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BAE Systems fabricates aft fuselages for the F-35 in Samlesbury, England. This work is among its businesses that requires a special security agreement (SSA) with the U.S. to allow BAE employees to have access to highly classified information. BAE officials say they will not merge their company with EADS if that deal jeopardizes this SSA.



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51 While most low-fare carriers are continuing to grow, strategies and behavior patterns are changing, particularly in Europe.

28 FAA nears completion of a public-private partnership that may provide \$1 billion for buying, installing NextGen CNS avionics.





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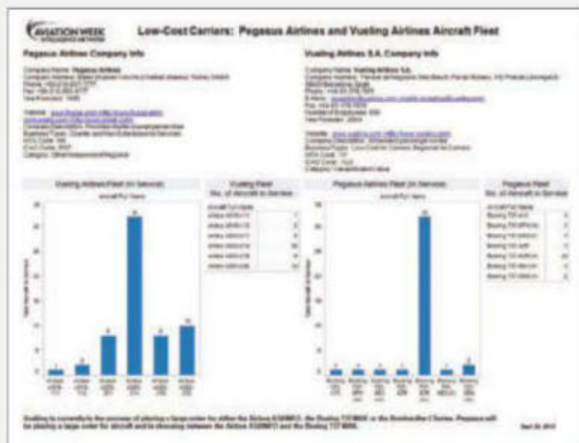
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58 Before going farther down the broken F-35 path, Pentagon needs to consider some opportunities



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AIRLINE FLEET DATA

✱ **European low-cost carriers** Vueling and Pegasus plan to announce new aircraft orders soon (see p. 54). AWIN allows users to see detailed fleet information on more than 130,000 aircraft around the world and profiles of more than 500 airlines. Detailed profiles on leading airlines include financials, key personnel, traffic and more. AWIN also has information on more than 25,000 industry organizations, including 14,000 suppliers and 130,000 professionals.

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U.S. 2013 FEDERAL BUDGET

✱ **Stay updated on details** as the 2013 fiscal year begins. AWIN offers defense program budget portfolios on aircraft; intelligence, surveillance and reconnaissance; military space; shipbuilding; ground vehicles, and more. Our fiscal 2012 U.S. federal budget report also offers updates on the FAA and NASA spending plans.

AviationWeek.com/usbudget

PROGRAM PROFILES

✱ **Major rotorcraft players are teaming** as European nations and the U.S. consider purchase of new heavy-lift helicopters (see p. 34). Get Major Program Profiles on 150 programs, including rotorcraft, commercial aviation, military aircraft, engines, missiles, UAVs, seaframes, satellites and weapon systems.

AviationWeek.com/programprofiles

Stories Seen First on AWIN

- **Europe, Japan Join Forces** On Hypersonic Technology
- **Yemen To Get U.S. UAVs**
- **Pinnacle's Losses To Grow** Under New Delta Contract
- **EADS Offers Merger Talks** With Skeptical Germany
- **SkyTeam Members To Share** Second Beijing Airport

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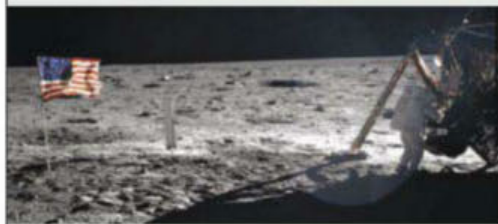
NORTHROP GRUMMAN





From the Web

Comments from readers
on **AviationWeek.com**



In the On Space blog, Senior Editor Guy Norris writes that though Neil Armstrong remained a deeply private man, one of the few arenas in which he seemed happy to speak was the Society of Experimental Test Pilots. In a talk at SETP's annual symposium in 2007, he covered the development and testing of the lunar landing research/training vehicle.

Redstone says:

To paraphrase Armstrong's famous pronouncement, his passing is "One Giant Loss For Mankind."

Mike Borgelt adds:

Armstrong was not just the first man on the Moon, he was the first human to ever walk on another world—no matter what else the human race does in space.

QNH1051 agrees:

Selflessly serving a cause greater than oneself. This is perfect tribute to a pioneer!

Congressional Editor Jen DiMascio notes on the Ares defense blog the critique of sequestration made by former U.S. Defense Secretary Robert Gates and Adm. (ret.) Michael Mullen at a recent seminar held by the Center for Strategic & International Studies.

Dave-in-Rio-Rancho says:

We'd be in a lot less trouble aircraft-wise if Gates had continued F-22 production and development while reducing F-35 spending until the production configurations of the Joint Strike Fighter were more finalized.

RSF says:

Gates's flawed concept for U.S. airpower sacrificed a critically needed fighter for a strike aircraft that has taken 11 years to finally drop a bomb, leaving us with legacy fighters flying far beyond their normal lifetimes while China develops multiple stealth platforms.



Comment on articles, blogs
and photos at: **AviationWeek.com**

Feedback

FACING DISSENSION

In the future, please refrain from publishing such obviously partisan political rhetoric as "Face to Face: Pilot Defender," an interview with Sen. James Inhofe (R-Okla.) (AW&ST Aug. 27, p. 32).

I know politics plays a role in virtually every aspect of commercial, military and space technology development today, but if I want to read such vile drivel from one of our senators, I'll read the transcript from last night's Fox News.

Dwayne Carter

GILBERT, ARIZ.

LICENSE TO DISAGREE

Sen. James Inhofe was incorrectly identified as "the Senate's only commercial pilot." In truth, he is just another politician who happens to hold a commercial certificate.

Darcy Vernier

MARINA DEL REY, CALIF.

FALCON 9 CALLED INTO QUESTION

SpaceX's Falcon 9 vehicle has far graver problems than merely being unflown.

First, its aerodynamically unstable configuration makes it a dangerous vehicle to fly. Second, its inefficient rocket engines pollute the atmosphere with thousands of pounds of unused kerosene. We do not allow gasoline, a



hydrocarbon, to be spilled into the atmosphere, yet there are no restrictions on kerosene, also a hydrocarbon.

Kerosene is spilled because rocket engines operate fuel-rich, which means there is not enough oxidizer to combine with all of the kerosene. This is not a trivial matter.

Aviation Week & Space Technology welcomes the opinions of its readers on issues raised in the magazine. Address letters to the Executive Editor, Aviation Week & Space Technology, 1200 G St., Suite 922, Washington, D.C. 20005. Fax to (202) 383-2346 or send via e-mail to: **awstletters@aviationweek.com**

Letters should be shorter than 200 words, and you must give a genuine identification, address and daytime telephone number. We will not print anonymous letters, but names will be withheld. We reserve the right to edit letters.

Rocket engines operate at a mixture ratio of 0.65, although SpaceX claims 2.2. To burn all the kerosene would require a mixture ratio of 3.45. As it is, only 20% of the kerosene combines with oxygen. The unused portion is "dumped" overboard.

The fuel-rich mixture ratio yields a specific impulse of 302 sec. whereas a mixture ratio of 2.2 would yield 420 sec., and 3.45 would provide a specific impulse of 445 sec. for a much more efficient rocket. The exceedingly fuel-rich mixture ratio allows a very cheap rocket engine to be built.

Dale L. Jensen

LAWNDALE, CALIF.

SPACE FANTASY?

In a recent Feedback column (AW&ST Sept. 3/10, p. 10) reader Karl Kettler opines that in lieu of Mars-like programs, NASA should concentrate "on more important endeavors such as assuring the survival of the human race through a methodical program designed to lead to the permanent human presence in space."

This objective is a pipe dream. Consider the math. How many taxpaying peasants would it take to send a few elite humans to survive elsewhere in space? Why should said taxpayers agree to do so? And where would the elite go in any reasonable period of time?

Don Hamerla

KING OF PRUSSIA, PA.

SUSTAINING SPACE TRAVEL

I agree with Karl Kettler that there should be a methodical program leading to permanent human presence in space. However, he seems to believe that finding minerals and water on potential future habitable bodies is not important to that aim. It is an essential component of extraterrestrial settlement. Does he envision forever sending water and other resources from Earth?

Maris Lauva

DIANELLA, AUSTRALIA

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Roger Sherrard



G. Wierzbanski



Tom Roche



Joe Bento



Von Gardiner



John Wallace



David Davenport

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.

Roger Sherrard (see photo) has been promoted to president of Irvine, Calif.-based *Parker Aerospace*, succeeding **Bob Barker**, who is scheduled to retire at year-end after 39 years with the company. Sherrard has been president of Parker Hannifin's automation and instrumentation groups. **Greg Crowe** has been promoted to VP-operations from VP and general manager of the Fluid Systems Div. He has been succeeded by **Guy Martin**, who was general manager of the Seal Group's Engineered Polymer Systems Div. **Frank Dubey** has become VP and general manager of the Control Systems Div.

Michael Merk has been named manager of real estate and business development at *Phoenix-Mesa Gateway Airport*. He was director of real estate for BAX Global.

Ginger Wierzbanski (see photo) has been named VP-space, missile defense, advanced technology and ground programs at *Northrop Grumman Corp.*, Falls Church, Va., succeeding **John R. Landon**, who is scheduled to retire at year-end. Wierzbanski has been VP-government relations and was legislative assistant to the vice chairman of the U.S. Joint Chiefs of Staff.

Robert L. Crandall, former CEO of AMR Corp. and American Airlines, has joined the board of travel site *Hipmunk* of San Francisco.

Tom Roche (see photo) has been appointed VP-customer support at Tempe, Ariz.-based *StandardAero*. **Alain Berube** succeeds Roche as VP-turboprops and fleets from his previous role as VP-operations.

Mark C. Cherry has joined *Aurora Flight Services*, Manassas, Va., as president and chief operating officer. He succeeds Aurora founder **John S. Langford**, who will continue as chairman and CEO. Cherry was VP-corporate strategy and synergy at Sikorsky Aircraft Corp.

Joe Bento (see photo) has joined Itasca, Ill.-based *SEKO Logistics* as chief sales officer for North America. He was executive VP of CEVA Logistics.

Dean Foley has become sales manager of the aerospace division of West Springfield, Mass.-based *Atlantic Fasteners*. He has more than 25 years of

experience in aerospace metals distribution.

Von Gardiner (see photos) has been named senior manager for Defense Department programs, and **John Wallace** VP-market management of Vienna, Va.-based *NJVC*. Gardiner was director of communications and information with USAF Special Operations Command at Hurlburt Field, Fla., and Wallace has been sales director for capital markets and banking corporate accounts, as well as VP-financial services industry at Hewlett-Packard.

USAF Lt. Gen. (ret.) **Dick Newton** has been appointed executive VP of the Arlington, Va.-based *Air Force Association*, succeeding **David T. "Buck" Buckwalter**. Newton was assistant vice chief of staff/director of the air staff at USAF headquarters at the Pentagon.

David Davenport (see photo) has been promoted to VP and regional operations manager of New York LaGuardia Airport-based *FlightSafety International* from manager of the Savannah (Ga.) Learning Center. **Fabio Miguez** was promoted to manager of the Columbus (Ohio) Learning Center from manager of the Detroit Metro/Toledo Center. He succeeds **Chip White**, who moved to the Gulfstream Learning Center. **Daniel MacLellan** has been promoted to regional operations manager and will continue as manager of the Dallas/Fort Worth Learning Center.

Paul Benshoof has been appointed global business development manager for military and government applications at *Locata Corp.* of Las Vegas and Canberra, Australia. He was chief of strategic development at the USAF 746th Test Sqdn. at Holloman AFB, N.M.

HONORS AND ELECTIONS

Women in Aerospace has recognized nine women for their contributions to the aerospace industry and the

advancement of women in the field with its 2012 awards. The Outstanding Achievement Award went to **Gwynne Shotwell**, president of SpaceX; Aerospace Awareness Award to **Susan Anderson**, public affairs specialist at NASA's Johnson Space Center; Aerospace Educator Award to **Shella Condino**, advanced-placement physics and chemistry teacher; Leadership Awards to **Simonetta Di Pippo**, ASI European Space Policy Observatory, and to U.S. Sen. **Kay Bailey Hutchison** (R-Texas); Lifetime Achievement Award to USAF Lt. Gen. **Ellen Pawlikowski**, commander of the Space and Missile Systems Center, Air Force Space Command, Los Angeles AFB; and Outstanding Member Award to **Debra Facktor Lepore**, industry professor at Stevens Institute of Technology in Hoboken, N.J., and president, DFL Space.

Sir Martin Sweeting, executive chairman of Surrey Satellite Technology Ltd. and director of the Surrey Space Center at the University of Surrey, England, has received the International von Karman Wings Award for his contributions to aerospace, presented by the *Aerospace Historical Society* and the Graduate Aerospace Laboratories of the *California Institute of Technology* in Pasadena.

