scout helicopter, and carry on funding the modernization of our fleet and the Joint Multirole helicopter," he says. Still, the Army is curbing its appetite for new helos, and many pundits expect reset and maintenance will come into question as soldier "end-strength," or force size, is cut after the wars. In October, Army Maj. Gen. Tim Crosby, program executive officer for aviation said, "We see our country's financial problems and know we cannot have everything we need."

### DO AS I SAY . . .

Finally, contractors who do business with cash-strapped NASA will be well advised to save money on color printing, attendance at conferences, and promotional pens and other "swag," as U.S. government agencies have to do. At least that is the word from Deputy Administrator Lori Garver at a closed-door session with CEOs. Curiously, Garver recently returned from a junket to the South Pole with other science agency chiefs after watching President Barack Obama sign an executive order limiting "unnecessary travel" and other waste by federal officials (*AW&ST* Nov. 21, p. 21).

# SEEN AND UNSE

**DAVID FULGHUM and BILL SWEETMAN/WASHINGTON**

The crash of a stealthy RQ-170 Sentinel unmanned aircraft in Iran is revealing details about U.S. intelligence monitoring of that increasingly bellicose and isolated nation.

Among these clues is evidence that Washington has been conducting intelligence-gathering overflights with both stealthy and nonstealthy unmanned aircraft to observe Tehran's military developments. That a Sentinel was involved is important because the Lockheed Martin-built flying wing currently carries a full-motion video (FMV) payload (*AW&ST* Aug. 9, 2010, p. 29; Dec. 14, 2008, p. 26). FMV is the key to activity-based intelligence analysis, the same discipline that revealed Osama bin Laden's hiding place. Both the CIA and the National Geospatial-Intelligence Agency (NGA) see activity-based intelligence as the path to better monitoring of Iran, and they are busy expanding that capability.

AGENCE FRANCE-PRESSE FILE PHOTO

Early on, officials said the crashed aircraft was possibly the Lockheed Martin Sentinel. That initial hesitation by the U.S. to confirm the downed unmanned aircraft as an RQ-170 indicates there are other aircraft monitoring Iran as well. Moreover, the intelligence community indicated that missile testing in eastern Iran was at least one of the targets of interest for Sentinel when it carried a different payload.

Yet there appears to be no panic in the military or aerospace industry about any loss of stealth or advanced intelligence, surveillance and reconnaissance (ISR) technology in the crash.

"The Iranians don't have the ability to reverse-engineer it, and there was no fancy [ISR] technology on board," says a veteran intelligence specialist with insight into the program. "There could be a bit of a problem if the Russians or Chinese get the [airframe]."

## Syria Showcases Surface Missiles

**ALON BEN-DAVID/TEL AVIV**

Iran is not the only Middle Eastern country where saber-rattling seems to be in vogue; Syria also wants the world to know it has a formidable surface-to-surface missile capability.

For the first time ever, the Iranian ally recently televised the launch of a Scud-B, SS-21 "Tochka," and Syrian 600- and 302-mm heavy rockets. The public demonstration represents a paradigm shift by the Syrian regime, according to Uzi Rubin, former head of Israel's Missile Defense Organization.

"In 30 years of developing ballistic capabilities, Syria never officially acknowledged them," he says.

The firings come as popular uprisings rattle Syria, and as international pressure grows, including from the Arab League, for President Bashar al-Assad's regime to stop oppressing the Syrian people.

The launches, televised Dec. 3, were conducted from the Palmyra area and were northeast-bound, toward the Iraqi border. "The Syrian signal is aimed more toward Turkey and the international community . . . rather than to Israel," an Israeli intelligence source tells Aviation Week. Turkey has taken a prominent role in criticizing the regime, and Syria's defense minister said the exercise was a test "in case of aggression."

"It is a sign of distress and not of strength," Israeli Defense Minister Ehud Barak declared. "The fate of the Assad family is doomed. It is a matter of weeks or months before they are overthrown."

# Overflights by U.S. unmanned surveillance aircraft revealed by desert crash

RQ-170 Sentinel (above) carries full-motion video to develop activity-based intelligence, a key to finding hidden activities or people. An Iranian video (right) shows that the crashed aircraft suffered little damage, the result of striking the ground while in a flat, right-hand spin, a standard procedure when a UAV goes out of control or loses power. The aircraft has an F-117-like grill over the engine intake to prevent reflections from moving parts in the engine.

SIPA/NEWSCOM PHOTOS

Video released by the Iranian government shows the airframe intact, but with the landing gear and bottom of the Sentinel hidden. Specialists say the aircraft was not shot down because there is no blast or fire damage. The lack of crash damage would indicate the standard UAV flight-termination procedure after an airborne mishap of going into a flat spin. The video also shows an F-117 type grill work over the engine intake to avoid radar reflections from moving parts on the face of the engine. A Lockheed Martin stealth specialist contends that it's still an acceptable idea if the size of the aircraft is constrained and it has "big, fat, round leading edges" to further attenuate radio-frequency reflections.

Russian missile developers explained to Aviation Week the problem they had using the remains of a downed U.S. Air Force F-117 stealth fighter to upgrade the stealth-detection capability of their next-generation air defenses. Because only sections of the F-117 survived intact, "we haven't been able to model the entire [low-observable bomber]," a Russian engineer conceded. "It's not the same as testing against an undamaged F-117. You provide us with a complete stealth aircraft and then we'll tell you how effective we are."

Having a virtually intact aircraft should present fewer problems for reverse engineering. However, it is a lengthy process and often means replicating a design that is already several years and at least a generation of technology behind.

The RQ-170, equipped with a full-motion video sensor, was a key element in

Syria is believed to have an arsenal of several hundred Scud-B, -C and -D missiles, with ranges of 300, 500 and 700 km, respectively; all are capable of carrying conventional and chemical warheads. The two Syrian Scud brigades operate both conventional and nonconventional missiles without separation. So far, there has not been an attack by the Syrian opposition against those capabilities, but Israel is warily watching who has control over Syria's vast chemical weapons stockpile.

One major Israeli concern is what could happen to these weapons immediately after Assad is toppled, if that occurs. Israel fears that the Lebanese Hezbollah organization might take over the Syrian chemical missiles and transfer them to Lebanon. "This would be a casus belli," says a senior Israeli defense source.

Apart from the Scud-B and the highly accurate 120-km-range (75-mi.) SS-21, the exercise was also the first display of the 600-mm Syrian rocket, a clone of the Iranian Zelzal-2 with a range of 250 km, and the indigenously developed 302-mm rocket, with a range of 120 km.

the Osama bin Laden raid in Pakistan. Perhaps the most important detail that emerged from the raid was how much its planning relied on activity-based intelligence. Bin Laden was never seen, but the coming and going of important people revealed that he was there. Much of the critical information was gathered by the FMV sensor system and the data was analyzed by the National Geospatial-Intelligence Agency (NGA). The need for even more sophisticated activity-based intelligence is being emphatically touted by NGA.

"We're moving into more of an anticipatory [style of operations]," a senior agency official says. "We look at key intelligence questions and bring as many pieces of information together as we can by using multi-intelligence fusion and nontraditional sources." The bin Laden residence was identified by "pattern of life activity, and [the NGA] worked with the assault team to look at the best way to get there," the official says. Information developed from the data included flight path and acoustics modeling, line-of-sight analysis, landing-zone surveys and calculating the heights of walls, as well as the locations of entryways, windows and doors.

The single-channel, FMV capability is being multiplied up to 65 times in new systems being packaged for carriage by unmanned aircraft and airships. Gorgon Stare is an Air Force version of the capability. An Army system is called Argus-IS. ISR specialists contend that the UAV loss in Iran would have been far more critical if one of the multi-channel systems had fallen into Iran's possession and made its way to China or Russia, where the capability can be reverse engineered.

Gorgon Stare, developed by Sierra Nevada Corp. and the Air Force's Big Safari program, has been flying over Afghanistan on MQ-9 Reapers since December 2010. The current payload is in two pods. One carries a sensor ball produced by subcontractor ITT Defense. The ball contains five electro-optical (EO) cameras for daytime and four infrared (IR) cameras for nighttime ISR, positioned at different angles for maximum ground coverage. The pod also houses a computer processor. Images from the five EO cameras are stitched together by the computer to create an 80-megapixel image. The four IR cameras combined shoot the equivalent of two 32-megapixel frames per second. The second Gorgon Stare pod contains a computer to process and store images, a data-link modem, and two pairs of antennas for the Common Data Link and Tactical Common Data Link.

BAE Systems' multi-channel system is being automated for monitoring by fewer intelligence analysts than the current system of FMV exploitation. The

MAVG

**Persistent surveillance systems like the Blue Devil 2 airship will be deployed to Afghanistan in 2012.**

# Know Thyself

## A long-awaited Pentagon review uncovers changes and challenges to come

**GUY NORRIS/LOS ANGELES**

A summer-long review of U.S. Air Force intelligence, surveillance and reconnaissance (ISR) capabilities is pointing to a growing need for systems able to operate in contested airspace, greater integration with space-based and cyberassets, and more collaboration with other services and intelligence components.

The review's results could prove crucial to determining which programs thrive or are shelved in the upcoming fiscal 2013 request.

Changes in this USAF portfolio of systems could total billions of dollars over the next five years as the Air Force weighs a variety of tiered choices from the least invasive to most draconian reductions. For ISR officials, the austerity will mean tough decisions hitting home after more than a decade of growth to fight the coun-

**BAE Systems' Argus-IS sensor pod, mounted on an U.S. Army UH-60, has 65 full-motion video windows to further improve activity-based intelligence.**

BAE SYSTEMS

wide-area persistent surveillance sensor, called the Autonomous Real-time Ground Ubiquitous Surveillance Imaging System (Argus-IS), provides that multi-channel functionality from a single sensor operating on a single platform.

The Pentagon, U.S. Army and NGA want to accelerate the use of fused data with a package that can be installed on platforms that stay aloft for days or weeks.

"That is how we are responding to the need for more access to information from the strategic to the tactical level," says Bob Fecteau, chief information officer for BAE Systems' intelligence and security division. "With this capability comes a new challenge—how to manage the increase in the volume of data. We are awash in information. The key for analysts is to find the data when they want it, deliver it to a consumer that can make a decision based on that information and, finally, ensure the data is up to date."

Argus-IS combines wide-area coverage (40 sq. km.) with impressive detail (15-cm.-resolution ground sample distance per pixel). Moreover, the imagery resolution allows tracking of moving vehicles and dismounted individuals.

"The way the sensor actually operates is to continuously image an area on the ground about the size of a small city, and it stores the data on board for the entire mission," says Jeremy Tondreault, program director of the company's electronic systems business. "When an operator interacts with the system in real time, he requests the video piece so he can look for a truck, a person or a safe house. Each of the [65] video windows is analogous to what he gets today with narrow-band FMV."

All of the data are recorded all of the time. An analyst can select any number of video windows focused anywhere around the town. He also could review what happened at the same place an hour or a day or a week before. If he missed something, he can find it. Already there are some automated functions—such as vehicle-tracking—to reduce the analysts' workload. More are under development.

"We're trying to find and characterize activity, document the critical patterns of life, discover the networks and recognize the anomalies within this group so you can find that needle in the haystack," says Wes Green, program director of BAE Systems' global analysis business. "We're talking about a pull system where you are only extracting critical information [instead of] a push system like we currently have where each pixel is [analyzed]."

"Now we have the ability to look at a network," he says. "So we do nodal analysis, characterize the network and create a capability to affect that network at a place and time of the Army's choosing."

A long-term task of the Argus team is to increase the amount of the electromagnetic spectrum in which the sensor package can operate. Right now, the main imagery is EO and IR. But it could become part of a multi-intelligence-gathering system that has several sensors in a pod.

terterrorism and insurgency wars in Afghanistan and Iraq.

Since 9/11, the Air Force's ISR efforts have been focused on operations in airspace in which manned aircraft and UAVs have flown essentially unchallenged. "But tomorrow's environment will be potentially different," says the Air Force's ISR deputy chief of staff, Lt. Gen. Larry James. Describing the future challenge as a "spectrum of conflict," James adds: "We have to prepare for that environment, and we need a balanced force that will allow us to operate in a nonpermissive/denied environment."

Speaking at the Air Force Association's Global Warfare Symposium here, James said the results of the ISR review had been briefed to Air Force Secretary Michael Donley and will inform budget requests beyond 2013, which is due out in February.

In a preview of the review, Donley told Aviation Week in September that the service was closely weighing its choices for the future ISR fleet mix (*AW&ST* Sept. 26, p. 30). Key points emerging from the review—which was modeled after another review for the USAF next-generation bomber—include greater integration of ISR across air-, space- and cyber-domains, better technology to handle the growing quantities of data and improved methods to fuse the information from various electro-optic, infrared, signals intelligence, and light-detection-and-ranging systems now in use.

"How do you fuse it? How do you integrate it?" James asks. "If you go to a Distributed Common Ground System site today, you'll see a noncommissioned officer staring at a screen for four hours trying to identify patterns as they stare at a compound in Afghanistan. There are opportunities for machines to be used to interpret patterns."

The ISR review also examined closer ties with coalition partners and sustaining adequate bandwidth capacity for ISR requirements. "How do we ensure we have the [bandwidth] to ship data around the world," and ensure it is secure? James asks.

Although he believes the ISR enterprise will "do relatively well compared to other areas" under dramatic budget cuts, James says the review nonetheless revealed disquieting news in the R&D and science and technology (S&T) areas. "As we try to peel back the onion, frankly we didn't find a robust and disciplined process," he says. Many areas were found to be "stovepiped" and "we didn't have our hands around managing the R&D and S&T budgets."

Describing this money as "seed-corn dollars," James says: "We absolutely have to do that and get it right in terms of prioritizing those R&D and S&T budgets."

# Waiting Game

## JSF's congressional backers wait for real threats to emerge

**JEN DIMASCIO/WASHINGTON**

Congress seems noticeably quiet on the Joint Strike Fighter, considering the program's tenuous future and the huge challenges still in front of the F-35. Contractor Lockheed Martin is in the midst of difficult negotiations with the Pentagon on the next set of aircraft. Defense Secretary Leon Panetta recently put JSF on the target list in anticipation of the steepest budget cuts in more than a decade. Then there are the aircraft's long-term support costs, which were projected to reach $1 trillion.

With the program's recent pain, the outcry from Capitol Hill has been by modest, at best. Sure, Republican Sen. John Cornyn and Rep. Kay Granger from Texas, where the aircraft is assembled, have written letters on behalf of the Pentagon's largest and most expensive weapons program. But their effort to sell new-model F-16s made at the same plant to Taiwan was much more aggressive.

REUTERS/LANDOV FILE PHOTO

**Sen John McCain (R-Ariz.) is critical of the JSF program's cost overruns.**

The loudest voice on the Hill regarding the F-35 these days is by far critic Sen. John McCain (Ariz.), the top Republican on the Senate Armed Services Committee. McCain, known as a bulldog for investigating lapses on the Air Force tanker program, has turned his sights more recently on the JSF program to make sure that Lockheed Martin, rather than taxpayers, picks up the tab for cost overruns.

But there may be a reason for the relative calm on Capitol Hill among the program's supporters. The threat by Panetta to kill the JSF is widely viewed as a move intended to appeal for the program's protection. With the overwhelming focus on potential long-term budget reductions at the Pentagon and without a bona fide inside threat to the F-35 this year, lawmakers may be saving their energy for future battles.

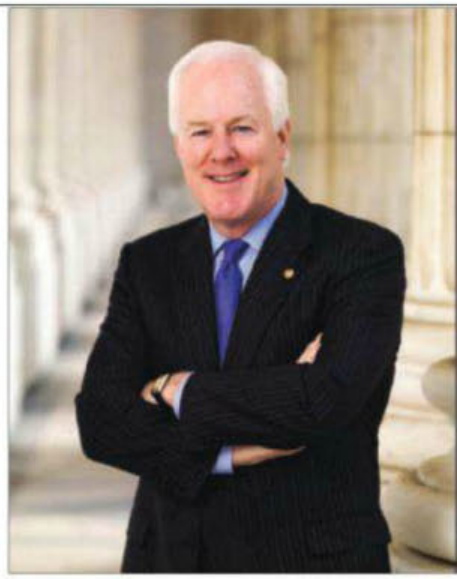
"People aren't being loud because they know they can't kill [the F-35]," says a congressional aide. Slowing the program's production ramp of jets wouldn't be fatal for the program. "It's quiet support."