David Barger, president and CEO of JetBlue Airways, has joined the Dallas-based *ISTAT Airlink Advisory Council*. Barger also is chair of the FAA's NextGen Advisory Committee and a member of the board of governors and treasurer of the Flight Safety Foundation. ☼

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AW&ST/S&P Market Indices

(as of 9/26/2012)

PERCENT CHANGE



Weekly Market Performance

Closing Prices as of September 26, 2012

Company Name	Current Week	Previous Week	Fwd. P/E	Tot. Ret. % 3 Yr.	Tot. Ret. % 1 Yr.
AEROSPACE & DEFENSE					
AeroVironment Inc.	23.41	23.05	15.6	-17.1	-20.4 ▼
Allegheny Technologies Inc.	31.38	33.98	13.5	-4.4	-23.2 ▼
Alliant Techsystems Inc.	49.80	50.21	7.4	-32.9	-9.0 ▼
BAE Systems plc	5.16	5.55	7.9	9.9	23.4 ▲
Boeing Co.	70.25	69.90	14.2	47.0	14.6 ▲
Bombardier Inc. 'B'	3.70	3.73	8.2	-14.6	-9.2 ▼
Cobham plc	3.65	3.71	10.6	16.4	27.0 ▲
Curtiss-Wright Corp.	32.69	32.43	11.5	-1.0	15.6 ▲
DigitalGlobe Inc.	20.48	20.87	19.4	-4.1	-1.0 ▼
EADS NV	31.43	33.50	11.4	70.4	17.1 ▲
Eaton Corp.	46.28	48.52	10.5	79.3	28.7 ▲
Elbit Systems Ltd.	33.19	32.59	8.7	-43.7	-10.0 ▼
Embraer-Empresa Brasil ADR	26.17	27.54	9.1	21.0	1.3 ▲
Esterline Technologies Corp.	56.64	58.47	10.2	48.8	1.1 ▲
Exelis Inc.	10.27	10.51	6.1		
Finmeccanica SpA.	4.69	4.97	7.3	-65.0	-32.8 ▼
FLIR Systems Inc.	20.09	20.96	13.1	-25.9	-24.1 ▼
General Dynamics Corp.	66.61	66.51	9.2	14.4	17.8 ▲
General Electric Co.	22.10	22.43	13.6	48.2	45.2 ▲
GKN plc	3.46	3.74	7.8	101.4	22.3 ▲
Harris Corp.	50.80	50.60	9.8	47.1	42.4 ▲
Hexcel Corp.	23.35	24.36	14.5	105.0	6.9 ▲
Honeywell International Inc.	59.44	61.28	12.6	70.3	35.1 ▲
Huntington Ingalls Industries Inc.	41.49	41.44	11.0		53.9 ▲
L-3 Communications Hldgs. Inc.	72.21	72.35	9.1	2.2	21.4 ▲
Lockheed Martin Corp.	91.91	92.24	11.7	33.1	29.7 ▲
Moog 'A'	38.16	39.59	10.8	20.7	14.1 ▲
Northrop Grumman Corp.	66.19	66.90	9.7	57.8	28.2 ▲
Orbital Sciences Corp.	14.58	14.75	13.6	-1.9	10.0 ▲
Parker-Hannifin Corp.	82.26	85.93	10.9	66.1	28.4 ▲
Precision Castparts Corp.	161.06	159.47	15.4	61.0	-3.7 ▼
QinetiQ Group plc	2.93	2.83	11.3	34.2	61.4 ▲
Raytheon Co.	57.59	58.15	10.9	33.5	47.4 ▲
Rockwell Collins Inc.	52.69	52.55	12.2	12.7	0.9 ▲
Rolls-Royce Group plc	13.54	13.93	14.0	79.6	35.0 ▲
Safran SA	36.01	36.96	12.7	129.0	21.8 ▲
SAIC Inc.	12.20	12.69	9.3	-28.5	1.4 ▲
SIFCO Industries Inc.	18.60	19.50		31.6	9.2 ▲
Singapore Technologies Eng.	2.83	2.86	18.8	47.7	23.5 ▲
Spirit Aerosystems Holdings	22.25	23.07	9.1	25.8	34.9 ▲
Textron Inc.	25.95	27.94	12.2	46.8	39.3 ▲
Thales	34.29	35.05	8.7	-15.0	10.9 ▲
Triumph Group Inc.	61.46	60.54	10.4	159.7	18.2 ▲
United Technologies Corp.	78.53	81.72	14.8	37.1	10.1 ▲

COMMENTARY

Rockwell Collins Plans For Life After Clay

Careful succession planning is the hallmark of any well-managed company. Chris Kubasik may be taking over as CEO of **Lockheed Martin** at the beginning of 2013, but the company telegraphed his ascent back in 2010, when he was elevated to president. Louis Chenevert was eased into the position of chairman and CEO of **United Technologies** over several years. And **General Dynamics** has long been grooming Phebe Novakovic, who plans to succeed the retiring Jay Johnson as CEO on Jan. 1. Now **Rockwell Collins** has chosen an heir apparent for its longtime chairman and CEO, Clay Jones. On Sept. 24, the Iowa-based avionics and electronics company announced that Jones was relinquishing the position of president—managing the company's operations—to 52-year-old Robert K. "Kelly" Ortberg, who will join Jones in the newly formed Office of the Chief Executive.

Few companies' identities have been as closely linked to their chief executive as Rockwell Collins and Jones. The 63-year-old veteran fighter pilot has led the company since its spin-off from Rockwell International in 2001. His intense focus has molded Rockwell Collins into an innovative, disciplined and highly profitable company—and a repeat winner of its peer group in Aviation Week's Top-Performing Companies study.

Since it went public, Rockwell Collins has provided a return more than three times higher than the Dow Jones Industrial Average. "Clay Jones is the gold standard for CEOs," says Tom Captain, the leader of Deloitte's global A&D practice. "He's set a new standard for financial performance."

It will be up to Ortberg to prove to investors and his board that he has the mettle to eventually step into Jones's shoes. After earning a bachelor's degree from the University of Iowa in mechanical engineering, Ortberg joined Rockwell in 1987 as a program manager and rose through the ranks, running the company's Air Transport Systems business and most recently heading its Government Systems. Jefferies analyst Howard A. Rubel says Rockwell Collins' practice of rotating senior managers through different positions has given Ortberg a broad view of the company and strong relationships with customers.

He certainly will be tested in the coming months. Earlier this month, Rockwell Collins issued guidance that predicts a 10% decline in its Government Systems sales in the coming fiscal year due to declining defense spending and hefty budget cuts scheduled to take effect in January. The company also has significant exposure to the business jet segment and the aerospace aftermarket, which are both affected by economic jitters in Europe and the U.S. "I think the next couple years are going to be really tough," Jones told Aviation Week editors in July.

Rubel says the management changes will allow Jones to focus on the company's strategic direction and turn his attention to longer-term challenges. Jones isn't going anywhere yet, but the planning for life after Clay has begun. ☺

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

EC Targets Airline Ownership

The European Commission has presented major changes to its aviation policy in an effort to react to the declining competitiveness of European airlines. The commission is taking on three areas—air services agreements, competition clauses and ownership and control regimes—where it sees urgent need for change. “Faced with the dramatic changes in global aviation, Europe must respond and adapt rapidly or will be left behind,” EC Vice President Siim Kallas says. The core issue Kallas plans to negotiate is the relaxation of ownership and control limits, particularly as part of renewed negotiations between the EU and U.S. There is already an open skies agreement in place between the two sides, but ownership and control is still limited to 25% in the U.S. and 49% in Europe.

ANA Boosts 787 Orders

With an additional order for 11 aircraft, Boeing 787 launch customer All Nippon Airways is boosting its fleet total to 66—36 787-8s and 30 787-9s—while extending its ranking as the largest airline buyer of the twinjet. Deliveries are scheduled in 2018-21. Boeing says pilots for the Japanese carrier have gained so many flight hours with the 14 787-8s ANA has in service that they have more experience than Boeing’s own flight-test crews. Starting Oct. 1, ANA adds its second international service from Tokyo for the 787-8 to Seattle and on Oct. 28 to Beijing. It also operates the 787s on eight domestic routes. The latest order is ANA’s third for the 787. The order raises Boeing’s total for the year to 35 787s, but it also has had 60 cancellations. Meanwhile, the company has recorded 11 737 orders from the U.S. Navy that will be converted into P-8A maritime patrol aircraft. It also added another 737 for an unidentified customer, bringing its net 737 orders for the year to 704.

DEFENSE

Improved Ilyushin

The first modernized Russian Ilyushin Il-76MD-90A military heavy-lifter, also known as Il-476, made its first flight at United Aircraft Corp.’s Ulyanovsk-SP facility on Sept. 22. This prototype was rolled out July 5 and has already un-

dergone ground tests. According to the industry sources, after several flights in Ulyanovsk, the aircraft will continue the trials at Zhukovsky, near Moscow. The Il-76MD-90A became the first aircraft of this type assembled in Russia, as all earlier Il-76 modifications were effected by TAPO in Tashkent, Uzbekistan. The center wingbox and the wing of another prototype are undergoing static and endurance tests in Zhukovsky. The Il-76MD-90A has an improved wing and reinforced landing gear to allow an increase in takeoff weight to 210 from 190 tons and payload to 60 from 47 tons.

Stevens Wins Wright Trophy

Lockheed Martin Chairman and CEO Robert J. Stevens is the recipient of the 2012 Wright Brothers Memorial Trophy, an award established in 1948 by the National Aeronautics Association to honor the memories of Orville and Wilbur Wright. Stevens, a Marine Corps veteran, was selected for his “dedication, leadership and major contributions to the security of the U.S.” Past winners include former astronaut Neil Armstrong, Charles Lindbergh and Southwest Airlines founder Herb Kelleher.

SPACE

SLS Issues

NASA’s Human Exploration and Operations Mission Directorate faces an integration challenge as it attempts to develop a mobile launch support structure for an evolving Space Launch System (SLS), the agency’s inspector general concluded in a Sept. 25 audit. Nonetheless, the IG endorses the agency’s plans to modify Constellation program Ares I hardware as the most cost-effective approach. NASA already has invested \$234 million in the Ares I mobile launcher at the Kennedy Space Center. Plans to ready the 70-metric-ton payload, or smallest version of the SLS, for a 2017 initial unpiloted test flight are driving early decisions on conversion of the Ares I mobile launch structure, which may not be compatible with the eventual configuration for the largest, 130-metric-ton version of SLS, IG Paul K. Martin notes in his report.

North Korean Setback

A Johns Hopkins University group that studies North Korea believes the hermit country has halted work at a new

Flight Trials Begin for Su-30SM

Irkut, a subsidiary of Russia’s United Aircraft Corp., began flight tests of the twin-seat Sukhoi Su-30SM multirole fighter with two aircraft in late September.

Su-30SM was developed for the Russian air force on the basis of Irkut’s export best-seller—the Su-30MKI platform. The Su-30MKI, in turn, was designed on the basis of the heavily upgraded Su-30 two-seat fighter at the end of the 1990s under the requirements of the Indian air force. India has already ordered 230 of the fighters both through direct purchases and under licensed, local production at Hindustan Aeronautics Ltd. facilities.

In the meantime, Algeria has ordered 44 Su-30MKAs, and Malaysia has received 18 Su-30MKMs. So far, Irkut has delivered more than 170 Su-30 variants to foreign customers.

According to Irkut, the Su-30SM is adapted to meet Russian air force requirements, including new radar, communications and friend-or-foe identification systems, and catapult seats. The aircraft can also use new types of air-launched weapons. In March 2012 the Russian defense ministry ordered 30 Su-30SMs with deliveries expected through 2015.



launch pad intended to conduct tests of larger, liquid-fueled rockets, possibly with intercontinental ranges. "Commercial satellite imagery of the Tonghae Satellite Launching Ground—commonly referred to as Musudan-ri—taken on Aug. 29, also shows that Pyongyang has stopped construction of fuel and oxidizer buildings designed to support future tests near the new pad," says 38 North, a program of the U.S.-Korea Institute at the university's School of Advanced International Studies. The group acknowledges they do not know why development has slowed or stalled, but surmised local heavy rains may have played a role.

VR-3A in Technology Test

Orbital Technologies Corp. (Orbitec) tested a lightweight rocket-engine nozzle extension Sept. 20 as part of a series of technology demonstrations for the 30,000-lb.-thrust VR-3A Vision engine it is developing under the U.S. Air Force Advanced Upper Stage Engine Program. The company also has demonstrated vortex/cold-wall combustion chamber cooling and an acoustic igniter in preparation for a subscale sounding-rocket flight demonstration Oct. 20 in Mojave, Calif. The nozzle extension, tested to full duration along with the igniter in a 3,000-lb.-thrust setup, uses technology developed by ATK Advanced Technologies and Products to join hot carbon-carbon components to an actively cooled metal housing.

Short Hop

Space Exploration Technologies (SpaceX) is advancing development of a reusable first stage for its Falcon 9 launch vehicle with the first "hop" of its Grasshopper vertical-takeoff-and-landing test vehicle. The modified Falcon 9 first stage is validating plans to fly that stage back to the launch site for an autonomous vertical landing,



NASA JPL/CALTECH/MSSS

Curiosity Confirms Water Flowed on Mars

Close-up imagery from three sites on the floor of the Gale Crater on Mars, collected by NASA's Curiosity rover, confirmed rounded pebbles were deposited there by water flowing in a "vigorous stream" down from the crater wall, conclude scientists examining data from the new robotic geologist.