At this point, recent comments by F-35 program manager U.S. Navy Vice Adm. David Venlet acknowledging the jet's problems with concurrency—in other words, finding developmental problems while producing jets that will later require retrofitting—allows lawmakers to reduce the purchase of the next-generation fighter (see p. 36).

And a top Democratic lawmaker assures Aviation Week that support for the F-35 on Capitol Hill is not going away.

Another Democrat, Rep. Rob Andrews (N.J.) says even though JSF is likely a "big tree" that will need to be examined for budget cuts during the process of reducing the nation's deficit, he's certain that the program can remain viable—without lowering the number of aircraft the Pentagon plans to buy.

"It means finding a way to produce the copies at a lower per-copy cost," Andrews says. "I'm not resigned to the fact that the per-copy cost we are at now can't be lowered."



**Lockheed Martin assembles F-35s in Fort Worth, Texas, the state represented by Sen. John Cornyn (R).**

In the coming years, as the reality of reductions to the Pentagon's previous plans for the Defense Department takes hold, the fight over JSF will grow more intense.

An industry official notes that the worst thing that can happen to the program would be the Pentagon capping the number of jets—a move that would drive up per-unit costs and could unravel the program's base of international support. If the JSF's viability is actually threatened, lawmakers are poised to protect it.

And one defense lobbyist disagrees that lawmakers have been less than aggressively supportive of JSF.

It is true that members are not entirely silent on the matter. During a November speech to the Hudson Institute, Cornyn said the U.S. needs to continue to make F-35s to stay ahead of advancements by Russia and China. "If we want to deter other nations from challenging America's air superiority, then we need to continue building the inventory of aircraft that can meet any threat," Cornyn said. And Granger and Rep. Norm Dicks (Wash.), the top Democrat on the House Appropriations Committee, recently created a JSF Caucus.

Congress is in the midst of reconciling its two key annual defense bills; one addresses spending, the other is primarily a vehicle for policy changes. The JSF plays a role in both measures.

The Senate version of the defense authorization bill includes a provision that would require the Pentagon to negotiate a fixed-price contract for the next lot of aircraft—the fifth—which would force Lockheed to pick up the tab for overruns that exceed a certain amount.

That language is facing some resistance in the House, which has no such provision in its version of the defense policy bill.

Andrews says that the language in the Senate version of the bill is probably too broad, capturing mistakes the Pentagon makes in terms of requirements-creep in addition to the ones that are the purview of contractors. "I think there will and should be some version of that language in the final bill."

On the spending bill side, lawmakers are likely to meet somewhere between the Senate Appropriations Committee plan to lance $695 million from the program to slow development and the House offer to provide nearly as much as the president requested.

*With Amy Butler in Washington.*

# The Big Picture

## Defense minister provides insight into Malaysia's upcoming defense procurements

**LEITHEN FRANCIS/LANGKAWI, MALAYSIA**

Air forces rarely get what they want. Instead they get what the government determines they should have.

Malaysia's air force has a requirement for 18 fighters and at least two airborne early warning (AEW) aircraft. The navy, meanwhile, is in need of six anti-submarine warfare helicopters. The armed services have been evaluating the technical specifications of the platforms on offer and calculating life-cycle costs. But the government looks at the bigger picture.

Malaysia did well in the latest Foreign Direct Investment Confidence Survey, by global management consultancy A.T. Kearney, ranking 10th. But Indonesia over took Malaysia, clinching ninth place. Singapore, meanwhile, secured the seventh spot. Malaysia is aware it needs to do more to attract foreign investment. And the fact that it is preparing to spend billions on big-ticket defense items, creates an opportunity for it to do just that, by insisting on offsets that will contribute significantly to its economy.

Malaysia's government will examine closely the financial and the offset packages, Defense Minister Ahmad Zahid Hamidi said in an interview with Aviation Week on the sidelines of the LIMA Airshow here last week. In terms of offsets, the level of technology transfer will be key, he says. "Malaysia is no longer content to be a traditional end-user. We would like to be considered a joint-partner, a 'smart partner' for assets and procurement. We would like [our suppliers] to share the knowledge in creating downstream activities," particularly high-tech products and services that Malaysia can help market in the Asian region, he says. That also means "giving us some intellectual property rights for components which would then give us some economic advantage."

Ahmad further notes that foreign defense companies that wish to clinch the deals on offer may not necessarily have to fulfill the offset requirement with investments in the country's defense industry. Investments in other sectors of the economy will count toward and can fulfill the offset requirement, he says.

Some companies in the running for Malaysia's business have already picked up on this. BAE Systems' director of Eurofighter Typhoon Malaysia, Ian Malin, says: "We [the Eurofighter consortium] are looking at a whole range of offsets,"

MALAYSIAN MINISTRY OF DEFENSE

**Defense Minister Ahmad Zahid Hamidi was one of Malaysia's high-ranking officials at the LIMA Airshow in Langkawi.**

some of which are outside the aerospace sector. He cites as an example the company's diesel-electric HybriDrive propulsion system, which is used to power public buses. BAE has also just moved its Asian regional headquarters from Singapore to Malaysia, in its effort to woo the country.

Other contenders in the fighter competition are the Boeing F/A 18E/F Super Hornet; Dassault Rafale; Saab Gripen; and Rosoboronexport, offering the Sukhoi Su-30 and RSK MiG-35.

Rosoboronexport's deputy director, Victor Komardin, says that they are "offering Malaysia the opportunity to participate in production of equipment, materials and parts for the MS-21." This is a 150-230-seat commercial aircraft being developed by the Irkut Aircraft Co..

Komardin says Russia's arms industry already has an on-the-ground presence in Malaysia having established a training center and maintenance company, in a joint venture with local industry, to support the air force's Su-30s and MiG-29s. Komardin says Rosoboronexport hopes Malaysia chooses Russian aircraft for its new fighter requirement so that the Asian country can "make use of what has already been created" in terms of product support and training. "[These two joint ventures] should be profitable, but to achieve that" a volume of work is needed, he says.

Dassault, meanwhile, says the Rafale International consortium has established an office in the country's capital, Kuala Lumpur, to lead its bid. Saab International says it has established an office there too, headed by Thomas Linden, who relocated from Sweden.

Saab is also in the AEW competition and is offering its Erieye radar mounted on an Embraer EMB-145. Saab turboprop aircraft were ruled out because the Malaysian air force is only interested in new aircraft. The other main contender is the Northrop Grumman E-2D Advanced Hawkeye.

Ahmad says Malaysia needs three AEW aircraft—one each to be stationed in East and West Malaysia and one for stand-by.

The Sikorsky MH-60R and AgustaWestland AW159 are in the running for the navy's anti-submarine warfare helicopter requirement. A senior official from the navy said at the Imdex Asia show in Singapore in May that this requirement was already in the country's current five-year plan (2011-15), but that it was stalled pending a budget allocation.

Ahmad emphasizes that "the project is in our pipeline, but because of budget constraints, it hasn't been given a priority [go ahead] yet." Industry executives say the government may be waiting until after the next national election, expected sometime in 2012, before moving ahead with this procurement.

In fact, this is the case with all the other requirements. Malaysia will only allocate a budget and select a winner for its AEW and fighter requirements after the elections. But in order to include the procurement in the 11th Malaysia plan (2016-20), a final decision will be needed before 2016. How soon before that remains a matter of conjecture.


# Operational Downwash

## Afghanistan and Libya battles shed light on future U.K. helicopter needs

**ROBERT WALL/LONDON**

Without Afghanistan, the U.K. might never have remedied the shortfalls in its helicopter modernization plan. Now the question becomes whether those gains will be lost once British combat forces withdraw.

One early test case could be the extent to which equipment lessons gleaned during recent tours of duty are addressed. Besides reflecting combat experience in Afghanistan, the assessments spotlight the use of AgustaWestland WAH-64D Apaches during the NATO-led air war over Libya, where the U.K. employed the attack helicopter from the HMS Ocean.

The latter mission was the helicopter's first operational employment from a ship, but the lack of a British carrier strike force until at least 2020 makes it likely that more such engagements loom. The novelty of the experience has also underscored the need to further adapt the helicopter for that environment.

One issue centers on adding some sort of buoyancy system to the skids to increase the crew's chances of survival if the helicopter goes down in water. Without it, the Apache sinks in about 16 sec., notes Lt. Col. Paul Tennant, commanding officer of the Army Air Corps' 3rd regiment. Similarly, a nonexplosive canopy ejection system may have to be added because the blast pressure underwater from an explosive separation would likely kill the crew.

A similar operational concern surrounds the battery life on the rotorcraft. In case of an electrical failure, the helicopter may not have sufficient backup power to return to ship or reach land when flying a long distance from shore, Tennant tells an IQPC symposium on irregular warfare.

Deployment preparations encountered other challenges, too. For instance, it took time to ensure that the fuzes on the weapons arming the helicopters were not susceptible to electromagnetic interference in the ship's dense radio-frequency environment, says Rear Adm. Tom Cunningham, head of the fleet air arm.

For Afghanistan, Tennant notes that a wider distribution of laser designators would be useful, in part to bolster the ability to hand off targets between ground troops and the aviation assets providing support.

For the Apache fleet in particular, one wish-list item is to allow the crew to receive UAV video footage via the U.S. VUIT program. However, a request for the technology has not gained funding support in London.

Not all of the operational lessons are Apache- or even hardware-related.

**The extended overwater missions performed by British WAH-64D Apaches during the Libyan conflict provided a number of equipment lessons.**

Tennant notes that more training in night conditions would be valuable. Moreover, for Afghanistan, he says, it would be useful to provide airlift more on-demand rather than on a scheduled arrangement. He likens the envisioned plan to hailing a taxi.

Although U.K. political leaders have been loath to reopen programmatic decisions stemming from last year's Strategic Defense and Security Review, there are now indications that may still happen. Royal Air Force Air Chief Marshal Stephen Dalton recently told *The Daily Telegraph* that the decision to retire the Sentinel after it is no longer needed in Afghanistan may be reassessed.

The R1 Sentinel "is vital when you are opening up a new theater," asserts another RAF official. He says military planners are starting to recognize that the putative replacements for the standoff radar system—such as the F-35 Joint Strike Fighter with its active, electronically scanned array radar and the Scavenger unmanned aircraft—would not provide the wide-area capabilities offered by the Global Express-based platform.

Other key issues also loom. For instance, despite the heavy use of the MBDA Dual-Mode Brimstone, some military officials believe the weapon could have increased battlefield utility with warhead options similar to those provided on the AGM-114 Hellfire air-to-ground missile. Brimstone's anti-armor warhead is less useful when trying to attack a target inside a building, where a blast-fragmentation warhead would be preferable. So far, there are no funded efforts to provide an alternative warhead for the weapon, but MBDA officials are believed to be considering such a project.

# Clearing the Decks

## EADS, Finmeccanica face critical business decisions in 2012

**ROBERT WALL/LONDON, JENS FLOTTAU/FRANKFURT and ANDY NATIVI/GENOA, ITALY**

EADS FILE PHOTO

**Airbus CEO Tom Enders is poised to succeed EADS CEO Louis Gallois when the current chief's mandate expires.**

As EADS focuses on putting in place a new management team next year, it only needs to look to Finmeccanica for a refresher course on how things can go wrong.

Despite efforts to address uncertainties before the year is out, both companies have failed to fully clear the decks in 2011, pushing difficult decisions into 2012. The situation at Finmeccanica is particularly critical after ratings company Standard & Poor's (which, like Aviation Week, is a unit of The McGraw-Hill Companies) downgraded the European company's long-term debt rating.

EADS, which boasts a strong balance sheet and healthy backlog, will primarily focus on avoiding internecine warfare, which has damaged the company before. The initial plan was to announce the leadership transition that has Airbus CEO Tom Enders pegged to replace EADS CEO Louis Gallois when the latter's term expires mid-year. But the board held off on making a decision, hoping to unveil the full roster of changes.

The broader transition strategy would see Airbus Chief Operating Officer Fabrice Bregier take the top job at Airbus, while EADS's chief of strategy, Marwan Lahoud, is expected to serve as EADS COO.

While the moves would avoid a repeat of the nasty power struggle EADS suffered in 2006, it also hones in on long-term succession issues the company faces as it continues to try to balance French and German interests—both governments are shareholders in the aerospace and defense contractor. EADS and Airbus will likely share a CFO.

On the French side, the question is who is being groomed to replace Enders at EADS down the road; unlike Gallois, his term is not limited to five years. Both Bregier and Lahoud are now jockeying to be heir-in-waiting.

On the other hand, Germany has not yet had any clear contender within the EADS hierarchy emerge as next-generation leaders; EADS's Eurocopter and Cassidian defense units are run by Germans, Lutz Bertling and Stefan Zoller, respectively, but neither have managed to build sufficiently broad experience in the company.

Although Enders has been willing to consider structural changes at EADS, including tackling the politically sensitive establishment of a single headquarters—the company now has headquarters in Paris and Munich—such a move has become less likely following a decision by the German government to buy out a 7.5% stake Daimler holds in EADS through the national KfW bank. The deal, aimed at preserving the Franco-German shareholding balance, is expected by mid-2012.

Even after the transaction is completed, Daimler still holds another 7.5% in EADS that it wants to sell over time. In fact, it is retaining it only because selling would be impossible politically. And, a further 7.5% block of shares controlled by the Daedalus consortium of German public and private banks has sent clear signals to Berlin that it wants to get out of EADS. The Daedalus stake was previously owned by Daimler, but was transferred to the banks in return for a dividend premium; the voting rights are still with Daimler.

Enders has made clear how unhappy he is with these moves. "This is going into the totally wrong direction," he says. "We need less government ownership, not more." He is particularly concerned that with an increasing portion of stock being controlled by French or German governments, EADS will be perceived more and more as a government entity in other countries and in important export markets. And even though Germany's Economics Minister Philipp Roesler says the solution is temporary and that EADS is still open for private investors, Enders says: "These temporary solutions have the uncomfortable habit of becoming permanent."

Roesler, a member of Germany's liberal party, has been at the forefront of efforts to persuade foreign investors such as a Qatar state fund to buy into EADS. But eventually Chancellor Angela Merkel squashed that idea.

Gallois seems less concerned. "In the short term, I'm not sure the German government had another option," he concedes. Without the intervention, Germany would not have been any more on an equal footing with the French main shareholders. The government and the Lagardere Group control a combined 22.5% and Merkel was keen to keep the German engagement at the same level. Gallois has been working toward a corporate governance arrangement that allows Germany and France to divest their shares and still retain the ability to block a hostile takeover attempt of the strategic industry.

The state is also a key player when it comes to hashing out the future for Finmeccanica. After prevailing in a power battle with Finmeccanica then-Chairman Pier Francesco Guarguaglini, the CEO (and now also Chairman) Giuseppe Orsi will have to move aggressively on his turnaround plan for the company, which has seen its market capitalizition tumble in recent months. Orsi is hoping to consolidate the entity's industrial structure and shed unsustainable businesses units, but Rome, which controls 30% of the company's shares, must agree.

Guarguaglini was forced out in a Dec. 1 board of directors meeting it light of accusations of illegal payments made by company executives when he was CEO. Guarguaglini's board seat will be filled by COO/CFO Alessandro Pansa.

The leadership change addresses a major governance concern at the top of the company. Guarguaglini had maintained control over strategic decisions at the Italian aerospace and defense giant even after Orsi was elevated to CEO in May, which was widely viewed as limiting the latter's power.

Although Orsi now has more power, he faces some turbulent headwinds in the transition period. S&P forecast "that improvements in 2012 and 2013 will be weaker than we previously anticipated." Perhaps of greater concern is that Orsi may have few options. "We view the headroom to accommodate unforeseen problems—whether from the restructuring of divisions, lower trading volumes, or any other operational risks—to be very low," the S&P report states.

As part of its review, S&P reduced the long-term corporate credit rating to "BBB-" from "BBB," although Finmeccanica is taking comfort from the fact its short-term credit rating was left at A-3.

S&P suggests Rome may dispose of its shareholding in Finmeccanica, although that seems politically unlikely.

The EADS and Finmeccanica situations overshadow another European aerospace transition debate, that at Dassault Aviation where Charles Edelstenne is due to retire. Edelstenne has been lobbying for an extension of his mandate that expires in early 2013, but the inability to secure an export order for the company's Rafale fighter has created tension with the French government and made an extension less likely.

# In Short Supply

## EADS has concerns about partners' abiilty to fund production ramp-up

**JENS FLOTTAU/MUNICH**


Airbus is ramping up production in all programs, including the A380, over the next few years.

JOEPRIESAVIATION.NET

During the 2008 financial crisis, manufacturers were worried that customers would be unable to pay for aircraft on order. This time, it is suppliers that are causing unease.

"The suppliers are our main concern," says EADS CEO Louis Gallois. That's because a possible financing shortage caused by banks refusing to lend would coincide with a steep ramp-up in production in almost all major programs, particularly on the Airbus side. Some suppliers have already encountered difficulties in accessing sufficient financing for the necessary investment in new facilities.

In an extreme case, Airbus was forced to acquire PFW Aerospace—a single-source supplier for some metallic components. However, Gallois says PFW's cash crisis was not really linked to the nearly global economic woes, but rather to management problems. "Airbus had no choice other than to buy them," he concedes. But he also notes that the situation was an exception, and he claims that PFW will be sold off once it is in better shape.

EADS's longer-term plan remains to jettison its subsidiaries and important suppliers Aerolia and Premium Aerotec, although that is not likely to happen until the Airbus A350 program is on a firm footing.

As far as airline customers are concerned, Gallois believes that financing is secure for the next few months. Cases like the temporary shortage of U.S. dollars at French banks, which resulted in a lending freeze, showed, in his view, that others are willing to step in. In particular, help has come from Deutsche Bank, HSBC, JP Morgan and, increasingly, Chinese banks.

And airlines are still doing quite well in terms of growth, especially in light of the circumstances, Gallois says. He hopes Air France-KLM will firm up its order for 25 A350s before the end of the year. As far as the A320NEO is concerned, Airbus benefited from Boeing's inability to make a decision. "They have not said for nine months [whether] they were going to do a new aircraft, a reengined 737 or [remain with] the current 737, but heavily discounted. We were basically alone in the market with the best product, [which was] good for us."

Gallois views the recently announced delay in the Airbus A350 program as a "sign of good management." That is based on his conviction that keeping incomplete parts at their manufacturing site until they are ready, thus limiting traveled work, is "the right strategy. That does not mean we will no longer have additional work in final assembly, but it will be much more limited," Gallois says. Airbus last month pushed back the A350-900's entry into service by up to six months, into the first half of 2014. And final assembly of the first aircraft will not even start until next year because it turns out that, among other items, center fuselage panels made by Spirit Aerosystems were not ready in time. Airbus had already pushed out first deliveries of the A350-800 and -1000 by 18-24 months.

In spite of very vocal protests by Emirates and Qatar Airways at the recent Dubai Airshow, Gallois believes "the market has understood that [the delay was necessary]."

# Keeping the Faith

## Airlines eye attempts to rescue eurozone as they brace for a challenging new year

JENS FLOTTAU/GENEVA and ROBERT WALL/LONDON

Even before the eurozone debt crisis ensued, 2012 was expected to be a difficult year for the global airline industry. But if things spiral out of control in Europe, the sector could be devastated.

"The biggest risk facing airline profitability over the next year is the economic turmoil that would result from a failure of governments to resolve the eurozone sovereign debt crisis," the International Air Transport Association (IATA) says.

While the trade body maintains that 2012 might not turn out to be quite as bad as many expect, given the economic uncertainty globally, its forecast hinges on Europe restoring normalcy. Chief

**IATA predicts airlines will achieve smaller profits next year in all regions except Europe and Africa, for which it forecasts losses.**

Economist Brian Pearce warns that Europe could slide into a deep recession if the debt crisis turns into a banking crisis, which would in turn cause a small recession in the U.S. and pull down China and other emerging economies as well. "Travel markets rarely decouple in economic downturns," Pearce says.

The breakup of the eurozone would be a major disruption for carriers worldwide, although industry analysts say that would have more to do with the downturn in global economic growth that it would trigger than with airline-specific effects. Andrew Lobbenberg, transport analyst at the Royal Bank of Scotland, says that though the impact of a potential eurozone dissolution is hard to predict, airlines clearly would struggle to finance aircraft if banks were to fail.

Based on the latest economic outlook from the Organization for Economic Cooperation and Development, IATA has developed a secondary scenario for 2012 that takes into account the risk of the debt crisis turning into another banking crisis. In that scenario, with global GDP growth receding to 0.9%, the airline industry would lose more than $8 billion next year. European carriers would end up losing $4.4 billion; those in North America, $1.8 billion; and Asian airlines, $1.1 billion.

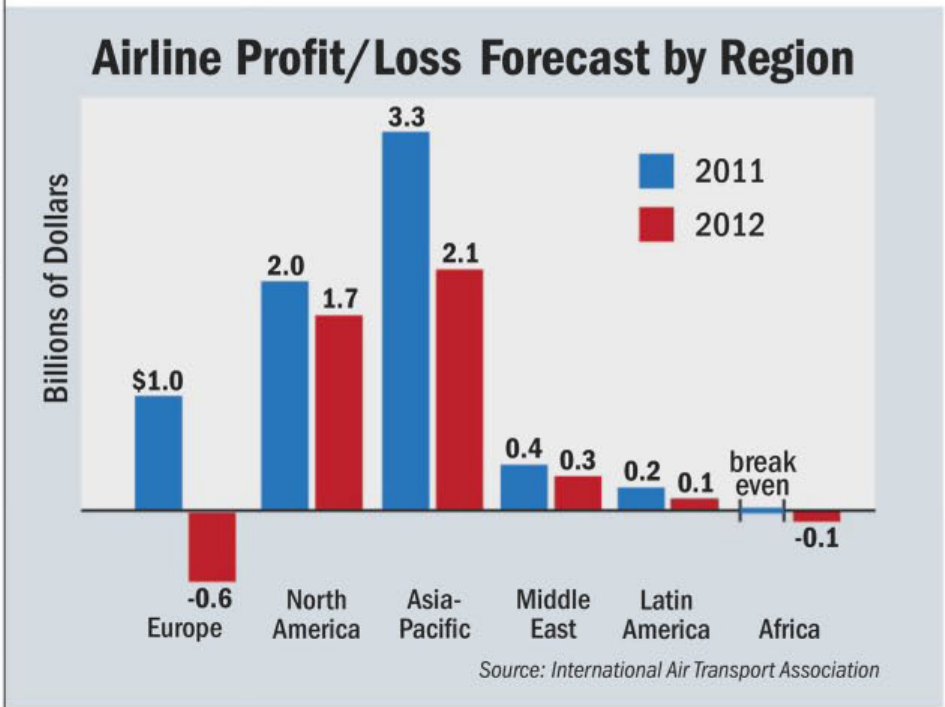
"This admittedly worst-case scenario should serve as a wake-up call to governments around the world," IATA Director General and CEO Tony Tyler says. "In a good year, the airline industry does not cover its cost of capital, much less in a bad one. But in a bad year, aviation's ability to deliver connectivity and keep the heart of the global economy pumping becomes even more vital to initiating a recovery."

IATA's negative outlook is based on the assumption that whenever global GDP growth plunges below 2%, the airline industry as a whole suffers losses. Moreover, IATA does not expect fuel prices to decline with a reduction in demand, at least not as much as in past crises. Pearce expects oil to remain at or above $100 per barrel next year. Airlines will pay $198 billion for fuel in 2012, according to IATA estimates, equivalent to 32% of their total costs.

Financing requirements for deliveries next year will climb to $95 billion, up from $77 billion this year, and grow to $106 billion in 2013, according to Kostya Zolotusky, managing director for capital markets leasing at Boeing Capital Corp. Unlike 2009, Boeing does not see a funding shortfall for 2012. For the main sources of delivery financing next year, the company forecasts that 25% of the $95 billion will come from equity, on par with this year, with export credit agency funding remaining roughly flat at 30%. Commercial bank lending will account for 21% of financing, a dip from 25% this year. Capital market financing, by contrast, will grow to 10%—or $10 billion—up from 5% of delivery monies in 2011.

Looking a little further ahead, export credit agency funding is expected to deteriorate in 2013, largely because this year's new rules for such financing have constricted lending terms. Many deals were grandfathered, but in 2013 the new terms will really come into effect.

Additionally, Boeing sees commercial bank lending tightening. That was already anticipated for 2013, when Basel III capital reserve rules (agreed by



global banking regulators in September 2010) are to become stricter, but the current European financial crisis has accelerated that situation, Zolotusky says. He adds that fewer European banks will be making funds available, as it will be harder for them to access dollars.

Another area of strain is that airlines are no longer able to obtain pre-delivery financing from banks that provided it in recent years. Instead, Zolotusky sees a return to earlier models, in which carriers have to use equity or regional funding sources to make such payments. For lessors, the situation should be a long-term advantage, since airlines are forced to lease aircraft when purchasing them becomes more expensive, and new borrowing terms will allow lessors to better align lease and loan deals.

However, the implementation of the Cape Town agreement, which is designed to make repossessing aircraft easier in the case of default, will allow airlines to tap bond markets more easily. That source of capital has been largely limited to the U.S. but is becoming more global now. In the last three years, $72 billion has been raised from capital markets for aircraft.

If European governments manage to avoid the worst, including another credit crunch, IATA projects that airlines will nonetheless be unable to sustain this year's level of profitability. The association revised its baseline profit guidance downward for 2012, expecting global airlines to achieve profits of $3.5 billion in 2012, compared to its previous forecast of $4.9 billion. This outlook is based on the assumption that Italy's and Spain's financing problems will be resolved, though IATA believes a short-lived recession in Europe is unavoidable.

European airlines would lose $600 million next year, IATA anticipates, while North American airlines would turn in a $1.7 billion profit and 2.4% earnings before interest and taxes margin. A structural increase in demand will likely shield China and the rest of the Asia-Pacific region somewhat from the cyclical move downward. The $2.1 billion profit IATA forecasts for the region is still weaker than the latest guidance for 2011 of $3.3 billion (see chart, p. 27).

Middle Eastern carriers have to prepare for tougher market conditions, given their large exposure to the weakening European long-haul markets. IATA now sees them reaching a $300 million profit next year, down from its previous $700 million guidance. Latin America will amass $100 million in profits, while Africa faces $100 million in combined losses, the association projects.

"Even our best-case scenario for 2012 is for a net margin of just 0.6% on revenues of $618 billion," says Tyler. "But the industry is really moving at two speeds, with highly taxed European carriers headed into the red."

In the upcoming economic slowdown, passengers will be moving to less expensive classes within aircraft and to low-fare airlines, Pearce predicts. Low-cost carriers will grow more strongly than the rest of the industry, but they are also hit hard by high fuel prices that make it difficult to sustain rock-bottom fares.

"The growth rate of premium traffic is slowing," says Lobbenberg. While it is still positive, the trend is coming down. "I think premium traffic is going to decline," he notes. And with that decline, yields in the critical sector also are expected to come under pressure, hurting the bottom line of major network carriers. "We think the premium carriers are going to struggle quite badly" in Europe, Lobbenberg says.

IATA says airline financial performance so far is still "reasonably good," in spite of the high fuel prices. Carriers were able to push through higher yields and cut non-fuel costs. Aircraft utilization was also kept high. "Airlines are resilient," Tyler said at IATA's annual media day in Geneva last week. "The last decade has built an industry that is very experienced in dealing with crisis, shocks, downturns and twists of events."

But Pearce warns that "excess capacity has made it difficult to make money." In the U.S., carriers have been able to retire older aircraft, as they had already been written off. In Europe, cutting into capacity would be more difficult because fleets are younger and the use-it-or-lose it rule makes it difficult to pull out of markets, he notes.

"A consolidated industry will be a more profitable industry," Tyler says. "It is quite possible that we will see further consolidation as the economic difficulties continue. That would be a good thing."

The downturn in Europe and efforts by governments to improve their own fiscal balance are creating more acquisition opportunities. For instance, the Portuguese government has committed to selling TAP, and Ireland will unload its shareholding in Aer Lingus.

Despite those opportunities, International Airlines Group (IAG) Chairman Antonio Vazquez urges caution, noting that buyers risk acquiring problems as part of such deals. He says the key is not so much to be opportunistic about pricing but to focus on the strategic fit. Vazquez says he wants IAG to remain resilient enough to undertake a "transformational deal" once the regulatory environment permits such a move, a reference to the possible acquisition of American Airlines if U.S. foreign ownership rules concerning airlines are relaxed.

A European Commission official notes that a planned review of antitrust rules next year could also impact merger and acquisition activity in Europe: it will look at further limiting state aid provided to airports and airlines.


**The Portuguese government is in the process of selling TAP to reduce its budget deficit.**

KEITH GASKELL

# Dry Run

## Fit-check and 747-8 maintenance preparations pave way for service entry

**GUY NORRIS/LOS ANGELES and LEE ANN TEGTMEIER/FRANKFURT**

Lufthansa already operates the world's largest-capacity airliner, the Airbus A380, and is now looking to use that experience to ease service preparations for the world's longest airliner—the Boeing 747-8—as it prepares to become the first carrier to operate both behemoths in 2012.

To pave the way for the 747-8's service debut, expected in the first quarter, Lufthansa used a Boeing test aircraft for ground-handling-process tests Dec. 6-9 at Frankfurt Airport. Similar to the 787 Service-Ready Operational Evaluation conducted by Boeing and All Nippon Airways in July, the tests rehearsed everything from inserting the aircraft into maintenance hangars to pulling up to an airport gate to check jetway fittings and catering services.


LUFTHANSA TECHNIK

**Lufthansa Technik fit-checks the stretched 747-8 in two of its Frankfurt hangars. This aircraft will be the fifth to join Lufthansa's fleet.**

The visiting aircraft, RC021, is one of three test airframes in the 747-8 passenger variant certification program and will be the fifth to join Lufthansa's fleet when it is delivered in the third quarter of 2012. It was specifically used to test interior systems such as heating and air conditioning, cabin lighting and systems and galleys. The first of 20 for delivery to the airline is completing assembly at Boeing's facility in Everett, Wash.

Lufthansa Technik plans primarily to use Frankfurt's Hangar 5, which was designed and built for the 747-100, to house the 747-8 for maintenance checks. The company intends to perform A checks, which occur every 1,000 flight hours; C checks, which happen every two years; and nonroutine maintenance for the new aircraft in Frankfurt.

This maintenance schedule is the same as that for the 747-400 fleet, but Frank Holterhoff, the maintenance division's project manager for 747-8 service readiness, thinks Lufthansa Technik will probably adopt a phased approach for maintenance, instead of using the manufacturer's letter checks, as it does for the -400s.

The 747-8 is more than 18 ft. longer than the existing 747-400s in Lufthansa's fleet and features a new 229-ft.-span wing. Due to the larger dimensions, Lufthansa Technik will be able to accommodate simultaneously only four 747-8s in Hangar 5, compared with six -400s. If Lufthansa's maintenance capacity requirements increase for the mixed 747/A380 fleet, the company says it will expand Hangar 7, the facility developed for the double-decker Airbus.

The maintenance division will decide whether it needs to expand its current facilities in the next few years, says Dean Raineri, director of new aircraft readiness and aircraft maintenance for Lufthansa Technik. The airline estimates that the -8 will require the same number of maintenance hours as the -400, says Holterhoff; for in-service performance, Lufthansa is targeting at least a 98.5% dispatch reliability. To help with the transition to the 747-8, Lufthansa Technik sent a team of 25 747-400 technicians to Boeing's Seattle facility for four weeks of maintenance training.