Images from 34-mm and 100-mm lenses on the rover's mast camera allowed the science team to reach consensus, based on the size and shape of the gravel they revealed. The conglomerate rocks were formed of rounded pebbles too large to have been transported by the Martian wind, but very similar to rock found in alluvial fans on Earth. William Dietrich of the University of California-Berkeley, a Curiosity co-investigator, estimates the stream could have been hip-deep, moving at about 3 ft. per second.

Additional study with the rover's internal chemistry lab is expected to give additional clues to the habitability of ancient Mars, but the early confirmation of flowing water on the surface is a good step in that analysis, says John Grotzinger, the Curiosity chief scientist. The discovery also underscores the validity of the broader strategy employed in the robotic exploration of Mars for the past two decades, with reconnaissance data from orbiters fleshed out with ground truth from rovers and landers. "Now that we're down on the ground we can see the textural evidence, where you see the individual pebbles, the rounding, the geometric relationship that they have to each other," Grotzinger says.

The nuclear-powered rover is most of the way to the feature known as Glenelg, where three different types of surface material come together. But before it reaches the scientifically interesting spot, it will park for 2-3 weeks to give scientists time to check out the chemistry laboratories inside the rover's body by pouring loose sand or other material into them for analysis.

using the more powerful Merlin 1D engine still in development. In the Sept. 21 test at the company's Texas test site, the 106-ft.-tall vehicle made a "short hop of approximately 6 ft." More

ambitious "mini-hops" are planned to reach 200-240 ft. and last less than 1 min. as part of checks of the Merlin's performance and four-legged landing system.

U.S. Says Subsidies Ended for Boeing

The World Trade Organization (WTO) battle over subsidies to Airbus and Boeing drags on.

The U.S. Trade Representative (USTR) office maintains in a Sept. 23 filing that NASA and U.S. Defense Department funding to Boeing that the WTO found to be illegal subsidies has been removed. The USTR added that the State of Washington is modifying tax credits to Boeing to bring them into line with the WTO ruling and that the City of Wichita is also changing industrial bond rates to comply.

For its part, Boeing charges that EU subsidies to Airbus that were found to be illegal have not ceased. The EU struck back a day later, filing a complaint with the WTO that charges the U.S. has neither withdrawn its subsidies to Boeing nor corrected their adverse effects, and asked the WTO to assess \$12 billion in penalties a year on U.S. products.

"The U.S. leaves us with no other choice but to insist on proper compliance," said EU Trade Commissioner Karel De Gucht. The WTO will now conduct compliance reviews on the withdrawal of subsidies for both airframers.

A high-angle, top-down view of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including its central truss and multiple large solar panel arrays, is clearly visible against the black background of space. The Earth's blue and white horizon is visible in the bottom left corner.

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COMMENTARY

Accepting Radials

Tires common on cars are slowly making their way onto commercial aircraft

Boeing's decision to make radial tires standard for main and nose landing gear on the 737 MAX is a welcome upgrade for airlines that have compared radials' performance with the alternative—the bias-ply tires that have been an industry standard for decades.

Bias-ply models account for 70% of all commercial aircraft tires even though radials are typically 20% lighter, wear better and have superior landing performance—traits that have given them nearly universal acceptance for automobiles and trucks. But the aircraft industry has “a lot slower pace [for acceptance] because of the regulation requirements” for certification, says Lee Bartholomew, Michelin Aircraft Tire R&D design engineer.

Radials are specified on the newest widebody transports, such as the Boeing 787 and Airbus A350 and A380. On narrowbodies, Airbus offers them as an option on the A320, which most carriers accept, and will do so for the A320NEO. Boeing is offering them as options for nose-wheel landing gear on the 737 Next Generation series and is to complete the transition to the main-landing-gear wheels in the first quarter of 2013.

After Southwest Airlines introduced nose-wheel radials on its 737-700s, average usage rates jumped to 30 days, a 10-day improvement over bias-ply tires, says Senior Engineer Rick Giacomello. Main-gear tires typically last 30 days, but they wear better than nose tires because they are larger and experience better load distribution.

Taxiing, not landing, is the big wear factor for aircraft tires. The trips to and



SOUTHWEST AIRLINES

Southwest expects a big improvement in main-landing-gear tire performance when Boeing introduces radials next year.

from the gate to the runway can be as long as 10 mi. “If you keep rolling them, they get hotter and hotter until they go poof,” says Bartholomew. The “poof” of a blowout can sound like a bomb going off and is more common on takeoffs when the aircraft has a full fuel load.

“Taxiing is a big wear-off, short turns are killers,” says Giacomello. “When the airplane backs out, the pilot turns the tiller full left or right, you can see the scuff marks.” Besides giving them better wear characteristics, cross-belted radials are less vulnerable to foreign object damage (FOD), which Michelin research shows accounts for an average 11% of tire loss. Wear accounts for 79% and the rest is covered by flat spots or miscellaneous failures. So once they are in use, Giacomello expects better performance from main-wheel radials.

Southwest standardizes on Good-year's radial, but it was Michelin that introduced radials to the industry in the mid-1990s, largely through their more common application on Airbus aircraft. The Michelin Man is a prominent corporate citizen in Greenville, S.C., home of its U.S. operations, and in Charlotte, N.C., home of its research

and test center, where Bartholomew and others gave me a tutorial.

Aircraft makers' tire performance specifications focus on such issues as taxi and rejected-takeoff operating times: 7.7 min. is common because that is a typical fire-truck response time.

Like commercial truck tires, aircraft tires are retread, but how they wear differs from ground vehicles. “An aircraft tire wears down to the first chord showing through, that's a wear indicator,” Bartholomew explains. “It's okay to go to it but not to go through it. If you go through it, you can't retread it.”

The average car tire is predominantly made of synthetic rubber. Aircraft tires are 90-95% natural rubber because it has better thermal characteristics. Just as on a car, an improperly inflated aircraft tire fails faster, either because of excessive heat buildup, sidewall vibration or wheel slippage when underinflated; or, susceptibility to FOD and improper contact with the surface if overinflated.

“Tire pressure is the most important thing in tire life,” says Giacomello. “It's a routine task that you basically have to check and double-check.” On a 737-700's nose or main landing wheel, proper pressure runs 190-205 psi; Southwest's philosophy is to run to the high side because tires lose about 1% pressure a day.

“At Michelin, we advise airlines that anything below 90% of inflation is flat,” says Keat Pruszenski, who manages the company's customer support engineering.

Quality-assurance burst tests on aircraft tires are impressive. To pass, the tire must hold four times its rated pressure for 3 sec. The tires are pumped full of water because it is safer when they burst. As we visited, Michelin was testing a 32 X 11.50-in F/A-18 tire, which needed to reach 1,400 psi.

The test is conducted within a chamber and personnel are kept away from its closed doors as a safety precaution. The Michelin testers were not surprised that the tire held pressure at 1,400 psi and seemed confident when it passed the 1,500 mark. When it finally blew at 1,531 psi—the sound of a bomb even if it was filled with water—it brought smiles of satisfaction. ☺



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COMMENTARY

Back For More

Carlyle returns to business aircraft handling

In a move that took a lot of people within the business aviation community by surprise, the Carlyle Group recently announced that it planned to acquire Landmark Aviation, which with locations in the U.S., Canada and France, is among the world's largest chains of fixed base operations (FBO).

The move was unexpected for two reasons primarily. First, the FBO business has been in a slump since the bizav recession began in 2008, with no sure signs of broad recovery on the horizon. And secondly, Carlyle had spent decades creating and building Landmark, which it then sold to Dubai Aerospace for \$1.9 billion just five years ago.

In that package deal, which included StandardAero, the FBO chain portion was thought to be valued at around \$400 million. Dubai subsequently sold the chain to GTCR and Platform Partners, private investment firms.

While the terms of the latest transaction, which is expected to close in the fourth quarter, were not disclosed, it is believed that Carlyle is paying about \$625 million for the chain.

GTCR and Platform Partners bought Landmark near the height of the market and managed it during the prolonged downturn, strengthening it by adding several new bases.

"Under our ownership, we expanded the network from 38 to 51 sites, acquiring nine new sites, and won open competitions at four sites where the airports had incumbent FBO leases expiring," GTCR Principal Craig Bondy told Aviation Week's Kerry Lynch.

"Most importantly, the new locations we added were much more strategic and high profile, largely in higher traffic 'NFL' cities like Miami, Atlanta, San Diego, Cincinnati, which dramatically enhanced the strategic quality of the network from what we started with

LANDMARK AVIATION



(which were mostly tertiary cities)."

But to succeed, Bondy says, Landmark still needs access to capital and the current owners had exhausted their resources set aside for the chain. For its part, Carlyle plans to invest in the continued expansion and modernization of its network and add to it via acquisitions and greenfield developments.

But why the once private but now publicly traded Carlyle wants back into the FBO business is an open question.

"It caught everyone by surprise," observed one FBO executive. "Those are smart guys, brilliant, so maybe the economy's going to do a lot better than we thought."

Many believed that industry-leader Signature Flight Services would prevail in the bidding process, which included a handful of other interested parties, mostly equity and other financial firms.

"I think Carlyle bought a great company and a great management team," says Jim Haynes, a longtime industry veteran who heads The Aviation Group consultancy. He adds that the prevailing sentiment is Carlyle "got a good deal."

Carlyle has invested \$4.2 billion in more than 40 aerospace and defense

companies since 1987, and currently owns or holds stakes in Arinc and Wesco. Its interest in Landmark spans back to the late 1980s with the creation of the Hawthorne Aviation facility at Dulles International Airport outside Washington (photo, left). It subsequently financed a series of mergers that evolved into Landmark. ☛

AVIATION'S BFF*

The recent annual gathering of the CitationJet Pilots Association in Coeur d'Alene, Idaho, drew Cessna's executive A-team of a happy yesteryear when jet production could hardly keep up with demand. The ex-Cessnans all convened to celebrate team leader, Russ Meyer, Jr., their former CEO and current chairman emeritus, who was being installed as the first inductee of the association's Hall of Fame.

Meyer was delighted to see his former colleagues, but it was the customer who first greeted him upon his airport arrival that really made the moment: Arnold Palmer.

The golfing great and Meyer met five decades ago when the latter, a Harvard Law graduate, was assigned to represent the former who was beginning his long career surge. Their bond seemed to strengthen as Meyer left the law to become an aviation executive. Palmer, an accomplished pilot, began buying Citations from Meyer, and still operates a Citation X.



CESSNA VISUAL MEDIA/CIPA

At the celebratory dinner, Palmer lauded Meyer, a former fighter pilot, and his "old school" passion for the aviation business. "I can't tell you how important Russ Meyer (above, left) has been to my life," Palmer continued, adding, "He's my best friend." ☛

* Best Friends Forever



By Jens Flottau

International Air Transport ✦
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COMMENTARY

Lost Chances

The deal has been in the making for more than a year, and now—after this lengthy process—the Lufthansa board of directors has finally approved what is a pretty dramatic breakthrough for the carrier's modus operandi: The group is setting up a subsidiary for European direct services, operating a fleet of around 90 aircraft. The unit will be headquartered at Cologne/Bonn Airport in Germany.

The exercise is the most significant experiment on how European legacy carriers are trying to compete against their low-cost rivals. British Airways has given up a lot of its former short-haul network because it was clear it could not compete with Ryanair and EasyJet when it comes down to cost. Air France-KLM have so far had relatively limited exposure to low-cost competition, but Air France has also launched regional bases that it hopes will be less expensive to operate than

the Paris hub. And now Lufthansa.

What Germany's flag carrier proposes is likely too little, too late. Ten years ago, Lufthansa launched its low-cost affiliate Germanwings. The Airbus A319-based carrier started out with a significant cost differential of around 40% compared to its parent. And although it was never as efficient as Ryanair or EasyJet, it at least had the potential to grow fast and keep out foreign competitors on behalf of its parent—if it only had been allowed to make its own decisions on investments, fleet, network and pricing. Over time, what little latitude of self-determination it had was curtailed. In fact, Germanwings' service became more closely aligned with the needs of Lufthansa. The carriers started code-sharing and accepted each other's tickets. Germanwings now does not have one frequent-flier program. It has two.

But with complexity came additional

costs and, subsequently, losses. Now the challenge is to merge two loss-making entities and make the unit profitable. But how is that supposed to work if the fundamentals remain unchanged?

There is a school of thought within the group that believes Lufthansa can still make that transition and at least stop the cash burn on short-haul routes. But a growing number of executives, even in the top ranks, are becoming increasingly convinced that they will eventually have to pull out of that market segment, too, and focus on long-haul and connecting traffic.

With its market base becoming wider and less-focused, and the lack of a single origin-and-destination center like Paris or London, it would likely be more risky for the carrier to pursue that strategy. But there may be no other options left.

If there ever had been a chance for this model, it was probably years in the past. ☹

EUA Rollercoaster

EU carbon dioxide allowances declined in September, in line with German power prices for 2013 delivery and on jitters over the extent of possible opposition to the European Commission's proposals to delay future carbon auction volumes.