In other preparations, NIJL Aircraft Docking, the Netherlands-based maintenance-dock specialist, has reconfigured some of Lufthansa's 747-400 maintenance infrastructure for the 747-8—including adding wheels to make the structure more portable. This is the same company that created the A380 rear docking system in Hangar 7.

Other steps include the addition of hundreds of special maintenance tools that Lufthansa Technik ordered for the 747-8, including hoist fixtures to lift heavy components. The German LBA aviation authority has already approved Lufthansa Technik's line maintenance program for the 747-8, and Holterhoff and Raineri expect the authority to approve their company's base maintenance plan by the end of the year.

In the meantime, Raineri expects to receive Lufthansa Technik's first spare General Electric GEnx-2B engine in January, and he believes that one spare will suffice for at least the first five aircraft. Raineri says Lufthansa will use some of Boeing's airplane health-monitoring services, but final contract signature is still pending.

Boeing, meanwhile, continues airframe and engine testing on the 747-8, including additional certification work on the 747-8F, despite the latter already having entered service. Test 747-8I aircraft RC001 recently was engaged in further tests of the GEnx-2B, with work focused on ground operations with engine-out taxi tests as well as checks on vapor leakage.

One 747-8F also remains in the active test program. Sister ships RC522 and 523 were ferried to San Antonio for refurbishment on Oct. 6 and Aug. 7, respectively. The last test aircraft is being used to help complete parts of the Russian aircraft certification program as well as to check final refinements of the troublesome flight-control system, which contributed so much to the original delay in FAA/European Aviation Safety Agency certification. Recent tests, for example, have focused on checking the tension of flight-control cables during cold-soak temperatures of the type that will be experienced by the Russian-operated aircraft in particular.

# Closer Look

## Antitrust authorities assess Alitalia's role on 18 domestic routes


KEITH GASKELL

**Alitalia may be forced to give up some routes, many of which are flown by Airbus A320s, pending an ongoing antitrust probe.**

**ANDY NATIVI/GENOA, ITALY**

Three years ago, Italian investor group CAI paid €1 billion ($1.3 billion) to rescue a struggling Alitalia, merging it with Italy's second-largest operator, Air One. Now antitrust authorities are questioning whether that deal resulted in Alitalia gaining too much dominance in its home market.

An investigation has been launched to determine if Alitalia has gained market dominance on 18 routes in Italy as a result of its merger with Air One. Results are expected to be announced by next February, and if competitive imbalances are found Alitalia would have until October 2012 to remedy them.

The airline was granted antitrust immunity for three years by the government as part of a deal engineered in 2008 by former Prime Minister Silvio Berlusconi aimed at convincing CAI to invest in the ailing carrier, which was being run by a state-appointed commissioner. Since then, Italy's transportation market has grown even more competitive as low-cost carriers such as Ryanair and EasyJet bolstered their operations here and new high-speed rail service between Rome and Milan provided an alternative mode for rapid travel within the country.

Alitalia still holds about 70% of the slots at Milan's Linate airport. However, the carrier may not necessarily be forced to relinquish any of them because authorities calculate an airline's reach on a particular route by measuring its service against all forms of transportation, not just airlines.

And while Alitalia's fortunes have improved, the carrier has not reaped a bonanza from combining with Air One. It is not yet clear that Alitalia can meet its modest 2011 financial goal of breaking even. CEO Rocco Sabelli says the airline should be "very close to operating breakeven" in 2011. The airline hopes to see a net profit in 2012 thanks to new "commercial agreements and deals."

That may prove to be a challenging goal. Alitalia is reeling from the combined blow of Italy's economic crisis and the rising cost of fuel. A deterioration of traffic volume in the third quarter accelerated in October and November. While the airline was able to improve its bottom line in the third quarter, the results are expected to be worse in the fourth.

Lucrative business traffic is suffering more than leisure travel. Alitalia still has sizable market share in Italy, accounting for just under half of domestic traffic and 12.5% of international routes. And the airline's managers have not retreated from a 2012-15 industrial plan that calls for gradual expansion of international/intercontinental routes and a fleet modernization. However, this could change if financial results continue their downward trend. Already, Alitalia has slowed the introduction of new Airbus aircraft into service.

Meanwhile, the airline received three A319s and is continuing to introduce Embraer regional jets, with the goal of having 15 Embraer 175s in service by mid 2012.

# Tugging NEO

**MICHAEL MECHAM/MONTREAL**

Safran and Honeywell expect to begin tests on an electric tug attached to an Airbus A320's main landing gear in 2014 in preparation for offering the system as an option in the A320 NEO program.

Safran has purchased an A320 to conduct the tests and expects its best sales opportunities to come from airlines flying short-haul, quick turnaround routes, which require numerous daily rotations, says Alain Coutrot, deputy director of research and development for Safran's Aerospace Div.

Speaking at the Montreal Aerospace Forum last week, he said that using an electric drive for taxiing rather than relying on the aircraft's fuel-burning gas turbine engines will save airlines about $300,000 per aircraft per year in fuel and push-back charges. Also, the so-called green power alternative to diesel tugs reduces greenhouse gas emissions.

The partners are focusing on a drive system attached to the main landing gear because they say it offers the best method of handling the power loads required to move an 85,000-lb. airplane. A rival approach from Chorus Motors powers the aircraft via the nose-wheel landing gear.

The Safran-Honeywell product will be powered from an adapter attached to the auxiliary power unit but will not require additional APU-generating capacity, Coutrot said. A 100-kw electronics system to distribute power to the tug will be installed in the cargo bay.

Although it will be retrofittable to the A320 family, there is no agreement with Airbus to offer that option.

The partners met with Boeing with the idea that the electric tug could be offered on the 737 MAX.

Safran's Honeywell partnership, announced at this year's Paris air show, will follow the risk-sharing model that Safran's Snecma unit uses with General Electric on CFM's engine programs.

Meanwhile, Snecma continues work on unducted fans with an eye to being ready by about 2025 in order to be a candidate powerplant for successors to the A320 and 737. At this stage, Snecma and GE are doing their research in parallel on behalf of CFM, with Snecma concentrating on composite structures for the low-pressure turbine to achieve a better configuration between the nacelle and engine, Coutrot says. Demonstration tests are expected in 2015.

# Boosting Kerosene

## NASA heavy-lift strap-on competition raises hope for new kerosene-engine development

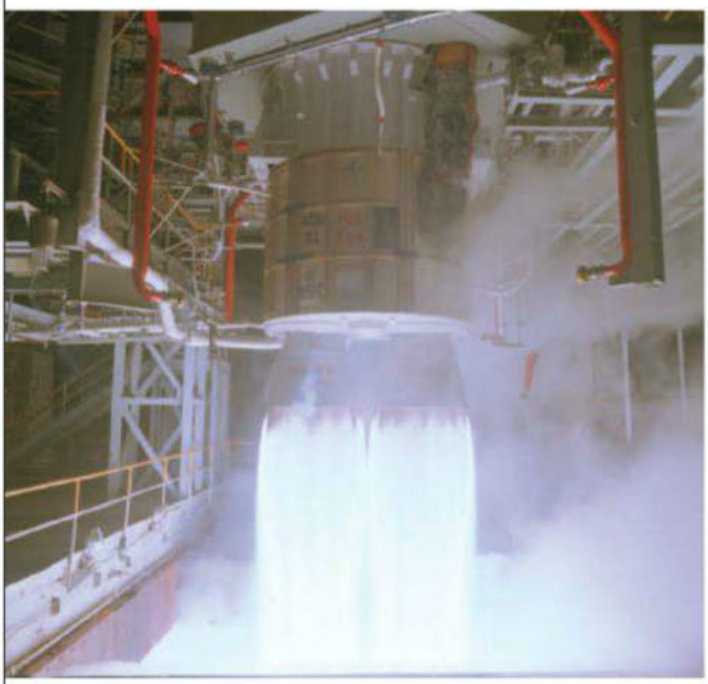
**FRANK MORRING, JR./WASHINGTON**

Advanced kerosene-fueled rocket engines will be a serious subtext this week when launch-industry representatives gather for briefings on NASA's plans to compete the strap-on boosters for its next heavy-lift rocket.

The Space Launch System (SLS) needs new boosters to meet the 130-metric-ton capability that Congress has ordered. While NASA is careful not to specify what kind of propulsion it wants in the boosters, there is a hope among many in the launch industry, and within the U.S. government, that a new kerosene engine is the ultimate choice.

The reason is not hard to see. Regardless of which U.S. commercial crew vehicle replaces Russia's Soyuz capsule as the ride to orbit for U.S. astronauts now that the space shuttle era is over, kerosene—or more precisely, Refined Petroleum-1 (RP-1)—will fuel it off the launch pad. And the U.S. government is not spending much now on advanced kerosene rockets, even though kerosene can provide more thrust for the volume of fuel and thus reduce the size and weight of first-stage fuel tanks.

The Falcon 9 rocket built by Space Exploration Technologies Inc. (SpaceX) to carry its Dragon capsule uses kerosene.



NASA MARSHALL SPACE FLIGHT CENTER

**NASA tested Russia's RD-180 engine for the Atlas launcher at Marshall Space Flight Center in 1998, but it decided to put its money on the liquid-hydrogen-fueled RS-25 for its next heavy-lifter.**

So does the Atlas V, which has been picked by Blue Origin, Boeing and Sierra Nevada Corp. to launch their commercial crew spacecraft: Space Vehicle, CST-100 and Dream Chaser, respectively. Given Blue Origin's recent inflight loss of a test vehicle, the Dragon, CST-100 and Dream Chaser are leading the pack to become NASA's commercial shuttle follow-on.

The Falcon 9 mounts a gang of nine Merlin rocket engines Space X developed in-house. The iconoclastic startup is at work on an advanced Merlin 1D variant and has plans for an even more powerful Merlin 2.

The Atlas V uses a Russian-built RD-180 as its main-stage propulsion system. United Launch Alliance (ULA), the Boeing/Lockheed Martin joint venture that flies the Atlas V and Delta IV, says it has enough RD-180s to operate for 4.5 years, with a steady supply chain running to replenish that stock.

But, given ULA's lead role in launching U.S. military and intelligence satellites, having a foreign engine in the critical path for any of its launches is less than optimal and drives a lot of the interest in a new engine. President/CEO Michael G. Gass is quick to point out that the SLS booster competition is a way to get some government money behind a new RP-1 propulsion system, even as he is careful to praise his Russian engine supplier, NPO Energomash, as a reliable business partner.

"We've bought the rights to manufacture the existing RD-180 here, but I've been advocating let's not manufacture an old engine; let's move the technology the next 15 or 20 years," Gass says. "There's things we would want to do. There's things the Russians would want to do. . . . Let's spend money building the next-generation engine, whether it's our money, the Russian money, but as a space community let's move the ball forward."

Kerosene also will fuel NASA cargo missions to the International Space Station as early as next year under the Commercial Resupply Services program, which will spend up to $3.5 billion to send unmanned commercial cargo carriers to the orbiting outpost. SpaceX plans its first ISS flight early next year, and Orbital Sciences Corp. also plans to fly its kerosene-fueled Taurus II with a Cygnus resupply vehicle in 2012.

The Taurus II first-stage engine is the Aerojet AJ26, a modification of surplus Russian NK-33 engines originally built for the Soviet N-1 Moon rocket. Some of them are 40 years old, and age was a factor in a fuel leak that triggered a test-stand fire during an acceptance test last summer that destroyed one engine and slowed the Taurus II development.

"Some of the engines do require some repair, and we're in that process right now," says Julie Van Kleeck, vice president of the space and launch systems business at Aerojet in Sacramento, Calif. "There were some small cracks in the manifolds, and we had to go develop inspection techniques and then repair techniques, and then we had to validate those. We've gone through that process, and have a method of screening now."

Aerojet has a relatively small Air Force Research Laboratory (AFRL) contract to develop advanced kerosene rocket technology under the Hydrocarbon Boost Technology Demonstrator program, a competitively awarded effort to build a flight-like oxygen-rich staged combustion cycle test engine that can be ready in 2018. In addition to that work, the company has an in-house architecture study for a kerosene engine that could play in the NASA booster competition.

Informally dubbed the "500," Aerojet's engine would be scalable, up to a point, in increments of 500,000-lb. thrust and be capable of powering an SLS strap-on booster. Aerojet already has a deal with Teledyne Brown Engineering to manufacture the engines in Huntsville, Ala., and backing for

the plan from the U.S. senators from Alabama and California.

"We're definitely advocates of a kerosene engine in this country," says Van Kleeck. "We've got the ongoing program with AFRL to work the technology side of it. We're now looking at variants of an engine that might be suitable for the advanced booster competition NASA's having, so we are looking at an engine variant that we think can make that competitive."

In its first budget request for NASA, the Obama administration called for development of a new kerosene-fueled engine, but it ultimately decided to maintain the U.S. lead in liquid oxygen/liquid hydrogen propulsion represented by the RS-25 space shuttle main engine, the RS-68 that powers the Delta IV and the J-2X under development for the SLS (*AW&ST* Nov. 14, p. 39).

Top SLS managers will conduct an industry day Dec. 15 at Marshall Space Flight Center to outline NASA's plans for procuring advanced boosters for the big new launch vehicle, which will start with a research announcement. The first two SLS flight tests will use five-segment versions of the four-segment solid-fuel boosters that powered the shuttle.

Alliant Techsystems, the manufacturer of those boosters, has indicated it probably will offer a solid-fuel entry in the advanced-booster competition, and other entrants are likely

# Reusable Revolution

## USAF contracts kick off plans for rocket-back booster demo flight tests

**GUY NORRIS/LOS ANGELES**

Stretched between growing operational space demands and shrinking budgets, the U.S. Air Force is funding the first major research phases of a reusable booster system (RBS) intended to replace its costly expendable launchers.

Although the value of the initial contracts to Andrews Space, Boeing and Lockheed Martin is only $2 million each, the agreements are potentially worth up to $250 million over the next five years. More importantly, the awards come on the eve of unprecedented budget cutbacks and appear to underline the importance the Air Force attaches to a concept that promises to slash launch costs by more than 50% compared to the conventional Evolved Expendable Launch Vehicle (EELV).

The RBS consists of a vertically launched reusable first stage and expendable upper stages. After deploying the upper stack containing the payload, the rocket-powered, winged first stage will return to make an autonomous, aircraft-like horizontal landing near the launch site. Although this and similar jet-powered concepts have been proposed over the years, the Air Force Research Laboratory's RBS Flight and Ground Experiments (RBS-FGE) program is the first to support a funded demonstrator, as well as the first to form part of a sanctioned Air Force Space Command spacelift plan.

However, the RBS faces major technology hurdles on the path to planned deployment beyond 2025, when it could begin to replace the current Atlas V and Delta IV vehicles. At the top of the list of challenges is a preferred "rocket-back" maneuver, which was selected by the AFRL over first-stage designs that glide back to land or return using high-speed turbine engines. The focus for the RBS-FGE design is a liquid oxygen/kerosene rocket-powered vehicle that will be able to achieve staging at a higher Mach number than the other options.

Following release of the second stage, which could also evolve to a fully reusable vehicle, the first stage will turn around 180 deg. so that its rocket engine is firing in the direction of the velocity vector. This rocket-back maneuver, involving extremely high angles of attack and sideslip, will be tested by a sub-scale RBS Pathfinder vehicle built by one of the three initial RBS-FGE contractors.

The AFRL will select the winning Pathfinder design in the second half of 2012, with flight tests expected to begin in 2015 and run into 2016. Individual contractor designs remain under wraps, but all are similar to the 15-ft.-long reference target Pathfinder that AFRL revealed in 2010, and all are expected to be ground- or air-launched on up to three flights to test different rocket-back maneuvers.

A follow-on reusable booster demonstrator (RBD) is expected to follow the Pathfinder into the air within five or six years. The RBD, likely to be allocated as an X-plane demonstrator, will be highly representative of the operational unmanned, reusable booster. Overall con-

LOCKHEED MARTIN CONCEPTS


The rocket-powered, winged first stage of the RBS would reenter the atmosphere at Mach 3-3.5 before slowing for a horizontal landing.

as well. So the prospect of more government funding for kerosene rocket propulsion is far from assured. And even if a kerosene engine is picked for the SLS booster, there still won't be coordination with the Air Force on the effort.