December 2012 EU Allowances (EUA) hit a six-month peak of €8.37 per metric ton (\$10.80/mt) on Sept. 7, according to Platts' assessments, taking support from bullish sentiment in the wider financial markets after the European Central Bank announced new economic stimulus measures.

Any moves that could help avoid further economic turmoil in Europe tend to support carbon prices along with other commodities, as a strengthening economy would likely see increased industrial activity in the EU Emissions Trading System-regulated sectors, driving up CO₂ emissions and demand for allowances.

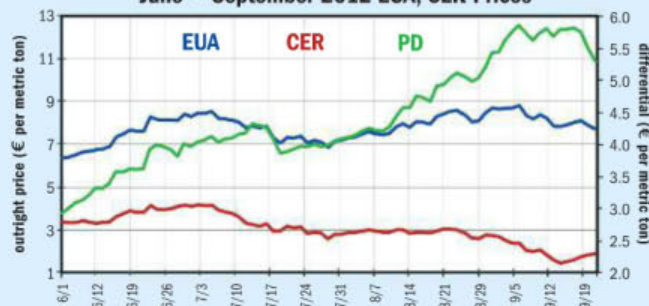
But prices fell back sharply from those highs, slipping to €7.27/mt by Sept. 24 amid signs that a number of EU member states may try to block the EC's proposals to delay auction volumes of between 400 million and 1.2 billion EUAs in 2013-15.

The EC has yet to specify the exact volume of EUAs to be delayed temporarily from the auctions, but several EU member states have already signaled opposition to such proposed market intervention.

Officials from Poland, the Czech Republic and the Netherlands have already voiced opposition to the EC's proposals, and the market will likely be watching to see if enough "no" votes can be gathered to form a blocking minority.

In the EU's weighted vote ballot system, a blocking minority would require 91 votes. Poland, the Czech Republic and

Daily Emissions Price Assessments
June – September 2012 EUA, CER Prices



PD = Price Differential, euros per metric ton
EUA = European Union Emissions Allowances for December 2012 delivery
CER = U.N. Certified Emission Reductions for December 2012 delivery
Source: Platts

the Netherlands hold a combined 52 votes, leaving 39 more needed. Some market observers suggest other member states could also be sympathetic to the opposition cause, raising the prospect that the regulator's efforts to bolster the carbon price could yet be derailed.

Elsewhere, the U.S. Senate Sept. 22 passed by unanimous consent a bill that would prohibit U.S. airlines from participating in the EU Emissions Trading System, and hold them harmless from costs arising from the EU legislation. The House could take up the bill during the week of Nov. 12, media reports quoted an airline official as saying. ☹

Frank Watson/Platts/London

For further information, please visit:

platts.com/ElectricPower/Resources/NewsFeatures/emission/index.html ✦



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COMMENTARY

Heavy Lifting

SLS gets funding for some real rocket science

Engineers at NASA, Boeing and Pratt & Whitney Rocketdyne are making good progress on the initial version of the agency's planned Space Launch System (SLS) for deep-space human exploration, but it's the advanced configuration that may actually drive some innovation in the field. The first few flights will use the 70-metric-ton version (at left in illustration). But Congress wants the 130-metric-ton rocket (at right) for serious exploration, as well as mix-and-match versions in between to launch big space telescopes and other scientific hardware, and the U.S. space agency is starting to spend some money to get there.

Beginning this month, 26 industrial and academic organizations will share as much as \$48 million in NASA funds for the sort of advanced engineering that is usually mistakenly called rocket science. There's a lot of science involved, but this will be hard-core engineering work of the kind that could apply well beyond the SLS.

The titles of some of the selected proposals give a clue to the possibilities they represent for rocket propulsion in general. Experts at the Massachusetts Institute of Technology will be funded

to develop "a new modeling approach for rotating cavitation instabilities in rocket engine turbopumps." Their colleagues at Penn State will be working to characterize "aluminum/alumina/carbon interactions under simulated rocket motor conditions." Numeric simulations of subsonic and supersonic film cooling will be validated at the University of Maryland.

In industry, engineers at Orbital Technologies Corp. of Madison, Wis., will work on "hybrid precision casting for regeneratively cooled thrust

chamber components," while ATK will develop advanced "affordable composite structures." "Structural weight reduction" will also be the goal of work at Collier Research and Development Corp. of Newport News, Va.

"[C]ost-savings may be realized if this work effort can be synergistically combined during negotiations with the selected work effort submitted by ATK," writes L. Dale Thomas of NASA's Marshall Space Flight Center in his source-selection document.

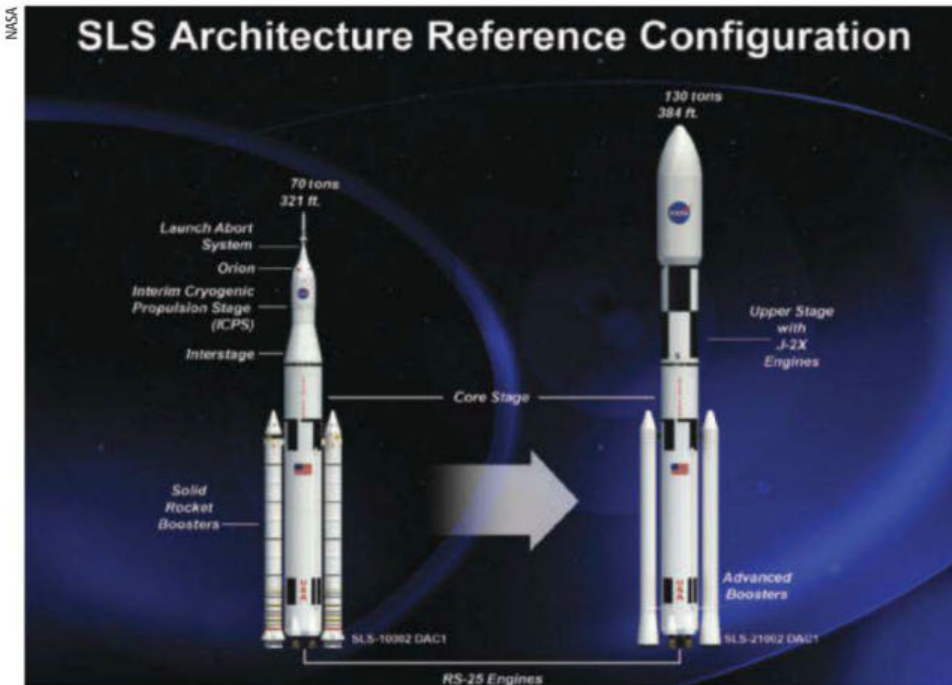
A lot of the work sounds esoteric because it is, but it could lead to more efficient rocket propulsion and stronger, lighter-weight engines and structures. It is the kind of work that sometimes falls in the cracks between profit-motivated corporate boards and academic trustees looking for sexier research.

"Engaging with academia and industry gives us the opportunity to take advantage of the ingenuity and expertise beyond NASA," says Associate Administrator William Gerstenmaier, who heads its Human Exploration and Operations Mission Directorate.

Work on the initial SLS configuration is ahead of schedule in some areas, with hardware for the first NASA exploration flight test being machined and a critical design milestone later this year. Todd May, the NASA SLS program manager at Marshall, says that while preliminary design review for the vehicle is scheduled next summer, it could come as early as December for the core stage.

NASA plans to use a Delta IV with a modified upper stage to stand in for the SLS in a 2014 flight test of the Orion multipurpose crew vehicle that will characterize the performance of its heat shield at near-planetary reentry speeds. That same upper stage will be used in the 70-metric-ton variant of the SLS that will fly for the first time in 2017. NASA is already machining the Orion/upper-stage adapter.

The first of those will be a 7-10-day mission to send an uncrewed Orion around the far side of the Moon and return it to Earth at the full 11-km-per-sec. (6.8-mi.) velocity it is designed to withstand, May says. "For the 2021 mission, we actually put astronauts in and go out into a high lunar orbit," he says. "We're still working through that."



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COMMENTARY

Reality Begins

Sequestration Rattles Rockwell Collins

Academic exercises about whether Congress will allow a nearly \$1 trillion in across-the-board budget cuts known as sequestration to take effect in January are taking on an entirely new reality. Aerospace and defense companies are already beginning to announce plant closures, layoffs and cutbacks, and at least one of them is citing sequestration specifically.

In recent weeks, Sikorsky, the United Technologies subsidiary that makes Black Hawk helicopters, announced it will close military helicopter facilities in upstate New York and eliminate about 570 jobs. Northrop Grumman Aerospace Systems in San Diego plans to drop 590 jobs via a voluntary layoff program. Both manufacturers cited defense spending declines and uncertainty as reasons for the cutbacks.

Rockwell Collins, a supplier to both the defense and commercial aerospace industries, is pointing directly at sequestration, anticipating a reduction of 5% in its business with the U.S. government, due to the sword of Damocles that Congress hung over itself for failing to agree on \$1.2 trillion in deficit reduction over a decade. Chairman/CEO Clay Jones is vowing "swift and appropriate action" to continue growth for shareholders. "These actions include a restructuring charge in the fourth quarter of fiscal year 2012 to position us for improved performance in 2013 and beyond."

Senators are still trying to lay the groundwork for proposals to delay the penalty. A group of senators, led by Armed Services Committee Chairman Carl Levin (D-Mich.), is asking Senate leadership to prepare bipartisan proposals so they can be easily considered during the lame duck session of Congress. "We do not believe that Congress and the president can afford to wait until January to begin to develop a short-term or long-term

sequestration alternative," wrote the senators. But any offer to delay sequestration is likely to require a significant package of spending cuts and with all the uncertainty, businesses are taking matters into their own hands. ☛

MASS DESTRUCTION

Nearly everyone knows that the U.S. is the largest arms exporter in history, selling or donating more weapons and defense services abroad than any other



'Actions include a restructuring charge in the fourth quarter of fiscal year 2012 to position us for improved performance in 2013 and beyond.'

CLAY JONES
ROCKWELL COLLINS CHAIRMAN

nation. But did you know that the U.S. also is the world's single-largest financial supporter of conventional weapons destruction? Since 1993, the State and Defense departments, the U.S. Agency for International Development's (USAID's) Leahy War Victims Fund, as well as the Centers for Disease Control and Prevention, have partnered to deliver more than \$2 billion in more than 90 countries for identifying, securing or destroying munitions. According to State's headquarters in Foggy Bottom, recipient countries have safely disposed of more 1.6 million excess small arms and light weapons, more than 90,000 tons of munitions and nearly 33,000 excess or poorly secured

shoulder-fired missiles. Meanwhile, for fiscal 2012, which ended last month, the U.S. is expected to notch a record \$65 billion or more in foreign military sales, according to the Defense Security Cooperation Agency. ☛

NO PROBLEM, HOUSTON

It's official: President Barack Obama last week signed into law a measure that confirms full ownership rights to artifacts received by Apollo-era astronauts from their missions. According to the House Science, Space, and Technology Committee, NASA managers routinely allowed astronauts to keep mementos, pieces of hardware and personal equipment from the spacecraft during the Mercury, Gemini and Apollo programs. But beginning in the mid-2000s, NASA began to challenge the ownership of these artifacts. The issue flared up this year when NASA questioned James Lovell, the commander of the almost fatal Apollo 13 mission, about a checklist he used on his mission after he put it up for auction and sold it for \$388,375. ☛

DECONFLICTING CONGRESS

As concerns about privacy and security begin to weigh on the launch of unmanned aerial systems (UAS) in civilian airspace, the Senate is forming a bipartisan UAS Caucus to help smooth the industry's takeoff. Aviation enthusiast Sen. Jim Inhofe (R-Okla.) and Sen. Joe Manchin (D-W.Va.) are heading

the push to move the industry out of the civilian world and into the hands of businesses and state and local governments. "One of the purposes of this caucus is to ensure we address these risks and protect Americans' constitutional rights, while also proving a way forward with UAS operations that improve our national security and emergency and disaster response," Inhofe says. Earlier this year, Oklahoma was designated a site for the Department of Homeland Security's Robotic Aircraft for Public Safety Program to test small UAS. And the caucus is envisioned as body to hear air safety, privacy, command and control, deconfliction and regulatory concerns. ☛



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A Test Of Wills

Air raids and cyberattacks lose appeal as Iranian defenses improve

David Fulghum **Washington**

Aerial bombing of Iran's nuclear and missile programs offers little political, deterrent or military value. That judgment encompasses bombing raids by either Israel or the U.S., contend a growing number of U.S. analysts.

There is evidence that patience on the part of the West may provide less-obvious opportunities to delay or halt the programs. But Israel fears that U.S. caution will turn into a containment policy that will enable Tehran to build a nuclear weapon.

"If the Iranians really wanted a store of enriched uranium, they could buy it," says a longtime U.S. defense specialist with links to the U.S. military's world of clandestine operations. "And they don't have to process it themselves except for the national prestige it would give the country and to keep the international spotlight on Tehran."

In fact, North Korea and Iran agreed to broad technology exchanges during an August meeting in Tehran of nonaligned nations. Large numbers of North Korean scientists have been traveling to Iran. The agreement calls for cooperation in research, student exchanges, and joint laboratories in the areas of information technology, engineering, biotechnology and renewable energy.

Probably the only nation to profit from an attack on Iran would be Russia, where declining oil prices are slowing the economy.

"The price of oil goes up if there is an attack on Iran," says Steven Pifer, director of the Brookings Institute arms control initiative. And while Russia's sale of its long-range SA-20 (S-300) surface-to-air missile to Iran remains a "dead issue," Moscow has "not seen a precautionary tale" in the fact that its advanced-capability, man-

portable SA-18s and SA-24s have migrated from military customers into the black market and into the hands of militants in Somalia, South Lebanon and Gaza, says Pifer. He predicts such sales will continue.

Nonkinetic cyberattacks cooperatively developed, financed and launched by the U.S. and Israel did delay the Iranian nuclear program for five or more years, says the U.S. defense specialist, but the eventual outing of the "Stuxnet" cyberattack and "Flame" cyber-reconnaissance programs allowed Iran to start organizing its cyberdefenses.

To defend against cyberattacks, the Iranian government has begun installing a network that is separate from the Internet to better control information flow, according to a report by the University of Pennsylvania's Center for Global Communications Studies. Critical government and military agencies



MEHR HEWS AGENCY

are expected to be on the network by the end of the month, according to the *Washington Post*. Project researchers say they already have evidence of a filtering capability. The technology is provided by China's Huawei corporation, the investigation finds.

"But it's a fencing match [that is standard in the world of electronic warfare]," the U.S. specialist says. "Now that they know our secret sauce [with discovery of the Stuxnet and Flame cyberintrusions], they've made it much harder to do."

So if the path for nonkinetic, cyberattacks is blocked by new technology, what could the U.S. and Israel do to slow Iran's progress?

"Kinetic attack [with aerial bombs or other explosives] is one of the few options left, but you need a lot of critical information to make an air attack on a deeply buried target work," says a senior U.S. Air Force official.

Some of those options are already in play. On Sept. 17, Fereydoon Abbasi, Iran's vice president and nuclear energy agency chief, said the electrical transmission lines between Qom and the Fordow nuclear enrichment facility (buried under a mountain) were severed with explosives, as were the power lines leading to the country's other underground enrichment facility at Natanz.



The Islamic Revolution Guards Corps rolled out its new Ra'd (Thunder) air defense missile system at the country's military day parade on Sept. 21. Its mission includes locating and destroying small and low-signature unmanned aircraft like the U.S.-operated RQ-170 Sentinel.

So far, Western justification for attacking Iran's nuclear development and delivery programs has been associated with the need to stop those efforts or create long delays. The goal is to ensure that sufficient enriched uranium cannot be processed to make nuclear weapons that could be delivered by missiles or even by trucks. Once the weapons are assembled and armed, they are difficult to keep track of, even by those who possess them.

Deputy Defense Secretary Ashton Carter, for example, was once part of a program to control chemical and biological weapons by making audits of what actually existed and where.

"The investigators found out that not even the senior Soviet leaders knew what they had or where it was hidden," the U.S. specialist says. "Nuclear materials are the same. If Iran wanted to, it could get all the enriched uranium it wanted on the black market. If it wanted to focus solely on possessing a bomb, it could buy one."

The technology to create effects against a truly deep underground facility, short of a nuclear weapon, does not exist. "We keep inventing and improving penetrating bombs," says the U.S. defense specialist. "We've hardened them and we've boosted them and we've only increased the amount of the deeply buried target set we can defeat by a frac-

tion. And right now the Israeli capability against deeply buried targets is not much more than a noise-level effect."

As a result, the enthusiasm for a U.S. attack on Iran is negligible, and the technological ability for Israel to create the necessary effects is not much greater.

"I don't see the U.S. initiating any near-term action," the U.S. specialist says. "The Israelis are unlikely to do it on their own."

In the meantime, the U.S. is intent on conducting defensive battleship diplomacy with its buildup of warships near the Strait of Hormuz.

"The wild card is if the Israelis create some unique capability that makes the Iranian facilities more reachable, or if there is some unexpected intelligence about a critical bottleneck that the Israelis could get to that stops [weapons] development," he says.

A budding politician, former chief of staff of the Israel Defense Forces Lt. Gen. (ret.) Dani Halutz, volunteered his expectation that "no one will surprise anyone in the near future." He had been asked about the possibility of a surprise Israeli attack before the November elections in the U.S.

Others expect such a move soon after, however.

"There will likely be military action, probably after the U.S. elections,

with or without the help of the U.S.," Ephraim Asculai, senior research fellow at Tel Aviv University's Institute for National Security Studies, tells Aviation Week. That decision will be driven by Israeli government fear that the "U.S. will accept [political] containment of Iran despite it having nuclear weapons. That's not a good choice in the case of Iran because the regime is very unpredictable."

The U.S.—but not Israel—would have the advantage of being able to employ cruise missiles, large penetrating weapons and stealthy, high-flying bombers.

"I believe Obama when he says he won't allow Iranian nuclear weapons, but the U.S. red line [for action] is an actual break-out" in producing weapons-grade enriched uranium, says Asculai. "But will they have that information? You can find a lot of cases when intelligence didn't provide the answer in time."

Israeli Prime Minister Benjamin Netanyahu blasted the U.S. for not setting hard red lines on Iran's development of weapons, suggesting that failure to do so is an immoral act that jeopardizes the continued existence of Israel. Halutz condemned the practice of making military policy based on such red lines. He says they are never respected, are overtaken by events and generally make the country that put them in place look foolish. Instead, the U.S. and Israel should sit down together and agree on the facts, and make decisions about what to do. They also must promote a relevant coalition and assemble an international force that includes China, Russia, India, Brazil and others, he adds.

There are circumstances that could change the march toward a conflict with Iran over its nuclear weapons program, says Halutz. These include the fall of the Syrian regime, Iran's major supporter; and decisions by Russia and China to not transfer advanced military technologies into the region.

In a passing reference to his own experience after the 2006 Israel-Hezbollah war, with the unhealthy brew of politics and bloodshed, Halutz says: "I'm bothered" because Iran has become more of a political problem than a military one. "We have to be careful with election rhetoric," because that argument has played out in public discussions of what can actually be done to hardened and buried targets. ☐

Pushing NextGen

Demonstrations and incentives are aimed at convincing airlines to join in

John Croft Atlantic City, N.J.

Airlines waiting for a reason to spend millions of dollars to equip their fleets with next-generation communications, navigation and surveillance (CNS) may see more convincing arguments from the FAA in the very near future.

Along with the awarding a contract to establish and operate a domestic data-link system that includes \$80 million in financial help for equipment, the agency is also nearing completion of a public-private partnership that may provide more than \$1 billion to help cover buying and installing NextGen CNS avionics.

The financial aid, along with increasingly relevant demonstration projects at key airports, is meant to provide a skittish airline industry with evidence that equipment will equal savings, an equation the agency says will not hold true if "critical mass" of retrofitted aircraft is not reached.

"The FAA needs to show some little victories," said Gerald Dillingham, director of physical infrastructure for the Government Accountability Office (GAO), at a NextGen avionics conference last month in Atlantic City. "In the past, the sense has been that airlines are equipping and the FAA is not following through. If we could get to the point where airlines see the benefits, hopefully that will increase the credibility of the program."

One example is American Airline's investment in a controller-pilot-data-link-communications (CPDLC) trial in which the carrier equipped 25 aircraft with technology that allowed for a variety of commands to be sent and received via text. Trials began in 2002 but the FAA ended the program in 2004 due to limited participation and growing cost.

Now, the hard feelings with American Airlines may have been resolved.

The FAA in mid-September selected Harris Corp. to install and operate a data-link communications network,

known as "datacomm," to transform what is largely a voice-controlled air traffic control system today to a data-based air traffic management system for the next decade. Teamed with Harris under the seven-year, \$331 million Data Communications Integrated Services (DCIS) contract is American, along with GE Aviation, Arinc, Thales and others (see p. 30).

Peter Challan, vice president of industry affairs for Harris, notes that some of American's aircraft are already equipped with the necessary avionics from the CPDLC trials and "we'll equip others" for demonstrations at five initial airports in the 2015 time-frame. The FAA has not announced which airports will be selected.

The long-term benefit of datacomm will be the evolution to real-time coordination of flight-management system parameters automatically between the ground and the air, paving the way for 4-D trajectory-based operations (TBO). With 4-D TBO, an aircraft will arrive at a desired waypoint within seconds

of a pre-determined time in the flight plan, boosting capacity while decreasing congestion and fuel burn as well as human errors related to voice and data entry. Operators of legacy aircraft will either need new equipment or system upgrades to participate.

FAA says the "tipping point" to optimize user benefits of datacomm is approximately 1,900 aircraft.

The agency is hoping that airlines, seeing the benefits of DCIS through early demonstrations at the five airports starting in 2015, will want to voluntarily equip, a different tactic than the agency used for automatic dependent surveillance-broadcast (ADS-B)-"out," the satellite-based surveillance system that will replace much of the legacy radar network after a 2020 equipment mandate comes due. The agency contracted with ITT Exelis in 2007 to deploy and operate the NextGen surveillance system, ADS-B. The system is expected to be fully operational in 2013, though aircraft operators will have until 2020 comply with the avionics mandate.



ERIK SIMONSEN

AIRBUS'S 'RETRO' MOVE FORWARD

John Croft Atlantic City, N.J.

Rarely is the economic decision to retrofit an aircraft with fresh communications, navigation and surveillance equipment as straightforward as for Airbus and its A300-600ST Super Transporter, better known as the Beluga.

Avionics-maker CMC Electronics is in the process of finishing up a retrofit to the five oversized transports that includes GPS units with satellite-based augmentation services and new flight-

management systems. Airbus, through its Airbus Transport International (ATI) subsidiary, uses the Belugas to move aircraft sections from production sites around Europe to final assembly lines in Toulouse or Hamburg.

Satellite-based landing guidance will allow the fleet to reliably reach destinations in instrument weather conditions where ground-based precision instrument landing systems do not exist. One such key



American Airlines equipped its Boeing 757s and 767s with data-link capability for an FAA program that was ultimately canceled in 2004.

Dillingham says a “top challenge” for convincing airlines of the merits of NextGen in the near term is to demonstrate benefits from avionics already installed on an aircraft, including performance-based navigation (PBN) systems. PBN includes GPS approaches that mimic instrument landing system (ILS) Category I approaches (200-ft. decision height and 1/4-mi. visibility) and required navigation performance (RNP) procedures. With RNP, the aircraft is certified to maintain a pre-determined accuracy in position and altitude, with real-time updates displayed to specially trained pilots via the avionics as the aircraft flies a custom-designed approach that can curve around noise-sensitive areas or terrain.

The FAA’s “Greener Skies” demonstration at the Seattle-Tacoma International Airport and nearby Boeing Field is meant to test RNP benefits

for broader use. The initial project is one of many NextGen demonstrations underway, completed or envisioned, similar in number to the projects taking place in Europe under the Single European Sky ATM research (Sesar) program. Locally created with national collaboration, the Greener Skies test—with Alaska Airlines as lead carrier—involves RNP approach procedures that diminish noise and increase the rate of arrivals to SeaTac’s closely spaced parallel runways in instrument meteorological conditions.

The Boeing-led trial, when it is completed and operational in 2013, in theory will be rolled out at many other U.S. airports once relevant separation standards are changed.

Per air traffic control rules for the ILS approach, aircraft arriving to the runways on the straight-in ILS approach end up queuing for the final approach 15 nm or more from the airport, but with the PBN approach, one aircraft is brought in on a precise curved path that cuts the final approach distance to about 6 nm, says FAA avionics systems branch manager, Bruce DeCleene.

“It is applicable to all airports with parallel runways,” says DeCleene. “Every major airport in the U.S. has parallel runways.”

Unless equipage rates are high however, controllers may not have the capacity to offer the most-efficient approaches to the best-equipped few, which comes back to the FAA’s quandary of how to entice airlines to equip.

Michael Dymont, general partner in the NextGen equipage fund, says deferred payments on loans for the needed avionics may be one answer. The fund, in the works for years, became a reality with the February FAA reauthorization, which Dymont says included a provision that cleared the way for the NextGen fund to gain a federal loan guarantee, which he expects to have in hand by year-end.

The fund at present includes \$100 million in equity from aerospace industry partners, including ITT Exelis, the FAA’s ADS-B infrastructure prime contractor, and \$1 billion in anticipated loans. Dymont expects the entire amount to be spoken for within one year, assuming the loan guarantees are approved by the government. “There are trillions more in funding looking for good projects,” says Dymont.

Under the program—to be operated in partnership with the FAA—airlines will secure operating leases for the avionics via the fund, with the option of deferred payments. The fund would retain the title to the equipment, allowing the “purchase” to be “off the balance sheet” for the airline. As an example, Dymont says the fund is “willing to defer lease payments” for onboard data-link equipment needed for DCIS “until the FAA starts offering the service.”