In the wake of the shuttle retirement, a group of propulsion experts at NASA is trying to find a more coordinated approach for U.S. government research across the rocket-propulsion field. Known as the National Institute for Rocket Propulsion Systems (Nirps), the organization has set up a series of teams led by experts from NASA and the U.S. Army to map ways government agencies and industry can work together.

The Nirps aims to cut development and sustainment costs for missile and rocket propulsion systems, maintain the U.S. industrial base and advance research in all types of rocket propulsion. For kerosene-fueled rockets, the hope is that NASA and the AFRL can find a way to work together toward common goals.

"We'll try to sit down with AFRL and . . . figure out if you took it as one body, how would you make it coherent, assess the gaps and overlaps, and do something from an integrated perspective," says Dale Thomas, associate director for technical issues and Marshall lead for the Nirps.

figuration is expected to be similar to that outlined by the Air Force in 2010, which indicated an overall length of 60 ft., span of 34 ft., 9-ft.-dia. body and gross liftoff weight around 230,000 lb. Early concept details also showed the demonstrator could be powered by a liquid-oxygen/kerosene RD-180 EELV engine. Another AFRL demonstration program, called Hydrocarbon Boost, is developing a large liquid-oxygen/kerosene rocket engine for the full-size booster.

"The RBD will be a good X-vehicle that could demonstrate all the parts of the puzzle, including the ability to fly and operate the RBS flight profile as well as ground operations," says Slater Voorhees, Lockheed Martin RBS program manager. "Some of that will be demonstrated by the Pathfinder, but the RBD will be much closer to the operational vehicle." Lockheed Martin's design will incorporate "a good mix" of design know-how from the company's fixed-wing and space vehicles ranging from the SR-71 to the X-33. Voorhees says the design will combine expertise in "materials, systems and solutions—not only for flying maneuvers, but also for affordability, operability and responsiveness."

Initial steps under the RBS-FGE program will include flight and ground experiments as well as demonstrations to address "aeromechanics, configuration, and flight performance; structures and materials; flight controls and health management; flight systems and propulsion; and ground systems and operations," the Air Force says. The technology road map is expected to support the eventual development of two versions of the RBS: a single, reusable first stage and expendable cryogenic upper stage for medium-lift missions; and two reusable boosters, cryogenic core stage and upper stage for heavy-lift and growth missions.

The latest contracts follow parallel research studies conducted into the RBS concept by Andrews, Boeing and Lockheed Martin for the Air Force Space and Missile Systems Center (SMC), from November 2010 to August 2011. These aimed to achieve a better understanding of the RBS trade space and, in particular, the flight dynamics, flight control and technological impacts associated with several unproven RBS flight maneuvers. The studies focused not only on the rocket-back and return-to-launch sites, but also the booster-phase abort and upper-stage separation.

Andrews Space, based in Tukwila, Wash., has been involved in several reusable booster studies including, most recently, the SMC RBS risk-reduction study earlier this year. It is a long-time proponent of advanced space systems, having worked on an air collection and enrichment system for a two-stage-to-orbit reusable launch system as well as ballute-based reentry systems and advanced materials. The company is also involved in the development of a variety of technologies ranging from unmanned ground vehicles to recoverable space cargo logistics modules and nanospacecraft.

Boeing, which has worked closely on several RBS concepts with Maryland-based research and development company Astrox, is expected to leverage its experience gained with the X-37 Orbital Test Vehicle.

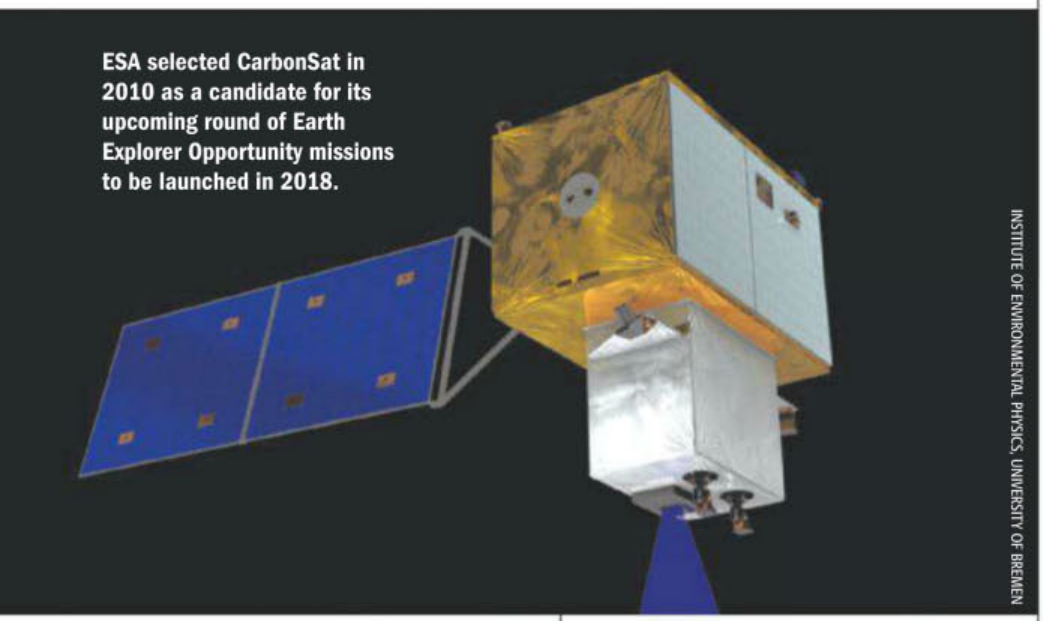
Lockheed Martin's RBS team is led by the company's Space Systems unit based in Denver, Colo., and includes the Skunk Works operations in Palmdale, Calif., and Fort Worth. Also part of the Lockheed team are: Science and Technology Applications of Moorpark, Calif.; UP Aerospace of Highlands Ranch, Colo.; and JFA Avionics Systems of Newbury Park, Calif. For the RBS Pathfinder, Lockheed says it has entered into an agreement with the New Mexico Spaceport Authority to conduct flight-test operations from Spaceport America, in Las Cruces.

**Most likely powered by a liquid oxygen/kerosene rocket, RBS will be vertically launched to a payload separation altitude of 200,000 ft.**

# Carbon Can't Wait

## Space-based tracking of greenhouse gases lags behind increasing emissions

**AMY SVITAK/PARIS**



ESA selected CarbonSat in 2010 as a candidate for its upcoming round of Earth Explorer Opportunity missions to be launched in 2018.

INSTITUTE OF ENVIRONMENTAL PHYSICS, UNIVERSITY OF BREMEN

Seizing on an unexpected jump last year in global emissions of carbon dioxide, European scientists are calling on governments to invest more in space assets that can supply policymakers with a credible means of monitoring carbon output worldwide.

Last year saw the largest increase in fossil-fuel-related emissions on record, according to a new study from the Global Carbon Project, an international consortium of scientists. The study found that carbon emissions rose 5.9%, equating to roughly 500 million more tons, a spike researchers attribute to the gradual economic recovery following a brief dip in carbon output during the 2008 recession.

Alarmed at the increase in carbon dioxide and methane gas concentrations over the past several years, climate scientists say a space-based carbon-monitoring system could provide policy-makers with a credible tool to support measures to curb greenhouse gas production. But stagnant funding and technological challenges have left international efforts to establish such a capability lagging behind the rising emissions.

Today, countries use a variety of means to measure global carbon cycles, including fewer than 200 in situ ground stations worldwide and a handful of carbon-sensing instruments on Earth-observation satellites operated by space agencies in Europe, the U.S. and Japan.

Philippe Ciais, director of research at the Laboratoire des Sciences du Climat et l'Environnement here, recognizes the value of in situ carbon-monitoring systems, but he argues that satellite-based measurements provide greater transparency, which he says is needed to regulate the global carbon market and ensure its large-scale development.

"Earth-observation data is more difficult to falsify," says Ciais, who advocates building a European constellation of carbon-monitoring satellites in low Earth orbit. He points out that the reliability of carbon-emissions data from individual countries is spotty—the uncertainty about carbon emissions declarations is estimated at 5% in industrialized countries and 20% in emerging countries.

"Putting a space-based system in place for independent verification would bring something that could be accepted by everybody," he says.

On the heels of a new round of U.N. climate talks in Durban, South Africa, European negotiators are hoping to lay down a blueprint for a global accord on curbing greenhouse gas emissions by mid-decade. Although the European Space Agency (ESA) was not formally represented at the talks, agency officials attended them to stress the importance of continuing climate observations from space. ESA is trying to draw attention to its Climate Change Initiative, a project that uses archived climate variable data going back three decades from agency and member-state satellites, as well as new missions that could support climate-monitoring initiatives.

As a leader in the field of Earth observation and remote sensing, it is no surprise that Europe boasts the first space-based imaging spectrometer specifically designed to monitor carbon and methane in the atmosphere. The instrument, known as Sciamachy, is on ESA's Envisat Earth-observation spacecraft launched in 2002. It measures trace gases in the troposphere and stratosphere and aims to maintain a legacy of continuous data for ESA's series of European Remote Sensing missions.

With no immediate successor to Sciamachy in the pipeline, however, ESA recently extended Envisat through 2014, when new climate-monitoring satellites are expected to come online under the European Union's Global Monitoring for Environment and Security program (GMES). Instruments planned for two of the GMES Sentinel spacecraft will monitor essential climate variables for the next three decades, including ocean color and deforestation. But these capabilities will assure data continuity for only a few carbon-based variables post-Envisat.

The EU's unwillingness to fund GMES beyond development, however, threatens to delay or descope the multimission program, a topic that is sure to generate intense debate in the coming months as the EU's executive branch, the European Commission, hashes out a multiyear funding plan for 2014-20.

Meanwhile, ESA is mulling development of a dedicated carbon-monitoring mission dubbed CarbonSat. The project is one of two candidates competing under the eighth round of ESA's peer-reviewed Earth Explorer selections (Earth Explorer-8). As CarbonSat is in the early stages of design review, it could be eliminated in a 2013 downselect before its development even begins.

CarbonSat's competitor is the Fluorescence Explorer (FLEX), which would study Earth's carbon cycle by measuring

photosynthesis in land vegetation. FLEX was one of six candidates proposed under ESA's Earth Explorer-7 round, but it was rejected because it was considered too technologically challenging.

Mark Doherty, head of ESA's Earth-observation exploitation division, says in general, developing instruments capable of precision carbon measurements remains a challenge.

"The technical requirements for monitoring carbon dioxide in the atmosphere are highly demanding, very stringent, and they call for new technology and higher performance," Doherty says. He adds that CarbonSat, if selected, would represent the state of the art in carbon monitoring when launched in 2018.

Despite the technological hurdles, European aerospace companies are undaunted. Marco Fuchs, chief executive of OHB AG of Bremen, Germany, says his company recently delivered its CarbonSat proposal to ESA. "We are prime contractor and Thales Alenia Space is our core partner," he says. "It is a study at this point, but our hope is that it will be implemented as a program."

Still, Doherty notes that while the carbon cycle is important, it is only part of the larger climate picture. According to an assessment produced in 2000 in conjunction with the Global Climate Observing System, satellites could be used to meet more than 40 climate-monitoring parameters. Doherty says space agencies around the world have spent the past decade heeding the call, optimizing existing assets while developing new capabilities such as GMES to address multiple climate-monitoring needs.

In the U.S., for example, NASA is building its own spaceborne platform to measure carbon in the atmosphere, the Orbiting Carbon Observatory (OCO). Although a failed launch attempt in February 2009 sent the first OCO spacecraft tumbling into the Pacific Ocean, NASA is working on a second OCO scheduled to launch in 2013.

Japan's GoSat spacecraft is also measuring carbon sinks and sources, though Ciais says more needs to be done to make carbon-monitoring a strategic objective internationally.

"During the financial crises, we continue to emit carbon," he says, noting that the countries most affected by economic turmoil in Europe are also the most likely to burn oil for fuel. "It depends on the political will and capacity to monitor carbon emissions, but it can be done."

# Tangled Webb

## Congress questions NASA's management of powerful, expensive space telescope

**FRANK MORRING, JR./WASHINGTON**

Technicians are wrapping up tests on the 18 state-of-the-art James Webb Space Telescope (JWST) mirror segments built to work together on collecting light from the very dawn of time, and NASA believes it can complete JWST in time for a 2018 launch date. But much remains to be done, and members of Congress wonder if the deep-space observatory has become what one lawmaker calls a "money pit."

"NASA now has a robust new baseline cost and schedule for JWST," Rick Howard, JWST program director, tells the House Science Committee. Congress added $156 million to NASA's fiscal 2012 budget request for the Webb telescope, and capped overall development cost at $8 billion. For the fiscal year that ends next September, the agency has $530 million to spend on the project.

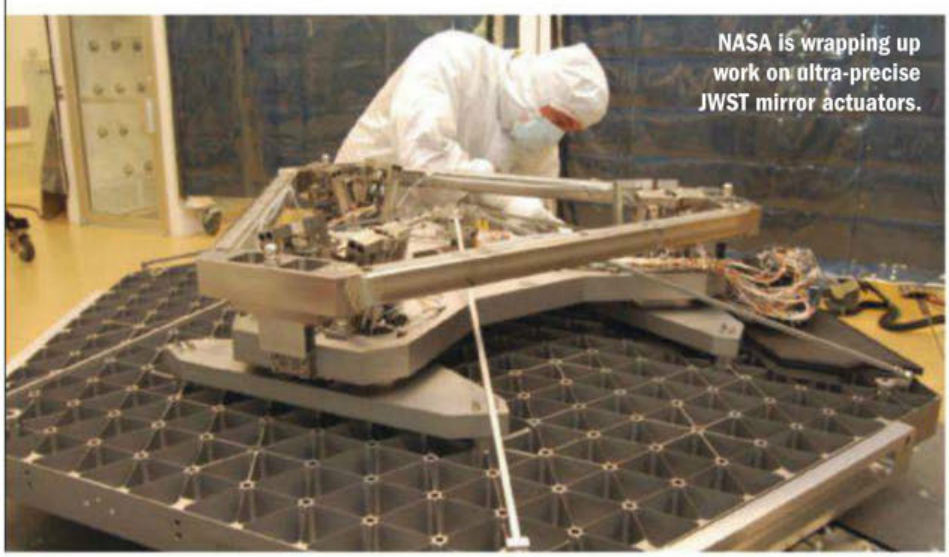
Among reforms Howard says NASA has taken to prevent more costly schedule slips are replacing the management structure—and managers—with him as the new chief running the program at NASA headquarters. The confidence level required for cost estimates has been raised to 80% from 70%, signifying more careful analysis of cost factors, and 13 months of funded schedule reserves were added to meet unexpected problems.

The primary challenges that remain are building the spacecraft and the sunshield that will allow it to operate at 40K from the Sun-Earth L2 Lagrange point, and integrating and testing the outsized elements in a large thermal vacuum chamber at Johnson Space Center. In the near term, Howard says Congress can gauge progress on the telescope's development by whether all four of its instruments are delivered in the coming year, testing of the 18 mirror segments is finished, and the center section of the primary backup structure that supports the mirrors is complete.

Ongoing testing includes trials of the 50-lb. mounting supports on the back of each mirror segment (see photo), which carry the electronics and actuators able to control position within 10 nm. Still to be determined is where the extra $156 million will be found in NASA science and cross-cutting spending plans, a decision due in January when NASA releases its fiscal 2012 operating plan (see p. 16).

"NASA thoroughly understands how to execute this program and has a solid plan to do so," Howard says. Fiscal conservatives on the science panel, though, point out that the original estimated cost of the telescope was $1 billion.

"Here we're talking about a project that has a $7 billion cost overrun from the initial proposal and an 11-year delay to completion," says Rep. James Sensenbrenner (R-Wisc.), a former Science Committee chairman. "Now how can we justify this to our constituents?"