The retrofit cost per plane? Dymont says the “average” cost for a CNS retrofit is expected to be \$370,000, though it varies greatly based on the magnitude of the upgrade. ☼

location is the Getafe Air Base in Spain, near Airbus’s Illescas plant that makes—among other components—the carbon-fiber panels for A350 wings, says Rex Hygate, manager of business development, airline solutions, for CMC Electronics. “It will lead to more reliable parts deliveries to Airbus,” he says. “They plan to double the utilization of the Beluga for the A350, which is why they did the upgrade.”

Launch customer Canadian North has three aircraft flying with the retrofit, using their newfound GPS approaches “for remote mining airports,” says Hygate. His company has also completed two upgrades on Boeing 737 classic aircraft for Russia’s Transaero Airlines with 21 more 737s in the queue. ☼

AIRBUS FILE PHOTO



ATI is retrofitting its fleet of A300-600 “Belugas” with new flight-management systems and GPS units from CMC.

Datacomm Windfall

Harris looks for “maximum bang” from FAA’s \$80 million equipage fund

John Croft **Washington**

Harris Corp., winner of the FAA’s \$331 million Data Communications Integrated Services (DCIS) contract in September, would like to accelerate the disbursement of \$80 million in avionics aid for select airlines to begin demonstrating benefits of the data communications (datacomm) technology to the broader community by 2015.

“We’re going to work with the FAA to get that money committed and start showing benefits,” says Peter Challan, vice president of industry affairs for Harris. “We think we have a good idea where we can get the maximum bang for the buck for those \$80 million.” The contract as written calls for the upgrade fund to be doled out in increments in 2013-18, with 90% of the fund allocated to airlines and 10% for air taxi operators. Challan says that plan will work but “early quippage momentum as we believe it, is key to achieving the operational tipping point.”

Challan notes that the Mitre report, provided by the FAA, included an assessment of upgrades needed in

Harris will demonstrate airport datacomm before 2015.

the airline fleet. “We have a wide and deep matrix of where those aircraft are and we have our targets within there to get to the optimal number of aircraft with the available funding,” he says.

To participate in datacomm operations, aircraft must be equipped with VDL (VHF Data Link) Mode 2 digital radios, a communications management unit, and either Future Air Navigation Systems (FANS) 1/A+ or Aeronautical Telecommunications Network digital radios, though the service will initially operate only with FANS 1/A+.

While new aircraft can be delivered with the required equipment from the factory, the legacy fleet will need a wide range of software and hardware upgrades to comply, with prices varying from \$30,000-500,000, according to one estimate. The upgrade aid only applies to aircraft that have at least 10 years of service life left, and neither training costs nor revenue lost during downtime for the retrofit are included.

Harris is assigned to oversee integration and operation of the datacomm services

initially at a group of airports, followed by the domestic en route environment, and lastly, the terminal area. To start, datacomm will replace certain routine voice commands with data transfers, also known as controller-pilot data-link communications (CPDLC), and in the long term it will become an optimal dynamic rerouting tool to digitally negotiate efficiency or weather-related changes to flight plans, a key element of 4-D trajectory operations. The seven-year contract contains options for 10 additional years in one-year increments. Partners include American Airlines, Arinc, General Electric and Thales.

For the airborne segment, capabilities will be incremental, starting with automated rerouting for pre-departure clearances—changes that today are time-intensive and rely on pilots to key in a new route, often after weather problems require a flight-plan change after push-back.

Pre-departure clearance updates will be included in a five-airport demonstration, the first of which, Challan says, will be “up and running” before 2015, when the FAA wants to have the first hard data showing the benefits of equipping.

The FAA has not yet revealed which airports will be included, but American Airlines’ hubs are likely to factor in, given that the carrier previously upgraded dozens of aircraft with datacomm capability for European and U.S. CPDLC trials. The European trials are ongoing; U.S. tests were canceled in 2004. Challan says Harris plans to equip more American aircraft, as well as those from other carriers to achieve “a significant number of flights” at the demonstration airports. The FAA estimates that more than 1,900 aircraft will have to be equipped with FANS 1/A+ for widespread use of datacomm in the National Airspace System (NAS) to be practical.

The ground portion of datacomm will include Harris’ FAA telecommunications infrastructure network, which carries all FAA voice and data throughout the NAS, as well as air-ground Aircraft Communications Addressing and Reporting System (Acars) networks operated by Arinc and Sita, but enhanced for the FAA’s security, availability and redundancy requirements for air traffic control operations. 



ERIK SIMONSEN

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Heeding Momentum

NASA testbed to assess traffic-avoidance tools for unmanned aircraft

John Croft **Washington**

NASA's Langley Research Center, Mitre and several partners have completed the first in a series of inflight evaluations of cooperative automatic sense-and-avoid (SAA) algorithms for unmanned air systems (UAS), in large part to validate a new testbed that will be used for more advanced trials next year.

Called the limited deployment cooperative airspace project (LD-CAP), the two-year program is designed to give industry and academia developers of SAA algorithms a realistic inflight avenue to evaluate their proposals, which typically rely upon sensor data rather than a pilot's eyes to strategically or tactically separate UAS from other air traffic that may pose collision risks.

Officials say the work is complementary to SAA efforts being conducted by the FAA, U.S. Air Force and others. "What we want to do is create the scientific data the community needs to mitigate [SAA concerns]," says Andy Lacher, UAS integration lead for Mitre. In addition to answering whether an automatic algorithm is feasible, Lacher says the project will help RTCA to develop technical standards for SAA.

SAA is regarded as one of the top priorities—and one of the most difficult issues to solve—in the FAA and Defense Department's effort to safely integrate manned and unmanned aircraft in civil airspace. Partners in the LD-CAP project, all of whom are using internal funding for the effort, include Mitre, the University of North Dakota (UND), Draper Laboratory and the North Dakota National Guard.

During a two-week deployment in early September, NASA flew a modified Cirrus SR22 as a surrogate UAS, with a safety pilot on board, in 147 convergence scenarios with an unmodified

UND-supplied Cessna 172 acting as the manned intruder aircraft. Scenarios were tested previously in more than 2 million simulator runs, says NASA.

The aircraft were spaced 2,000 ft. apart vertically for safety, but the Cirrus's Automatic Dependent Surveillance-Broadcast (ADS-B) system was biased by 2,000 ft. to make the avionics believe the aircraft were generally at the

one developed by UND and the other by Mitre, and flights were conducted in a region of airspace west of Grand Forks, N.D.

"Part of the test here was not only how well the algorithms work, but us validating our capabilities," says Frank Jones, the LD-CAP deployment lead for NASA Langley.

Complexity will be increased during flight tests planned for June 2013 in North Dakota, with plans for new algorithms that will handle multiple intruder aircraft and noncooperative targets tracked by primary radar, as well as a flexible task automation "super app" developed by Draper.

The super application is based on Draper's Timeliner engine, originally



NASA/LANGLEY/SEAN SMITH PHOTOS

Modifications to Cirrus include a throttle actuator (arrow), allowing for speed, heading (inset) and altitude-based avoidance maneuvers.

same altitude. The two SAA algorithms were allowed to maneuver the aircraft in heading, horizontal speed and vertical speed using an add-on "general purpose" computer in the back of the Cirrus that commands the aircraft's two-axis autopilot and throttle.

Both were equipped with Garmin GDL 90 ADS-B units as the sensors for the algorithms, though the testbed in general is designed to be sensor-agnostic. Two algorithms were tested,

developed in 1981 and now used, among other tasks, for control and sequencing of International Space Station payload bay experiments and control moment gyros. When installed on the Cirrus, the super app will allow multiple algorithms from multiple providers to run in parallel, with Timeliner making command-level decisions based on user-defined parameters. For example, a variety of SAA apps can be running simultaneously with terrain and weather avoidance apps to determine the safest vehicle path with many constraints.

Draper plans to test the algorithms on Mitre's "fast-time" simulator later this year, followed by integration onto the SR22 for the demonstrations in North Dakota in June. ☛

Balancing Act

Washington seen as holding key role in deciding future of the BAE-EADS merger proposal

Amy Butler **Washington**, Jens Flottau **Toulouse** and Amy Svitak **Paris**

EADS and BAE Systems are scrambling on several fronts to put together their proposed merger, and while decisions in favor or against the deal are being made in Paris, London and Berlin, Washington is playing an important role, too.

BAE Systems executives believe any threat from the merger to its special security agreement (SSA) with the U.S. government would be a “deal breaker,” says an industry official close to the talks. Each SSA is tailored to the specific business of a particular company.

BAE's SSA enables it to employ thousands of people with security clearances higher than top-secret—allowing for code-word access to special projects, for example. By contrast, EADS North America's SSA provides for only one such employee, according to the industry official. BAE is unwilling to alter the framework under which it conducts its sensitive business because it is the “crown jewel of the deal,” the official says.

This business includes manufacture of the F-35 aft fuselages, electronic warfare systems, reconnaissance sensors, radiation-hardened hardware for satellites and anti-jam communication waveforms, among others. BAE also boasts that it is the largest provider of intelligence analysts to the Pentagon and intelligence community, many of which are deployed.

Some pundits suggest BAE's sensitive U.S. work could be “fenced off” from the merger if there is a threat that the SSA would need to be changed. However, that is not an option from BAE's perspective because it could jeopardize the company's ability to continue operating in that market.

BAE Systems would also set up a deal with the U.K. government called a “national security agreement” that would function much like the SSA does with the U.S. As the U.S. portion of the company would report to the new merged entity through the U.K. business, the industry official suggests that both agreements would provide a “dual layer of protection.”

Another industry official says one way to protect the BAE Systems SSA would be to keep EADS North America and BAE Systems Inc. as separate entities—but this would come at the expense of possible synergies.

It is not only in the U.S. that the planned merger faces serious challenges; there is also opposition within the German government. Hans-Joachim Otto, a state secretary in the German ministry of economics and technology, told a parliamentary hearing that “it is not only a matter of how, but whether” the merger should take place. After the

**The moment is favorable
for the defense industry to press
ahead with consolidation and
establish greater control**

hearing, Otto said the proposed deal will not be accepted without further clarification. He sees many questions surrounding it, including the valuation of the two companies.

EADS CEO Tom Enders also attended the hearing and tried to convince members of parliament of the deal's merits, saying the proposed merger is a once-in-a-lifetime opportunity to create a world market leader. Enders also offered negotiations on further details of the transaction.

One key issue that could derail the merger concerns the German government's plan to buy up to 15% of EADS, the same amount that France holds. EADS and BAE Systems have offered “golden shares” to the U.K., France and Germany, meant to protect the company from a hostile takeover. Voting rights are limited to no more than 15%, a rule that can only be changed by an 85% majority. There are additional veto rights protecting that status further.

However, in the current pact, EADS core shareholders have effective control over management because they determine the composition of its board

of directors. Core shareholders include the French and Spanish governments, the Lagardere Group, and Daimler. The car manufacturer represents the German interests but wants to sell its stake, as does Lagardere in France. Once the shareholder pact is dissolved, Daimler could sell its holding on the stock exchange, though the German government has been planning to buy it.

Otto did not indicate whether that position is changing; he only suggested that too much government influence is detrimental.

Industry officials say Germany's investment in EADS could sour the deal for the British government and would impair the company's ability to compete for Pentagon business, particularly under the SSA regime, because the combined entity would be perceived as government-controlled.

EADS and BAE Systems have until Oct. 10 to decide whether to proceed with or cancel the proposed arrangement. German Defense Minister Thomas de Maiziere says that deadline may be too tight. BAE can apply for an extension, though, which would likely be granted.

While obstacles to the merger are many, the moment is favorable for the defense industry to press ahead with consolidation and establish greater control, notably for EADS, which has been subject to political maneuvering for too long, says Helen Masson, an industrial policy expert with the Fondation pour la Recherche Strategique in Paris.

“In this context of limited defense equipment budgets and order cancellations, current governments are likely working with less freedom of action, less influence on the evolution of the defense industrial landscape,” Masson says.

Even if the merger is derailed, industry observers say just the fact that the two companies are talking could lead to cooperative efforts in key areas, such as unmanned aerial systems. Both BAE and EADS are developing Medium-Altitude, Long-Endurance (MALE) system concepts, and in September, French Defense Minister Jean-Yves Le Drian said common Franco-German operational requirements for a European MALE have been agreed to, with the potential for operational cooperation as an intermediate step. ☐

Closing In

As Korean Air moves on KAI, Hyundai Heavy Industries also makes a bid

Bradley Perrett **Beijing**

Unlike most countries of its size, when South Korea wants to build a military aircraft locally, it has two aerospace manufacturers to choose from.

In an increasingly concentrated global industry, this state of affairs has perhaps been unnatural. So it is not surprising that one of the companies, Korean Air Lines, has long wanted to buy the other, Korea Aerospace Industries (KAI).

The quarry has evaded its hunter for nine years. But with an outgoing presidential administration keen to sell its stake in KAI before leaving office in February, the company's number may finally be up.

Or maybe it is not. Originally the only bidder, Korean Air finds that

One objective of Korean Air Lines' bid for KAI is to increase utilization of equipment such as this riveting machine.

Hyundai Heavy Industries has made a surprise competing bid for KAI. Definitive bids should be lodged in November after a month of due-diligence investigations of KAI, which now seems certain to lose its independence. Its managers must be hoping for the company to become a unit of Hyundai Heavy, since KAI and Korean Air's Aerospace Div. have a reputation in the industry for loathing each other.

The defense ministry is also probably hoping that Hyundai Heavy wins, to preserve competition in a country that tries harder than most to spend its defense budget at home.

Hyundai's reason for bidding for KAI is unknown, but the government reportedly urged it and other conglomerates to do so. They were reluctant because of widespread complaints that they already own so much of the economy. It is not hard to imagine Hyundai wanting to emulate Japanese heavy-industry companies that have aerospace divisions.

Korean Air openly wants to put an end to competition. Fierce rivalry has

hurt the profitability of both companies, says Choi June-chul, head of Korean Air's Aerospace Div., explaining to South Korean media why it should be allowed to take over KAI.

Certainly the combined group would have much greater pricing power when foreign customers such as Airbus and Boeing seek South Korean suppliers, says an adviser to a company involved in the deal. Another result, also com-

the scale of leading aerospace groups, even by the standards of the country's neighbors. KAI's sales last year were 1.29 trillion won (\$1.15 billion). Korean Air's Aerospace Div. is much smaller, with revenues of around 550 billion won last year. By comparison, Mitsubishi Heavy Industries reported aerospace sales of ¥495.9 billion (\$6.38 billion) for the year to March 31.

Remarks by Yoo Seongmin, an influential member of parliament who could be defense minister within months, have hinted that the defense ministry is worried about ending up with a monopoly supplier but has been bureaucratically bypassed. The departments driving the sale are the finance ministry and the ministry of knowledge economy, as the industry ministry is



mon in almost any industrial takeover, would be to economize on overheads and to optimize use of costly machinery, in part by avoiding duplication.

If Korean Air wins, the government would probably forbid reorganization of the two groups for two years, says the adviser. Choi suggests the two companies would be operated indefinitely as separate subsidiaries. The advantage of doing so is not clear, except that it would help mollify KAI's managers.

A combined group, being larger, would be more competitive on the world stage; that was one reason why, four years ago, China began grouping together aeronautics plants that regarded each other as rivals.

Even a cursory look at the two South Korean companies shows they lack

known. They "recklessly want to sell KAI without asking the opinion of the defense ministry," Yoo says.

He is expected to become defense minister if Park Geunhye of the ruling Saenuri Party wins the election. That should unnerve the whole industry and the bureaucrats that seek to guide and promote it, since his public statements show that he puts their interests well behind those of national security. "Weapons are for fighting and winning wars, not for developing an export industry or for serving as a new engine for economic growth," he told parliament last year. He is also opposed to indigenously developing a stealth fighter under the KF-X program, arguing instead for cheaper imports (AW&ST Sept. 24, p. 30).

To some extent, Korean Air Aerospace and KAI have become complementary rather than competitive suppliers to the defense forces. KAI is the country's fast-jet builder and seems to have been anointed as the national rotary-wing specialist, while drone programs are now consistently assigned to Korean Air. Also, KAI has a much larger design office and therefore the greater capability for in-house development.

Both companies rely heavily on manufacturing of parts for Airbus and Boeing civil programs, but defense accounts for almost 60% of KAI's business. Hyundai

dai Heavy, separate from but related to Hyundai Motor, has diversified activities such as shipbuilding and oil refining. The conglomerate that spawned them contributed its aerospace division to the formation of KAI.

The size of South Korea's economy highlights the anomaly of the country having two aircraft builders. Japan has three to choose from, but only by carefully nurturing them at great public expense, and its economy is more than five times as large as South Korea's. Australia, also with an economy larger than South Korea, is not much interested in such nurturing at all; no

company there can fully build aircraft, apart from simple general aviation types.

KAI has willing sellers as well as a willing buyer. Four groups, led by the government's Korea Finance Corp., are offering a combined 42% stake in the company. The administration of President Lee Myung-bak has put Korea Finance under pressure to sell state assets before he leaves office, because that is what he promised before his election five years ago. The other three big shareholders, all private and including Hyundai Motor, propose to sell jointly with Korea Finance. Lack-

Rotorcraft Dynamics

Helicopter makers pair off as customers consider new programs

Amy Butler Berlin and Washington

Major players in the rotorcraft market are teaming—some as odd bedfellows—as defense customers in the U.S. and Europe eye purchases.

In Europe, industry is posturing for a potential Franco-German heavy-lift helicopter program despite a lack of clarity from customers on what the requirements for such a project will be.

Stateside, the U.S. Air Force is expected to make yet another attempt at buying a replacement for its HH-60G Pave Hawk, which is used to rescue downed pilots behind enemy lines. The U.S. Marine Corps is expected to kick off a competition next year for its presidential helicopter replacement program. Both projects were botched by their respective services, sending both back to the drawing board for years to revalidate requirements.

These potential programs, on both sides of the Atlantic, are a welcome change of pace for the industry heavy-hitters who have been working mostly on existing production and upgrade projects after a relative drought of R&D dollars.

Now, the industry teams are shaping up to allow the major players to potentially share risk and—if they win the work—the rewards. Boeing and EADS, bitter global rivals in the civil aircraft

market, have formalized a relationship to jointly explore rotorcraft opportunities globally. The companies signed a memorandum of understanding to this effect in 2009 with a renewal last October. It was later followed with a more specific agreement to examine options for the potential heavy-lift rotorcraft program in Europe, which will be the first practical application of the collaboration.

Boeing Military Aircraft President Chris Chadwick says he is open to unconventional partnerships to explore risk-sharing and, potentially, penetrate new markets. The team, while codified through the agreement, is far from firm, as questions linger about the heavy-lift project's viability.

At issue is just how much European customers are willing to pay for requirements above what industry can provide today with aircraft such as Boeing's CH-47 and Sikorsky's CH-53K.

German and French officials are keen on transporting large pieces of equipment internally instead of relying on external slings. And the size of some of this equipment is driving a need for a larger cabin, raising the question of whether Europe is willing to go to a new design rather than off-the-shelf models.

Germany's head of army aviation,



JOHN MORRIS/AW&ST

Brig. Gen. Reinhard Wolski, says this requirement was derived from lessons learned in Afghanistan. "Low flying at night, at high speed, is some kind of life insurance," he told a heavy-lift helicopter transport panel at the ILA Berlin Air Show. "That puts quite an effort on [industry for] building the airframe as well as our cargo compartment." Additionally, military customers are eager to purchase a helicopter that can still conduct missions with only one engine, another design stresser.

While such a large lifter—the notional target is an aircraft capable of carrying 32 metric tons of cargo—is desirable, it could be financially unattainable.

"Clearly, we could go build it," says

ing much reason to own stakes in an aircraft builder, they have been waiting for such a chance. Under South Korean law, only local investors can buy the stake.

A person involved in the deal and familiar with Korean Air's thinking says it will never pay anything like the market price, which last week valued KAI's equity at 2.5 trillion won.

While noting that the company is highly priced compared with foreign aerospace manufacturers, such as Boeing, equities analysts at Nomura say that "KAI has a better growth outlook for the next five years, in our

view." It is unclear why KAI should be expected to grow strongly, however. Its civil work will presumably expand only in line with global commercial aircraft demand. As for defense, its biggest new program—to build the 245 Surion utility helicopters—will run at a modest building rate over roughly 10 years. The prospective Korean Attack Helicopter program, not yet launched, will have a similarly drawn-out production profile. Like any national arms supplier, its prospects for revenue and profits are very much in the hands of its defense-ministry customer.

One reason for the high price of

the shares could simply be patriotism among South Korean investors, combined with the small fraction of the company's stock that is freely traded.

Until the Asian financial crisis of 1997-98 forced reorganization, South Korea had four aircraft manufacturers: the aerospace divisions of the Samsung, Hyundai and Daewoo conglomerates, which were merged to make KAI, plus Korean Air. Korean Air was able to resist a government push to include its aerospace business in KAI, too—presumably because Korean Air would have been only a minority shareholder. ☐

EADS displayed a cross section of the fuselage of its large tandem-rotor helicopter design, a joint endeavor with Boeing, during last month's ILA show in Berlin.

one industry official. "The question is: Does it make sense?" The Pentagon has also funded research to support a notional heavy-lift helicopter program, but a firm timeline and funding have been lacking.

Adding to the ambiguity about European requirements is an upcoming shift in the German military project management. The Luftwaffe is poised to assume oversight of the heavy-lift effort from the army on Jan. 1, 2013.

To keep their options on the table, Boeing and Eurocopter intend to continue work on their large tandem rotor-lifter concept, on view at the Berlin show as a beefed-up Chinook.

Boeing would bring its tandem-rotor technology to the project, while Eurocopter has extensive contacts in the French and German militaries, and could handle some parts and composite work.

Sikorsky also has design options that would include a platform larger than its CH-53K, which is now being developed by the Marine Corps.

However, both U.S.-based companies—Boeing and Sikorsky—also see an opportunity in offering off-the-shelf options that could reduce the cost for Europe to procure a system and, potentially, operate it.

Boeing, with EADS as a partner, could offer the CH-47F, which is now in production for the U.S. Army at the company's Philadelphia plant.

Sikorsky's option, the CH-53K—which is being designed to roughly double the load of today's CH-53E while maintaining the same aircraft footprint for shipboard use—is less mature than Boeing's concept, but the Marine Corps appears satisfied with the program's progress. The first CH-53K ground-test vehicle is slated for delivery in early October, says Col. Robert Pridgeon, the Marines' program manager. Two of three engines are already installed on the aircraft.

A bare-head light-off without attached rotor blades is planned for the second quarter of 2013; a powered test with blades should follow within another eight months. Sikorsky is on contract to build four flight-test articles, and a low-rate, initial production decision is slated for 2015.

Because Sikorsky is not yet through testing, Boeing may see an opportunity to push Europe for the Chinook in hopes of whetting the customer's appetite before Sikorsky can demonstrate its off-the-shelf candidate.

In the meantime, another industry pairing has emerged with Northrop Grumman as prime and AgustaWestland (owned by the Italian Finmeccanica conglomerate). They would offer the AW101 platform for the U.S. Air Force Combat Rescue Helicopter (CRH) project and the Marine Corps presidential helo replacement.

Though Boeing's CH-47 previously won the U.S. Air Force Pave Hawk replacement effort, the selection was dashed after procurement irregularities surfaced. The AW101 won the Marines' last attempt at buying a presidential helicopter under the

prime control of Lockheed Martin, but that project was terminated owing to poor management and requirements creep.

Northrop Grumman is not known for its rotorcraft work, aside from integrating mission systems into the Fire Scout product line. However, the company is approaching the partnership with AgustaWestland as an opportunity to feature its expertise as in integrator coupled with an off-the-shelf 101, says Scott Winship, Northrop Grumman's lead for rotorcraft projects. "We don't want to learn everything that needs to be learned about rotorcraft," he says; as prime, Northrop plans to defer that expertise and work to AgustaWestland, he adds. But the Italian company clearly needed a U.S. partner to manage its bids, and "we saw a pattern of failure that we can turn around" from the previous Marine One program, he says. "It appears we can do better, so we jumped in."

Gaining a foothold in this market would be a success for Northrop Grumman during a tough time for the company. It is fighting to keep its Global Hawk line with the Air Force alive, and the service has passed on its efforts to pour more money into its E-8C ground surveillance program. Northrop appears to be filling a void left by the dissolved relationship between Lockheed Martin and AgustaWestland.

Lockheed Martin and Sikorsky, meanwhile, remain teamed to pursue the CRH and Marine One projects, a partnership in place for about two years. ☐

Working Together

Mars sample-return is seen possible for NASA, and ESA might participate

Frank Morring, Jr. **Washington** and Amy Svitak **Liege, Belgium**

NASA has decided it can do a Mars sample-return mission on its own, but it will continue to collaborate with the European Space Agency on Mars exploration despite dropping out of Europe's ExoMars program last year.

Even though Europe has shifted to working with Russia on ExoMars, the program's 2016 orbiter could help provide data and command relays between Earth and a 2018 NASA rover on the surface of Mars. However, it remains to be seen if there will be such a rover, and what it could do if NASA finds the funds to build it.

The U.S. space agency has 4-6 months to decide how it will proceed under its reduced Mars-exploration funding plan. That decision will be shaped by a new set of mission options from the agency's Mars Program Planning Group (MPPG) instrument landing system, and possibly by congressional signals on fiscal 2013 funding levels for Mars. Also in the mix is the role of potential collaborators outside NASA's Science Mission Directorate, including the European Space Agency (ESA).

"Now what we're trying to do is go out and work with the human exploration folks and the technology development folks and decide how we synergize the four areas of NASA and still enable the U.S.—along with our international

partners—to put humans on Mars in the 2030s," said NASA Administrator Charles Bolden, speaking Sept. 26 during a visit to Liege, Belgium.