NASA is wrapping up work on ultra-precise JWST mirror actuators.

NASA

# Crisis Management

## F-35 is plagued by another year of cost debates, despite improvements

The completion of 72 vertical landings and short takeoffs on an amphibious ship using two F-35Bs in October was one of five major development goals Lockheed Martin is expected to meet by year-end.

LOCKHEED MARTIN

**AMY BUTLER/WASHINGTON and NEW YORK**

*Ten years and $38 billion into the development of the Joint Strike Fighter, the program is still fighting to stay intact.*

*This is as much about changing times as it is about unmet expectations. A decade ago, Washington had a budget surplus. Today, it is saddled with debt. As the single-largest Pentagon procurement, the $380 billion F-35 cannot escape unprecedented scrutiny.*

*The F-35 should now be an adolescent in the Pentagon's portfolio. Instead, it has been stuck at the toddler stage.*

*When then-Air Force Secretary James Roche announced Lockheed Martin's win on Oct. 26, 2001, he predicted a "fly-away cost [of] roughly $40 million" for the F-35A, which is designed for the U.S. and at least eight other air forces for conventional takeoff and landing. Vice Adm. David Venlet, the government's F-35 program executive, now expects to pay $80 million apiece including an engine, at peak production (which is not likely to be reached until 2017 at the earliest). Roche predicted that fielding the aircraft would begin in 2008, but that date actually turned out to be the first year for flight testing (see p. 39). The U.S. Marine Corps, the first customer, is now eyeing 2016 as a deployment date for its F-35B .*

*Program officials hope 2010 will prove to be the low point wherein there was a standstill in F-35B testing due to reliability problems and Lockheed Martin was struggling with production setbacks.*

*This year, testing has begun to pick up, though the program still faces problems with the F-35 helmet, a flaw in the F-35C tailhook and the specter of unknown "concurrency" costs. Program officials are cautiously optimistic that the improved pace of testing will continue to bolster customer confidence.*

F-35 program overseers had hoped in 2011 to finally determine how much the stealthy fighter would cost to buy and operate, but it has turned out—once again—to be a year riddled by debate and unanswered questions associated with the price of the multinational Joint Strike Fighter.

Having laid in a $4.6 billion restructuring early this year, F-35 program executive Vice Adm. David Venlet declared 2011 "the year of sustainment"; he said the intent was to understand the cost of ownership for the F-35 via deep-dive studies. After an ownership figure exceeding $1 trillion for the U.S. was sent to Congress in April, the crisis of the moment was to more accurately assess the ownership cost and address the sticker shock experienced by customers around the globe.

"There is going to be a significant reduction in the sustainment estimate," Venlet tells Aviation Week. He declined to specify a new figure. The updated cost data, which was expected last summer, will be sent to Congress after the Pentagon delivers its fiscal 2013 budget request in early February. The new number is "realistic and it has got a sound foundation" owing to a new "technical baseline" recently established for sustainment; this includes changes to some program assumptions such as the number of bases.

Roughly 20% could be shaved from the total life-cycle cost by adjusting assumptions in the pricing models, says Tom Burbage, Lockheed Martin executive vice president of F-35 program integration.

Though it was the focus of a fierce debate early in 2011, the sustainment issue has taken the back burner amid the most recent fight. The Pentagon and Lockheed Martin had been locked in a particularly contentious dispute over who picks up the tab for so-called "concurrency costs." These refer to the predicted prices of retrofits to production aircraft based on deficiencies found in testing. In the F-35, the concurrency cost issue is far more prominent than in other projects because production is reaching 30 aircraft annually even though 82% of flight testing—the stage where problems typically reveal themselves—remains (see p. 39).

At issue is ensuring the fighter's parts are reliable for 8,000 hr. of service; program officials plan to identify deficient parts in fatigue testing, and fixes will be devised on a case-by-case basis. In some instances, a fix is needed quickly to ensure safety. In others, it could take place later. Some parts may also simply be monitored and only replaced at a sign of trouble.

The months-long concurrency quarrel was only resolved last week, with the government and Lockheed Martin agreeing to an undisclosed risk-sharing ratio.

The company balked at the government's initial demand that it cover all bills associated with reworking the 30 aircraft in low-rate-initial-production (LRIP) 5. This would have exposed Lockheed to "unbounded" financial risk, according to CEO Robert Stevens. The emergence of the concurrency debate into the public dialogue underscores the fear by both parties of getting stuck with an unacceptably high bill owing to the decision made in 2001 to allow for overlapping production and development.

Concurrency costs for 28 F-35s in LRIPs 1-3 amounted to $136 million, but there is concern that further flight and durability testing will uncover problems that could drive that figure substantially higher as the fleet grows.

For example, Venlet, who represents nine customer nations, says "many" structural problems have been discovered on all three variants. "When we got to investigating that crack in the Stovl [short-takeoff-and-vertical-landing] bulkhead last November and scrutiny of other areas around the structure started to happen in greater detail, analysis showed that there are numerous other 'short-life' areas. They are different in each variant," he says. "Each of those needs to be addressed" and each of the fixes requires validation testing, adding time and money to the cost of delivering the aircraft to specifications.

The risk for the government is clear—each dollar for these items will likely be taken from the production program. For Lockheed, the issue is profit. The LRIP 4 contract stipulates that concurrency cost over the $52 million dedicated for that purpose would come out of the available award fee. "The liability could have exceeded available profit," said one program official. Though the company is likely to make a solid profit at peak production, corporate executives tend not to focus on the long term because their performance is tied to stock price.

However, Lockheed Martin only earned $7 million of $35 million of the award in 2010—thanks to a meager test-

## Lockheed Martin's 2011 F-35 Development Report Card

| | | |
|---|---|---|
| **F-35B Shipboard Trials** | To "complete 100% of the test objectives of Stovl sea trials was just an amazing accomplishment" – Vice Adm. David Venlet, F-35 program executive officer. | MET GOAL |
| **F-35C Ship Suitability Testing** | Tailhook redesign to be tested in 2012. No valid arrested landing attempts. 57 catapult launches considered largely successful. | UNMET GOAL PAYMENT UNLIKELY |
| **Deliver 1B Software for Training** | Lockheed Martin CEO Bob Stevens acknowledged a six-week delay. Whether the company can earn some award fee within the 30-day flex window is unknown. | PARTIALLY MET GOAL SOME PAYMENT POSSIBLE |
| **Release Block 2A Software For Flight Testing** | Delayed owing to 1B software slip. | UNMET GOAL PAYMENT UNLIKELY |
| **Complete F-35C Static Structural Trials** | Completed in September. | MET GOAL |

*Source: Aviation Week & Space Technology*

ing performance—but its stock price was unaffected. Of five development goals in 2011, each worth $10.5 million, two are likely to be declared successful; the others were missed or partially achieved.

Though the development goals for 2012 have not yet been released, Venlet hopes to demonstrate a redesigned tailhook. The company has failed to perform arrested landings. Testers must also focus on correcting problems with fuel "smearing" on the jet as pilots dump it prior to landing as well as fix performance issues with the Vision Systems International helmet. "I am disappointed in the lack of progress in the helmet in '11 and I expect more in '12," Venlet says. Envelope expansion work will also continue, and Venlet says the Block 2A software will also fly in 2012.

The risk of finding more concurrency problems diminishes around 2015, Venlet says. Lockheed Martin is required to conduct fatigue life tests for three lifetimes of use, each 8,000 hr. long. The first will conclude in late 2013; the second two years later, and the third a year after that. During these tests, overseers will gain a better understanding of parts durability and be better able to scope concurrency work.

Burbage says the government's concurrency estimates are bloated. Rather than scheduling a modification retrofit package as with many earlier fighters, the government is taking a "no aircraft left behind" approach, he says.

Venlet hopes to insert as many fixes into production as possible to avoid post-delivery retrofits. "My view of adequate management would be to speed the process of getting known changes cut into production [to] retire a concurrency risk or a concurrency mod when it shows up in a production jet—not when I get the keys," he says. "Getting that process to happen faster is a powerful lever on the burden of dealing with concurrency."

In some cases—structural problems for one—the design fell short of expectations. [It] "should have been more robust in some areas . . . I would have hoped to have had fewer [problems] than we are seeing on the -35 but we are where we are," he says.

"Performance as the program has proceeded has made concurrency more challenging and greater than it was" designed to be, says Venlet. He notes that the challenge for F-35 is that the buys began two years before flight tests, so a number of jets have to be retrofitted. This happens on all programs, but more so on JSF than on the less-concurrent F-22, F-18 or F-16 programs.

Meanwhile, the current cost debate for the F-35 is over the per-unit price of the LRIP 5 jets. The LRIP 4 negotiations were intense and protracted and Venlet says that 30% of the way through the LRIP 4 build, the aircraft are projected to cost about 7% over the targets of $111.6 million for the F-35A; $109.4 million for the F-35B and $142.9 million for the F-35C. A program source suggests that these prices mirror those proposed by Lockheed in its original LRIP 4 bid. The Pentagon recently wrapped up a "should-cost" review that began this spring. It was designed to provide the government with more detailed insight into the cost of work for primes and suppliers. Lockheed Martin, as prime, and Northrop Grumman, its radar supplier, participated. BAE, which supplies the F-35 aft fuselage from the U.K., was not involved.

"The right level of engineering support for a program with three variants in production and three variants in flight test is an important element to look at . . . We recognize the complexity in the program so we certainly expect to be fair with industry, but [also] to negotiate the right deal for the government," Venlet says. "Labor costs are less of an unknown, [but we ask] 'How appropriate are they?'"

The Pentagon is also scrutinizing overhead across all its contracts. Industrial Policy chief Brett Lambert says companies are adjusting their overhead rates but can still make changes in areas such as reducing their footprints.

When the Lockheed F-22, also managed by the company's aeronautics sector, was scrutinized for cost, "it was painful when [government officials] realized they were paying [a] huge budget for people in Washington" for program support, says former Air Force Secretary James Roche.

Venlet says he is willing to take as long as necessary to hammer out the LRIP 5 terms.

Additionally, a renegotiated development contract should be sealed by spring; development cost is estimated at $50.5 billion, up from an initial $32 billion. Program officials are wrapping up an integrated baseline review that began late last month. It matches funding to the technical baseline review established last year, after which contract renegotiations will move forward, Venlet says.

The Defense Acquisition Board, which was slated to review the program last summer, is now expected to convene in January whereupon Venlet will request a new approval for development (which was rescinded with last year's cost overrun). A new program cost figure that includes updated life-cycle pricing will also be reviewed and released, most likely next spring.

Finally, a Joint Executive Steering Board meeting, which includes senior officials from each member country, was set to take place this month but has been shifted until after the February budget release so the program office can share the most up-to-date numbers with foreign partners. It is typically at the December meeting where partners outline their annual commitments for the F-35; these are not expected now until the partners see how the Pentagon's budget shakes out.

Though the pace of testing F-35As at Edwards AFB, Calif., continues to grow, the aircraft has yet to earn a military flight release to begin unmonitored pilot training at Eglin AFB, Fla.

U.S. AIR FORCE

# Gaining Momentum

## JSF effort builds margin for first time as faster-than-planned test rate kicks in

**GUY NORRIS/LOS ANGELES and GRAHAM WARWICK and AMY BUTLER/WASHINGTON**

Three years into flight trials, the Lockheed Martin-led F-35 test program, which has been plagued by delays, is showing clear signs of turning around. All flight-test jets have finally been delivered, and the sortie rate is on track to meet design-validation goals.

Yet it is way too early to declare victory. Though the unprecedented success of the recent F-35B sea trails on the USS Wasp showed what can achieved, development issues with the helmet and the carrier version's tailhook show much is still to be resolved. The test pace, for instance, remains slower than foreseen in 2009, when a program official famously predicted that 12 test aircraft would each be making 12 flights a month by September 2010.

But the rate is picking up and by early December, Lockheed Martin passed the 900th flight milestone for the year and had amassed more than 6,800 test points against a 2011 target of 872 flights and 6,622 points. To underscore this accelerated rate, the 1,000th flight in the overall program was notched by an F-35A on July 29; by early December, the tally had already hit 1,370. Target totals were passed early despite testing being halted twice—once briefly in March after an inflight dual generator failure, and for two weeks in August after a failure of the aircraft's integrated power package during ground runs.

Rebaselined in January, the F-35 test program has been extended by two years to provide additional margin for discoveries and to refly test points. "Flying rates in the new plan were supposed to accommodate such findings, and we are happy with its ability to do so," says J.D. McFarlan, vice president for F-35 test and verification. Since flying resumed in mid-August, the F-35 fleet has been averaging 100 flights a month. "That is slightly higher than the pace we need in 2012," he says.

The higher pace is a needed now because the flying rate will drop early in 2012 as test aircraft go through upgrades. "The rate at which we have been flying in the latter half of the year is up a step on what we expect to get, because we will start the year with a fair number of modifications to the aircraft that will require downtime and a bit of a catch-up," says Andrew Maack, government chief test engineer at NAS Patuxent River, Md., where the U.S. Marine Crops' short-takeoff-and-vertical-landing (Stovl) F-35B and U.S. Navy F-35C carrier variant (CV) are undergoing testing.

Much of 2011 has been dedicated to gathering data to support low-rate initial production (LRIP), including clearing control software and the initial flight envelope for pilot training on the U.S. Air Force's conventional-takeoff-and-landing (CTOL) F-35A. "A major requirement was to deliver data for the training envelope. We've done that, and delivered several updates to that envelope," says McFarlan.

"For CTOL, the envelope was 350 kt. to start. Now it's out to 450 kt. and Mach 0.9 for the jets at Eglin [AFB, Fla.]," he says. "We've been flying in the supersonic corridor [at Edwards AFB, Calif.] to M1.6 and 630 kt. We've finished flutter testing at 630 kt. and are ready to go to 665-700 kt." M1.6 is the maximum design Mach number for the F-35. With the exception of these higher-speed test points, the bulk of envelope expansion is focused on "the lower right, higher dynamic pressure corner" says Lt. Col. Hank Griffiths, commander of the 461 Flight Test Sqdn. and director of the F-35 Integrated Test Force. "So far it looks good for speed and flutter, now we're testing loads and rolling maneuvers using AF-2," he adds.


F-35B tests on USS Wasp included short takeoffs.

LOCKHEED MARTIN

AF-2 is one of three flight sciences test aircraft at Edwards. Another three F-35As—AF-4, -6 and -7—are used for mission systems work. AF-1 through -4 form the original system development and demonstration contingent, while AF-6 and -7 are the first two LRIP 1 production-standard aircraft that were diverted to bolster the test program earlier this year.

Testing at Edwards remains ahead of plan in spite of the hold-ups earlier in 2011. For the year to date, Griffiths says, "we've achieved 430 flights out of 390 planned, so clearly we're ahead and we'll make our year's goal for CTOL." By the start of December, the CTOL fleet (not including the pre-production test aircraft) has amassed more than 625

LOCKHEED MARTIN

**Six F-35A test aircraft, including two for LRIP, are based at Edwards AFB, Calif.**

flights and around 1,190 flight hours.

The test rate is 10% above the planned rate despite a "lot of significant modifications and a lot of smaller roadblocks," says Griffiths. "We schedule five to six sorties per day and have about 40% attrition, which means we get three to four flights on average. It can be because of maintenance or software issues, or weather or availability of range assets. It's not just jet-related. On average this works out at eight flights per month per aircraft, and we can do double-turns. This is very good compared to legacy test aircraft, which took four years to get to this rate."

An extra 40 sorties were added to the Edwards workload for the Eglin maturity evaluation (see p. 44). "The first phase was in July-August, but these showed problems with software and the envelope, so we created another software load [Block 1B] and did five more flight evaluations. Now we are looking at whether or not to tweak it one more time before letting Eglin fly," says Griffiths, who expects Eglin to get the all-clear by the end of January.

Overall flight-test results so far are meeting expectations. "CTOL up-and-away handling qualities get very favorable ratings from the pilots," says McFarlan. Cruise drag and range results from testing of AF-4—the first to fly with the initial-service-release-standard F135 engine—are "positive," he says. "Fuel flows at cruise are 1-5% better than the specification engine deck we use for calculating KPPs [key performance parameters] for spec compliance." How much of that improvement is due to the engine and how much to the airframe will not become clear until the aircraft is fitted with an inlet pressure rake in the summer of 2012.

Flight-control modifications have been developed to mitigate the sudden onset of an uncommanded roll encountered during a turn. Dubbed the transonic wing roll-off, the phenomena is common in fighters, and has been countered on the F-35A by using roll-rate feedback to tailor the scheduling of leading- and trailing-edge flaps. The nonlinear aerodynamic response "was expected," says Griffiths. "We've had to try and predict vortex shedding off the wings, and the loss of lift it causes." The goal was to use existing flight surfaces to cure the problem. "I'm still within the design space and didn't have to add hardware like fences or anything that would impact the low-observable characteristics," he adds.

The cure was fast-tracked using a flight-control-system parameter change device that enabled multiple control-law solutions to be evaluated in a single flight. "We can try 20 in one flight and we've improved it quite a bit. We've reduced it from around 30 degrees-per-second roll-off to the single degrees per second. Not only that, but the Stovl guys have learned from us and are not starting from point zero," Griffiths says.

"We have done most of the B flying, and flown the C at higher altitude, and are pleased with the results," says McFarlan, who adds that initial results suggest the deployable spoilers built into the F-35C's bigger wing will not be needed when transonic wing roll-off testing with the CV variant is conducted next year.

Mission system testing is also accelerating with the increasing maturity of software loads. Griffith says the move to Block 1B helped improve performance and reduced issues with "cold restarts" on the F-35A. "One of the challenges is to get all the computers to talk to each other when they wake up. The issue has mostly been with the integrated core processors. If those two didn't connect properly we'd have to restart to do the handshake again." The problems appeared to peak last December, "but it's been getting better as new software has been introduced," he says.

Upgrading with Block 2A hardware and software is scheduled to begin this month. Block 2A, which introduces sensor fusion, has completed more than 50 hr. of flights on the 737 cooperative avionics testbed. "We have demonstrated fusing data from three sensors into one track on several flights," says McFarlan. "We have done synthetic-aperture radar tests, a lot of electronic warfare [EW] tests, and we have just started putting DAS [distributed-aperture system] im-

U.S. NAVY

**F-35C tests have included steam (right) and electromagnetic catapult launches at NAS Lakehurst, N.J.**

agery on the helmet-mounted display," he says.

Initial sensor fusion between the EW systems and radar "went pretty well," says Griffiths. "We have had the DAS running on the aircraft for the first time, providing 360-degree coverage. You can see right through the aircraft, which is wild," he comments. The DAS is an internally mounted, multifunctional sensor for air-to-air and air-to-surface targeting capability. Tests of another key sensor, the nose-mounted Electro-Optical Targeting System (EOTS), is also getting underway with the first firing of the laser range-finder in November from AF-3 equipped with Block 1B software.

"We have also have conducted CNI [communications, navigation and integration] sweeps and tested the anti-jam and secure voice systems. We've also completed signature testing using AF-3, 6 and 7," adds Griffiths. The aircraft "is meeting or exceeding the low-observable requirements, so we know we have a stealthy aircraft, which is fantastic."

The biggest 2011 test target for the F-35B was initial sea trials of the Stovl variant on the LHD-class amphibious assault ship USS Wasp in October.

"We spent three weeks at sea and had two of the aircraft complete 100% of the test objectives of Stovl sea trials. This was just an amazing accomplishment and I believe a very strong testament to the soundness of the Stovl design," says U.S. Navy Vice Admiral David Venlet, Joint Strike Fighter program executive officer. "They cleared more of an envelope for F-35 than Harrier has today in its mature life. This airplane experienced wind conditions, crosswind limits, from different spots . . . and we actually went to parts of the envelope that Harrier doesn't go to today."

The primary objective of the sea trials, which involved BF-2 and BF-4, was to characterize the environment on the ship during Stovl operations, using instrumentation on the deck. Aircraft handling qualities data were also collected during vertical landings and short takeoffs in various wind conditions.

Three types of vertical landings were demonstrated, the aircraft approaching straight-in from the stern or flying along the port side of the ship, hovering and performing a 90- or 45-deg. crossover to land on the deck.

"In general, the aircraft did very well at the ship, and we got around a significant portion of the wind envelope," says Marine Corps Lt. Col. Fred Schenk, government test-flight director at Patuxent River.

"The air over the ship is pretty unpredictable, and local crosswinds were not necessarily what we expected." This caused "a little bit of drift" on short takeoffs as the aircraft passed through the "burble" of disturbed air in the lee of the island. "We learned a few things for the control-law team about how the air-data system behaves in winds and in the burble. We have data now to optimize the controls," says McFarlan.

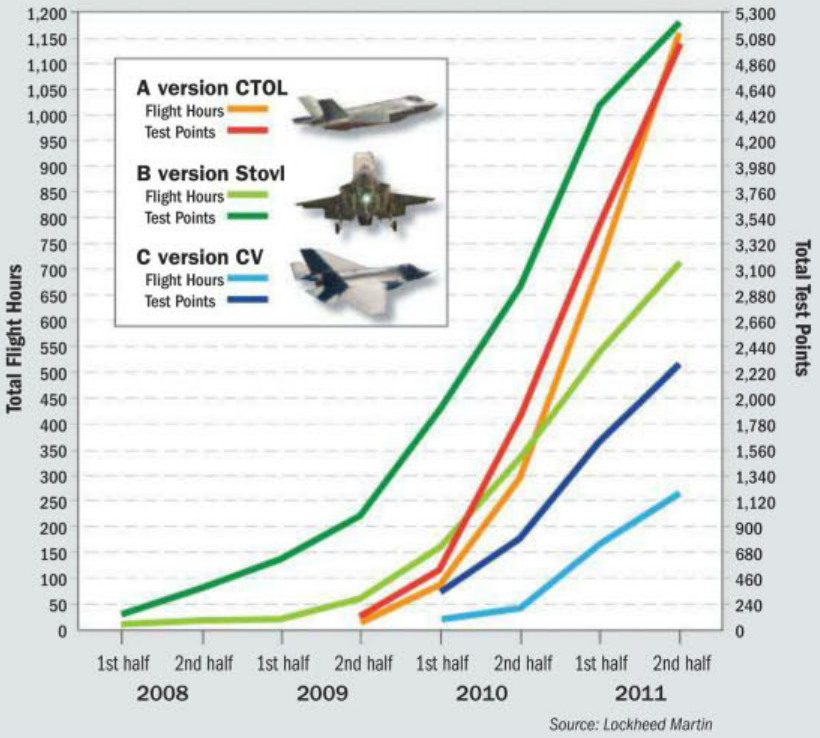
One of the key questions was whether the F-35B would encounter hot gas ingestion (HGI), a phenomenon in which hot exhaust recirculates into the inlets during a vertical landing and reduces engine thrust. On the Wasp, HGI was a non-event, according to McFarlan. "Most of the tests were with forward speed. Where we see HGI at [Patuxent River] is with tailwinds of around 10 kt.," says McFarlan, adding the cool lift-fan exhaust blocks most of the hot air. "It happens in the last 15 ft. of landing, and the control system handles it well."

Much of the Stovl development for 2011 focused on overcoming issues with the lift system that have delayed testing or imposed operating limitations. These included flutter and related wear of auxiliary air-inlet doors on top of the fuselage, and overheating of roll-post nozzle actuators in the wings (see p. 43). Redesign of the inlet-door actuator and mechanism has increased stiffness and moved the natural frequency of the doors higher to eliminate flutter. Aircraft BF-1 has completed ground-vibration and proof-load tests and is expected to fly this month.

Other issues uncovered include vibration of the large underfuselage doors that open to allow the three-bearing swivel nozzle to deploy. A new, stiffer backup structure is available to avoid any operating limitations, McFarlan says. Cracking of a structural beam in the lift-fan bay, which supports actuators for the upper and lower doors, was a "hot spot" identified during structural testing. BF-1 has been modified, and BF-2 will follow during scheduled down time. BF-4 also has microscopic cracks, but BF-3 has less Stovl time and is not cracking yet, while BF-5 already has a redesigned beam. "It's not holding us up, as BF-3 and -5 are doing the Stovl flying," he says.

Another redesign is tackling reliability problems caused by recurring failures of the upper lift-fan door actuator. "The mechanism that locks the door in the mid-position has a tendency to get stuck on the ground," says McFarlan, adding that there is an emergency opening capability in flight. Pawls inside the

## F-35 Flight-Test Progress




Source: Lockheed Martin

actuator are being modified to eliminate the problem. "It's a small design change that will be available within a month," he says. A trade study is also under way on a simpler actuator.

Stovl tasks for 2012 include continuing envelope expansion and collecting data for KPP compliance. "The initial envelope [450 kt./Mach 0.9] is nearly done with; 630 kt./Mach 1.6 is next," says McFarlan. "A big focus for the [F-35B] will be going out to Edwards to do airstart and high angle-of-attack tests," says Schenk. Weapons tests will also begin for all variants, initially the internally carried Joint Direct Attack Munition, and will involve clearing externally carried AIM-9X missiles to act as camera pods for separation testing.

Development of the F-35C is not as far along, but the focus for 2012 will be on carrier-suitability testing to ready the aircraft for its first sea trials early in 2013. This began in 2011 with jet-blast deflector (JDB) testing and catapult-launch tests. Arrested-landing tests were halted after tailhook "skip" prevented the aircraft catching the wire.

"What we discovered is different on the F-35 than other generations of aircraft," says Steve O'Bryan, vice president of F-35 business development. "On a single-engine airplane the main landing gear is closer to the hook touchdown point than prior generations of airplanes. On older airplanes, it is pretty simple. You roll over the arresting gear—the wire—and then the wire goes flat and then it springs up to its normal position. Then, the hook generally engages it. The F-35's distance is much closer. So the springing effect isn't there," he says. The hook is being redesigned with an improved damper to hold it down and a reshaped shoe to catch the wire.

JBD tests at NAS Lakehurst, N.J., evaluated the heating environment on the deflector and blast environment on the aircraft. Lakehurst tests included degraded catapult launches, with no engine issues seen from steam ingestion, McFarlan says. A test with the electromagnetic aircraft launch system, which will replace steam catapults on future carriers, was conducted on Nov. 18, but was not a 2011 test task.

The revised plan pushed mission-system testing later in the F-35 development program, but some progress was made this year. "We did more testing than planned in 2011, including Block 1A maturity testing to confirm functionality and stability for the Eglin training aircraft," says McFarlan.

# Ramping Up

## Extended test phase aids Pratt's production buildup as Stovl fixes developed

**GUY NORRIS/LOS ANGELES**

As another turbulent year for the F-35 Joint Strike Fighter draws to a close, Pratt & Whitney is optimistic that 2012 could prove a potential watershed for the program and its F135 engine.

Ahead lie the challenges of ramping up production, reducing costs and completing improvements to the F-35B short-takeoff-and-vertical-landing (Stovl) propulsion system. Left behind is the haunting specter of the General Electric/Rolls-Royce F136 alternate engine as well as the teething problems that dogged the early phases of the F-35B test effort and pushed the Harrier replacement into an uncertain probationary period.

"The engine is performing very well, and we're happy with the progress we've made on the Stovl system this year," says Chris Flynn, director of F119/F135 programs at Pratt & Whitney. "The key focus I have right now is working on a production ramp, making sure it is successful and driving the affordability of the product through our affordability initiatives."

Assembly of production engines, as well as additional F135s for flight testing, continues with up to 32 production-standard units expected to be delivered by year-end, versus 12 in 2010. "That's a two-and-a-half times ramp rate on the production line," says Flynn.

Additional engines, added to the program through the technical baseline review (TBR) restructuring process announced early this year, will boost deliveries to 45-50 engines in 2012, says Flynn. The extra engines will support the extended flight-test phase that emerged from the TBR and, with the exception of a single F135 in 2013, will all be handed over in 2012. The process "could actually help" Pratt in its efforts to accelerate toward full-rate production, says Flynn.

Pratt is in the midst of closing out deliveries of engines for low-rate initial production (LRIP) 3 batch aircraft, and late in December will deliver the first for LRIP 4. "On Stovl we'll start delivering the first LRIP 5 lift system before the end of the year, though the first 'main engine' won't be until mid-2012," Flynn explains. Propulsion deliveries for F-35Bs are staggered because part of the lift system is also an integral part of the aircraft's fuselage. The variable-area vane-box nozzle, which vectors the lift-fan exit flow as well as back-pressures the fan to control stall margin, is therefore one of the earliest modules to be delivered, while the lift fan is almost the last.

Pratt aims to deliver F135s at the same cost as the F-22's F119 engine by the 250th unit and, working jointly with the F-35 Joint Program Office and the Pentagon's Joint Assessment Team, the company developed an "affordability curve" in 2010 to help it get there. "We've been delivering right to on that curve," says Flynn.

As part of the affordability initiatives, Pratt has signed a long-term sourcing agreement with Turkey's Alp Aviation to provide lower-cost integrally bladed rotors (IBRs) in the low- and high-pressure compressor. The 15-year deal covers provision of titanium IBRs for Stages 2 and 3 in the low-pressure compressor and Stages 4 and 5 in the high-pressure compressor, all of which will be made using specially developed titanium-flank milling-cutting tools and other automated procedures. The new tool cell is in its "qualification cycle and expected to yield over 30% monetary savings when activated, creating millions of dollars of savings for the JSF program," says Alp.

The IBR process is expected to reduce overall production hours by up to 40%, and Alp says most of the planned savings have already been demonstrated for Stages 2 and 3. "They've started initial delivery of qualification parts, and they're very close to starting production parts," says Flynn, who expects the initial IBR shipsets to arrive over the next three months. "We continue to look for other opportunities and are focusing on partner countries first," he adds.

Pratt is also closing in on final fixes for the three lift system integration issues identified during flight tests of the F-35B


PRATT & WHITNEY

**The first production standard F135, LRIP1-1, undergoes acceptance tests at Pratt's Middletown, Conn., facility.**

and has completed all temporary retrofit work with Lockheed Martin and lift system partner Rolls-Royce to enable the resumption of "meaningful flight tests at Eglin AFB [Fla.]," says Flynn. Modifications included adding shim-spacers to the lift fan driveshaft to compensate for the unanticipated expansion and contraction of the shaft experienced during flight, as well as temperature sensors for the clutch and improvements to the insulation in the roll posts.

Tests of the new production-standard shaft, which incorporates a more flexible bellows coupling, are ongoing and anticipated to run through early 2012. "The long-term improvements will be introduced in late 2014, but today we have a system which provides full capability," stresses Flynn.

"We are in the process of introducing the roll post thermal improvements," he adds. The upgrade includes thermal blankets and better potting material to the roll post nozzle actuator components

# Time Served

## Some Pentagon officials predict an early end to F-35B probation, though the program is still unable to train pilots

**AMY BUTLER/WASHINGTON**

The F-35B, which only a year ago faced a premature termination, appears to be poised for release from its probationary status for good technical behavior.

"We have a presumption of success with the F-35B [and] it is no longer in the crosshairs," says Gen. Joseph Dunford, assistant Marine Corps commandant. The Marines are the first service slated to declare operational capability with an F-35 variant. After repeated delays, weight problems and technical setbacks, the Marines now hope to field the first F-35B squadron designed for short-takeoff-and-vertical-landing (Stovl) operations on large-deck amphibious ships in 2016.

"We are on a threshold now [such] that I don't believe that there is anything more unique to Stovl than the other variants that should cause it to have special attention," says U.S. Navy Vice Adm. David Venlet, F-35 program executive officer. Defense Secretary Leon Panetta and Marine Corps Commandant Gen. James Amos will likely release the B from probation by spring, nearly a year earlier than planned, says Venlet.

In January, then-Defense Secretary Robert Gates said he would kill the B in early 2013 if performance and cost problems were not resolved.

Though Gates's public admonishment of the F-35B stuck (lawmakers latched onto the issue), a sense of relief among program officials hoping to save the project was palpable last summer when Gates retired.

Gates left no specific criteria, perhaps giving the program some breathing room, but he "decoupled" F-35B work to avoid further problems from hindering the progress of the conventional F-35A and F-35C carrier version.

However, Venlet says the test team has either proven or is poised to demonstrate fixes to each problem. That and the successful at-sea trials onboard the USS Wasp LHD-class amphibious ship in October bodes well for the B variant's technical recovery (see p. 39).

Even if the F-35B clears this hurdle, challenges remain to field the system. Pilot training, which was to begin at Eglin AFB, Fla., early this fall, has slipped into next year owing to a disagreement among Pentagon officials over the readiness of the aircraft to conduct unmonitored flights there.

In October, the Pentagon's chief tester cited several concerns. These include a need for mature technical manuals, software modifications to correct problems with the integrated power package, improved fault-detection software and an upgraded ejection seat that has fully passed qualification testing. Furthermore, the program has not yet exceeded 2,000 flying hours, the earliest point at which testers typically consider releasing a new system for unmonitored flights.

The chief tester says the risk of a mishap "would overwhelm the very modest benefits of beginning flight training this fall" and argues for a slip of up to 10 months. Winslow Wheeler, a former congressional aide and longtime Pentagon critic, suggests that the entire program—including production and training—be put on hold until more testing is completed.

Ultimately, the Air Force Aeronautical Systems Center is responsible for issuing the military flight release (MFR) for unmonitored F-35A flights at Eglin; five aircraft there are now being used only as maintenance trainers.

Testers at Edwards say the MFR could come as early as

to cope with greater than anticipated heat experienced inside the nozzle bay. The problems became acute in jet-borne flight below 60 kt. and were caused by engine air leaking through nozzle roll-post seals and heating the actuator. The revised potting compound increases the unit's thermal capacity says Flynn, who adds that a nozzle actuator component redesign effort is well underway and will be introduced into production engines in late 2012. "The basic configuration is relatively stable, and the changes give it much more thermal capability," he adds.

The third issue, and what originally threatened to be potentially the most-expensive redesign effort, concerns the lift fan clutch plate which showed higher than expected drag during conventional mode flight. This heated the clutch to unacceptable levels to the extent it affected the ability to transition to Stovl mode for landing. The short-term solution involved adding a temperature sensor to the clutch housing so pilots can monitor the conditions, as well as introducing pilot procedures such as lowering the landing gear or changing altitude and airspeed. The longer-term focus has been on developing potential cooling systems as well as evaluating the root causes.

"We want to eliminate the source of the heat-up of the plate. Approximately every 500th flight we'll get a heat-up event, and the testing we have ongoing today is to confirm the trigger mechanism for that. We are pretty darn close to identifying it," says Flynn. Pratt "has a couple of tests still to do, but the feeling is this is going to be a relatively simple adjustment to the tolerances. We believe it will be completed within the current production configuration."

Pratt is also completing work with Lockheed Martin to boost thrust through the lift fan to provide additional vertical-lift bring-back (VLBB) margin. Although described as "a couple of 100 pounds of thrust," the additional power will assist with meeting the VLBB requirement, which calls for a vertical landing with an unused weapons load of around 3,000 lb., or corresponding to two 1,000-lb. Joint Direct Attack Munitions and two Amraams.

"That's going through the incorporation process," says Flynn. The revised engine control software "takes advantage of reduced variability in the scheduling" to eek out additional power without mechanical changes. Regarding the need for future thrust growth, Flynn says: "From everything I've heard, the capability we're providing meets the requirements."

January, however, after conducting a "risk acceptance" process.

Meanwhile, Naval Air Systems Command is reviewing a request for an MFR to ferry the first production F-35B to Eglin from Lockheed Martin's assembly plant in Fort Worth. Marine Corps officials say that could take place as soon as this month. However, another release would need to be issued to allow for flight training with the B variant. The fiscal 2011 Marine Corps Aviation Plan calls for 10 F-35Bs equipped with Block 2B software, six aircraft capable of austere and/or ship-based operations, and a flight envelope of 7g and 50-deg. angle of attack to declare initial operating capability.

## Key F-35B Development Issues


LOCKHEED MARTIN PHOTO

# Debris Danger

## With orbital detritus at a tipping point, NASA scientist makes a clarion call

**MARK CARREAU/HOUSTON**

Get serious, get together or get clobbered—this is the message from Nicholas Johnson, NASA's chief scientist for orbital debris and the top U.S. representative to the U.N. on the issue.

The world's space-faring nations must forge a cooperative strategy for the costly and technically challenging elimination of orbital debris that poses a growing threat to strategically important robotic as well as manned spacecraft, Johnson says.

Failure to address the issue methodically could place future generations of vital communications, navigation and weather satellites in jeopardy, he warns. Johnson's concerns come on the heels of a Sept. 1 report by the National Research Council (NRC), which states that "the current orbital debris environment has already reached a 'tipping point.'"

According to Johnson, efforts over the past two decades to mitigate the growth through changes in the design and operation of launch systems and satellites have given way to a new concern: the increasing risk of collision between existing debris in Earth orbit, which adds to the fragment population faster than gravity can pull the junk through a descent into the atmosphere, destroying it.

"It took a lot of effort, energy and money to get these things into space, and by golly, it will take a lot of that to get them out," Johnson told an American Institute of Aeronautics and Astronautics gathering here Nov. 29. "That is our challenge right now."

To address the prospect of new collisions between existing space junk, the NRC urges a reexamination of internationally recognized restrictions that prevent any one nation from sweeping away the debris from another country's spacecraft.

Last year, the Obama administration's national space policy recognized the threat as well and tasked NASA and the Defense Department with developing remediation technologies and techniques.

NASA's Johnson Space Center, where the agency's orbital debris assessment efforts are led by Johnson, was recently charged by NASA's chief technologist with forging a response that includes contributions from experts throughout the agency.

"It's not a sense of urgency, but [it] is a sense of responsibility," says Johnson, who consults on the issue with the Inter-Agency Space Debris Coordination Committee and the International Academy of Astronautics as well as the U.N. "We know we can't do it today, surely not economically, and in some cases the technology is not quite there yet either," he says. "But we know in the long term we have to do something. So we need to start thinking about the problem seriously."

The Pentagon's Surveillance Network tracks 22,000 large objects in Earth orbit, with a combined mass exceeding 13.4 million lb. Only 1,000 of those represent operational satellites. Experts estimate that there are 500,000 debris pieces larger than 0.5 in., any one of which could prove lethal to crew on the International Space Station (ISS). Indeed, the debris threat has grown dramatically in the past four years due to two major events (see chart).

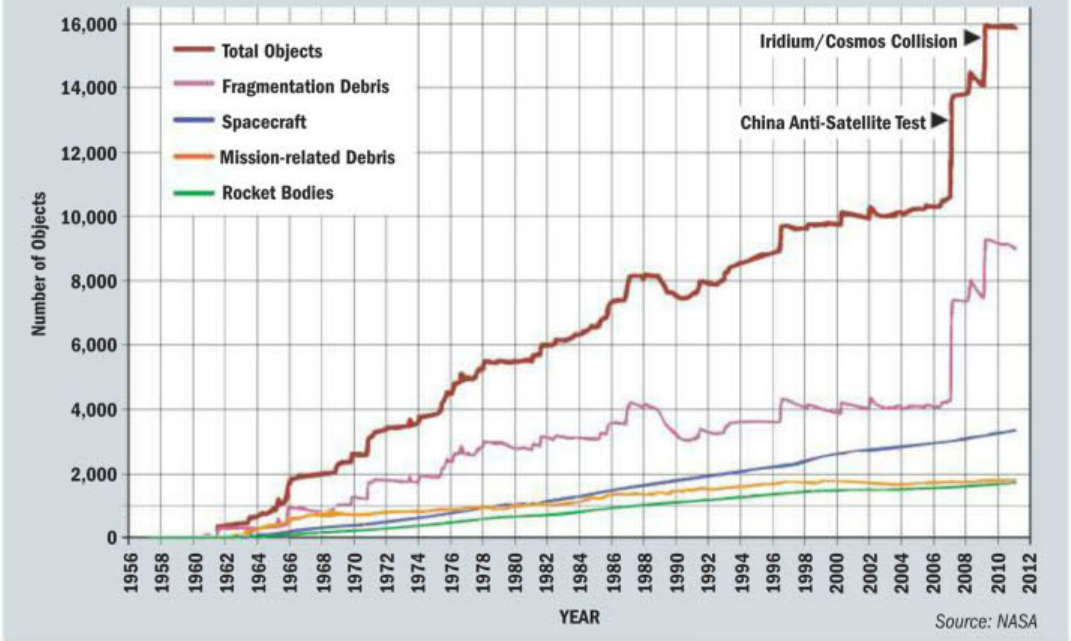
In 2009, a defunct Russian spacecraft collided with an active U.S. communications satellite. Two years earlier, China blasted one of its own polar-orbiting weather satellites in an anti-satellite demonstration that prompted worldwide alarm.

Twice this year, the ISS has had to make an evasive maneuver to avoid a debris collision threat, double the previous annual average for evasive action. In addition, a collision threat to the station on June 28 forced the crew to take refuge in their Soyuz transport capsule, and crew members nearly had to do so again on Nov. 23, when a 4-in. piece of space junk passed near the ISS. Last year, NASA carried out six debris avoidance maneuvers among its 60 various robotic spacecraft.

The debris population grows by a "couple of hundred" fragments annually, mostly in response to an average half-dozen "fragmentation" events, typically the result of a propulsion system explosion or weakened pressure tank.

About one piece of debris falls harmlessly back to Earth daily.

### Growth of Orbital Debris Since Space Age Began

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**Jan. 15-16**—American Institute of Aeronautics and Astronautics' 15th Annual FAA Space Transportation Conference. Walter E. Washington Convention Center, Washington. Also, 10th Annual U.S. Missile Defense Conference and Exhibit. Ronald Reagan Building and International Trade Center, Washington. And, **Feb. 15-16**—15th Annual FAA Commercial Space Transportation Conference. Walter E. Washington Convention Center. See www.aiaa.org

**Jan. 15-18**—National Business Aviation Association's Annual Schedulers and Dispatchers Conference. San Diego Convention Center. See www.nbaa.org/events/sdc/2012

**Jan. 18-19**—Canadian Institute's National Forum on Business and Commercial Aircraft Transactions. Intercontinental Hotel, Montreal. Call +1 (416) 927-7936 or see www.canadianinstitute.com/2012/321/aircraft-transactions

**Jan. 19-22**—U.S. Sport Aviation Expo. Sebring (Fla.) Regional Airport. See www.sport-aviation-expo.com

**Jan. 20**—Learjet's Eighth Annual Living Legends of Aviation Awards. Beverly (Hills) Hilton, Calif. Call +1 (303) 668-2688 or see www.livinglegendsofaviation.org

**Jan. 23-26**—World Business Research's "Defense Geospatial Intelligence." Queen Elizabeth II Conference Center, London. Call +44 (207) 368-9465 or see www.wbresearch.com/dgieurope/

**Jan. 24-25**—SMI Conferences' Joint Forces Simulation & Training. Grange City Hotel, London. Call +44 (20) 7827-6000, fax +44 (207) 827 6001 or see www.jointforcestraining.com

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

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

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

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

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

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

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**March 13-14**—Innovation Supply Chain Showcase. Orlando, Fla.
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**April 3-5**—MRO Military Conference & Exhibition. Dallas.
**April 23-25**—NextGen Ahead: Air Transportation Modernization. Washington.
**May 8-9**—Civil Aviation Manufacturing. Charlotte, N.C.
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**Oct. 9-11**—MRO Europe. Amsterdam.

**PARTNERSHIPS**

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**July 9-15**—Farnborough air show.
**Oct. 1-5**—63rd International Astronautical Congress. Naples, Italy.
**Oct. 9-14**—Japan Aerospace. Nagoya.
**Dec. 11-13, 2012**—Middle East Business Aviation. Dubai.

# What Next in Airline Safety?

BY FRANK TULLO
AND KEY DISMUKES

*Tullo (far left), an instructor at University of Southern California, was chief of flight operations at Continental Airlines and has chaired the Air Transport Association's Human Factors Committee. Dismukes recently retired as NASA Ames Research Center's chief scientist for aerospace human factors.*

Aviation just passed a remarkable anniversary. It has been 10 full years since any passenger has been killed in the crash of an aircraft of a major North American airline. The remarkable level of safety achieved in advanced nations should be the envy of all industries. But even as we celebrate we should pause to reflect on how this achievement has come to pass. Many forces constantly work to undermine safety, and we must resist complacency.

Numerous advances contributed to the steady decline in accident rates over the past several decades. Reliability of equipment systems has improved greatly due to materials science, solid-state electronics, computer science and engineering development methods. Flight management and enhanced ground proximity warning systems as well as sophisticated navigation and electronic flight information system (EFIS) displays are just a few of the new tools. Crew resource management and threat-and-error management disciplines have contributed to the enhanced training of pilots and are gradually being applied to train other personnel. Intensive investigations by the NTSB have provided insight into accident causes and remedies.

> "No airline would knowingly compromise safety to shave costs, but it is difficult to know up front how cost-cutting measures will affect safety."

Nonetheless, substantial challenges remain. We must address the safety record of commuter airlines. In its hearings on the Colgan Air Flight 3407 accident, the NTSB noted that all of the fatal accidents in the U.S. in recent years have occurred in the commuter segment of the industry. Many commuters operate aircraft as sophisticated as those of major airlines, so equipment does not seem to be a major issue. The 3407 hearings highlighted lower levels of flight experience, training issues, fatigue and low pay for new commuter pilots. What was not emphasized is that commuters operate under more challenging conditions than the larger airlines. Short-haul flights include a larger percentage of time in climb, descent, approach and landing than longer segments. And they fly at lower altitudes, with more exposure to weather.

Contrary to some claims, not all Part 121 flights operate at the same level of safety under FAA mandate. Rather, FAA standards establish an important floor for safety. Many major airlines and commuters go beyond FAA requirements. The challenge is to develop practical ways to bring all commuter operations up to the level currently displayed by major U.S. airlines. Although regulation must play a role in this, it will not suffice. The entire industry must be engaged in brainstorming. The NTSB hearings on commuter airline safety started the ball rolling; how can we keep it going?

Across the industry, the current economic climate has forced substantial cost-cutting. Many airlines have gone through bankruptcy or merged. No airline would knowingly compromise safety to shave costs, but it is difficult to know up-front how a cost-cutting measure will affect safety in the long run. In this respect, our high level of safety works against us. Accident rates are so low that whether an airline has an accident in a given year is more a reflection of statistical variability than its safety program.

The industry needs statistically valid measures of accident precursors that will let us detect and evaluate trends before accident rates go up. Several measures have already been developed with help from federal funding. The Line Operations Safety Audit, Flight Operations Quality Assurance and Aviation Safety Action Program programs in the U.S. can provide an airline with information about what is really happening in day-to-day line operations and identify troubling hot spots and trends. However, these programs can overwhelm an airline with raw numbers. Research is needed to find ways to effectively massage the data into useful information. Also, not all airlines use these tools, and we lack a way to consolidate data from these programs across the industry and analyze it to ferret out trends and weaknesses.

Finally, a troubling trend is the several-year decline in the U.S. for federal funding for aviation safety research. The FAA and NASA have historically supplied the great majority of funds for aviation safety, directly resulting in many improvements. The FAA's R&D is now focusing heavily on developing NextGen systems for traffic management and is appropriately concerned with developing and implementing these systems safely. However, R&D safety issues are not limited to NextGen. The percentage of NASA's funding directed to aeronautics in general and to aviation safety in particular has declined substantially over the past two decades. We probably will not see a spike in airline accidents due to this decline in the next few years, but the long-term story may be very different as the challenges of densely occupied airspace, introduction of UAVs into that airspace and airline budget woes grow.

So let us pause to celebrate a major accident-free decade, but not forget the lessons of the past. To paraphrase Thomas Jefferson, the price of safety is eternal vigilance.

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