ESA Director General Jean-Jacques Dordain says his agency was involved in the MPPG study, and that he expects ESA to play a role in any future effort to send humans to Mars. But first, Europe needs to rebound from NASA's almost total withdrawal last year from its ExoMars campaign, a two-pronged mission that would send robotic spacecraft to the red planet in 2016 and 2018.

Dordain says he plans to meet with Roscosmos Director Vladimir Popovkin at the International Astronautical Congress in Naples, Italy, this week to finalize a revamped ExoMars strategy. ExoMars prime contractor Thales Alenia Space of France and Italy already is making progress on the mission.

"We are cutting the metal for the 2016 mission," Dordain says. "It's not yet a reality, but close to a reality."

In Washington, the MPPG reported last week that NASA may be able to return samples from Mars without significant international cooperation, in part by eliminating stovepipes in the way it organizes for scientific and human space missions. Set up after the

NASA JPL/CAITECH/MAIN SPACE SCIENCE SYSTEMS

NASA is seeking evidence of past life on Mars, which probably will require finding a promising sample and returning it to Earth. This raw image of the terrain inside Gale Crater, collected Sept. 21 by the Curiosity rover's Mastcam, shows just what a daunting task that is.

Obama administration dropped its plans to collaborate on ExoMars, the planning group found lower-cost—but less-capable—sample-return missions still are possible, particularly if NASA's space science and human exploration organizations work together more closely, using the agency's Office of the Chief Technologist to develop hardware that serves the needs of both.

"Sending a mission to go to Mars and return a sample looks a lot like sending a crew to Mars and returning them safely," says John Grunsfeld, a former space shuttle mission specialist who is the associate administrator for science.

Headed by retired NASA "Mars czar" Orlando Figueroa, agency and outside scientists and engineers on the MPPG spent five months developing options for a U.S.-only mission that follows the sample-return priority set in the "decadal survey" of planetary scientists run by the National Research Council last year.

Briefing the NRC's Committee on Astrobiology and Planetary Science (CAPS) Sept. 25, Figueroa presented robotic Mars options that could fly in the planetary launch windows in 2018, 2020 and 2022. With U.S. spending for the next mission to Mars limited to a Discovery-class mission capped at \$800 million, Figueroa said there is probably not enough funding to land another rover on Mars in the 2018 window to identify and cache samples for eventual return to Earth.

Congress may not agree, however. Both houses added back \$100 million for Mars exploration in fiscal 2013 spending measures that are still pending, although superseded by continuing resolutions. At that level, some of the options presented by the MPPG could be affordable under the fairly rigorous cost estimates included in the MPPG report.

"Basically we're getting what the decadal survey wanted in terms of science, and now the cost numbers have been looked at much more carefully," says Arizona State University geological sciences Prof. Philip R. Christensen, who is chairman of the CAPS panel that Figueroa briefed. "We know MSL [the Mars Science Laboratory] worked, so we can rely on build-to-print MSL elements, so I think the \$1.5-1.7-billion estimate is far closer, far more accurate, and will do exactly the science that the decadal survey was asking for."

Based on the \$800 million cost cap

the MPPG used, Figueroa left the impression that a rover in 2018 could supplement the aging "infrastructure" of Mars orbiters able to relay commands and data. The planning group lists four orbiter options of increasing complexity that could be flown within the \$800 million constraint. They include a \$200 million single-purpose relay satellite launched to Mars as a secondary payload, and a combined science and relay orbiter based on the Mars Reconnaissance Orbiter and the upcoming Mars Atmosphere and Volatile Evolution (Maven) mission that could probably stay under the cost cap if launched on private contractor SpaceX's Falcon 9. Other options were a \$500 million solar-electric-propulsion sample-return orbiter built with commercial components and piggybacked on the launcher for a lander, and an orbiter that would conduct research while waiting for

porated in their mechanical systems.

Christensen says the Rover D concept probably is too complex and costly to hit the 2018 planetary launch window, which scientists favor because it is sooner rather than later and offers the best planetary alignment in two decades to put a heavy lander on the surface of Mars. Rover C makes more sense, he says.

Technologies needed for a lower-cost sample-return mission—atmospheric guidance as demonstrated on MSL, hypersonic decelerators and supersonic parachutes—would also serve a human landing in the 2030s, the MPPG reported. And NASA's human-exploration directorate may be able to collaborate on sample-return for scientific study, collecting the samples in Mars orbit or elsewhere and returning them to Earth, in the process "breaking the chain" of possible biological contamination by

encapsulating them in the sterile environment away from the planet.

"A lot of this is a coordination problem, and I do believe it could be better coordinated, better integrated over time," says Bobby Braun of Georgia Institute of Technology, a longtime engineering adviser on NASA's Mars program and the agency's immediate-past chief technologist. "A couple of things that the MPPG team pointed to that I thought were interesting

examples of additional ways that the technology programs could be involved [include] even more advancements in entry, descent and landing technology [and] in situ propellant production."

Braun notes that all the ideas are intriguing, but need further study.

While the science community sees a sample-return mission to Mars as the "Holy Grail" of planetary space exploration, Bolden is not so sure.

"One piece of NASA, and the National Research Council, say the international community is going to figure out how to capture the Holy Grail," Bolden says. "The question for many of us is what the timing of accomplishing the Holy Grail is. Do you have to do it before you can send humans? Some would say 'Certainly.' But when Neil Armstrong landed on the Moon, we did not have a sample." ☼



MARS PROGRAM PLANNING GROUP

Scientists believe this MSL-based solar-powered sample collector could be launched in the 2018 Mars planetary window.

sample deliveries from the surface, at a cost of \$700 million plus a Falcon 9 launch.

Sample-return also would require a Mars ascent vehicle that possibly could be carried by the most expensive rover option the planning group identified. Designated Rover D, the vehicle would be a solar-powered version of the nuclear-powered MSL to save money. It would carry an ascent rocket along with a robotic arm to collect samples. Other rover options are a solar-powered version of Rover D without the ascent vehicle, designated Rover C, and two solar-powered rovers—A and B—based on the twin Mars Exploration Rovers Spirit and Opportunity, both with the guided-entry capability that put Curiosity down in Gale Crater, and distinguished from each other by the level of heritage hardware incor-

In the Works

Mankind's route to space after shuttle will be simpler and a lot less capable

Frank Morring, Jr. **Washington**

A journey of 1,000 parsecs begins with a single step, to paraphrase Lao Tzu. Before humans can explore the stars—or the Solar System—in person, we still must travel that first 100-km step through Earth's atmosphere.

Now that the space shuttle is a museum piece, human access to low Earth orbit is down to two spacecraft—Russia's venerable Soyuz capsule, and China's new Soyuz-derived Shenzhou. Today Shenzhou is the most modern operational human spacecraft flying, and it is likely to remain so for at least five more years.

Work is underway around the world on new ways to orbit humans and keep them alive in space. At least seven different orbital human-spaceflight vehicles are in development—most of them in the U.S.—and other longer-term work is beginning to take shape in India, Europe and elsewhere.

Not all of the vehicles in the computer-aided design (CAD) workstations today will fly, and some of those that manage to get off the ground once or twice won't be able to keep flying for lack of passengers. As it struggles to replace the shuttle, NASA has set up a competition to hold down development costs and perhaps influence the per-seat price of astronaut travel. But the U.S. agency does not plan to use all of the competing vehicles once the commercial crew capability becomes operational.

"We say 'likely one provider' in that region," says William Gerstenmaier, who as associate administration for human exploration and operations is responsible for keeping crews on the International Space Station. "That avenue of competition up front also gives us some pretty strong benefits to help us get a good price coming out the other end, even though we may ultimately downselect to one contractor."

Gerstenmaier is overseeing four human-vehicle developments with NASA funding, and holding the door open for at least three more. At the top end of the price list is the Orion multipurpose crew vehicle, a holdover from the defunct Constellation program that has already consumed more than \$5 billion. Under NASA's post-Constellation space policy, as modified by Congress, Lockheed Martin is developing Orion for missions beyond low Earth orbit that would lift off atop the heavy-lift Space Launch System (SLS).

Also working with government funds are Boeing, Sierra Nevada Corp. and Space Exploration Technologies Inc. (SpaceX), on three different commercial crew vehicles intended to take astronauts to the ISS. Building on the George W. Bush-administration commercial cargo program that will

start delivering supplies to the space station this fall, the Obama administration is using federal funds as seed money for what it hopes will one day be a low-Earth-orbit economy.

In August, the U.S. government committed \$1.1 billion in funding for the latest round of commercial crew vehicles—\$460 million for Boeing's CST-100 and \$440 million for the SpaceX Dragon, both of which are capsules. Another \$212.5 million will support development of Sierra Nevada's Dream Chaser lifting body. The smaller amount for the most ambitious design reflects pressure from Congress to minimize the up-front development expense, and recognizes the higher degree of development risk in the Dream Chaser.

"There's a lot more complexity with a winged vehicle, so

Derived from Russia's Soyuz, the Chinese Shenzhou capsule is much roomier. It is also the most modern human spacecraft flying today.



our logic was 'why don't we let them try to buy down some of that complexity first and see how well that goes,'" says Gerstenmaier. "If I didn't think they had a chance of actually competing in the end, being in the potential finalists, we wouldn't have kept them in this phase."

As with earlier commercial crew competitions, all of the money in the Commercial Crew Integrated Capability (CCiCap) phase will be spent under Space Act agreements, which are less restrictive than traditional U.S. government procurements under the Federal Acquisition Regulation (FAR). To address safety concerns growing out of reduced government oversight, NASA will also conduct a two-phase human-rating competition designed to deliver the necessary design data to agency safety engineers in parallel with vehicle development.

"If NASA were to delay certification activities, the development of industry's capabilities could eventually reach the point where any changes necessary to meet NASA requirements would likely not be technically feasible or affordable, potentially extending our reliance on foreign systems," NASA states

in a white paper on its commercial crew procurement plans.

The safety competition's 15-month first phase, expected to result in multiple \$10 million awards in February 2013, is open to all comers. In addition to the three CCiCap winners, other potential bidders for the safety-review funding include ATK Aerospace Systems, Blue Origin and Excalibur Almaz. ATK is working with Astrium to build a big launch vehicle named Liberty, using a solid-fuel first stage based on the Constellation Ares I crew launch vehicle in the first-stage position, with an Ariane 5 main stage as the new vehicle's upper stage. Riding atop it would be a composite version of the aluminum capsule that was developed at NASA's Langley Research Center.

ATK lost out in the CCiCap bidding, but may still go ahead with the Liberty development without government seed money (see p. 44). Blue Origin, the secretive startup endowed by Amazon.com founder Jeff Bezos, did not enter the CCiCap competition, and has apparently decided to continue developing its orbital commercial crew vehicle with its own funds. If that is the case, it will need to enter the safety-review competition if it wants to fly NASA crews in the future. The same is true of Excalibur Almaz, a startup based on the Isle of Man that has bought surplus Soviet military crew vehicles with an eye to converting them to commercial operations (see p. 50).

None of the vehicles in development will come close to matching the unique capabilities of the space shuttle, with its reusability, 24,400-kg (53,680-lb.) payload to low Earth orbit, airlock for spacewalks and Canadian-built robotic arm. And despite NASA's effort to stiffen its insight under the Space Act agreements with what Gerstenmaier calls a "hybrid" approach to human safety, critics worry that the next vehicle will not be much safer than the shuttle, which cost 14 lives during 135 flights over 30 years of operation.

Joseph Dyer, chairman of the independent Aerospace Safety Advisory Panel, calls the parallel development/certification approach a "workaround" that is unlikely to produce the desired safety levels, particularly as uncertain budgets generate downward pressure on safety spending.

"It is not yet clear to us how waivers and deviations will be approved, who is accountable, and how the process shall be administered," says Dyer, a naval aviator who retired as a vice admiral. "[And] both from the Congress's and NASA's perspective, budget and budget stability are a significant challenge."

Appearing with Dyer before the House Science Committee Sept. 14, Gerstenmaier noted that NASA is restricted to spending \$406 million on commercial crew development this fiscal year in the absence of a fiscal 2013 budget figure from Congress. Beginning in fiscal 2014, the agency will need \$830 million a year to meet its plan to fly humans in a commercial vehicle by the end of 2017.

Given election-year budget politics on Capitol Hill, and the possibility of a spending sequestration early next year that the White House budget office says would chop almost \$1.7 billion from NASA's budget, many lawmakers doubt that schedule can be met.





Soyuz TMA-03 descends by parachute to its landing zone in Kazakhstan Sept. 13 carrying the ISS Expedition 32 crew.

"We're going to take care of this next six-month period, and then figure out what to do next," says Gerstenmaier. "Because then we've got to figure out a better strategy of how we phase in, or how do we get assurance that the commercial guys are going to be there."

Russia's three-seat Soyuz capsule remains the workhorse of human spaceflight. It was baselined as the original lifeboat for the ISS, and one or two of the vehicles are docked there at all times in case the crew needs to return to Earth in an emergency. During the shuttle era it provided vital redundancy in human transport to the space station, which it demonstrated after the Columbia accident grounded the surviving shuttles. Now NASA wants the commercial crew vehicles to play that same role.

"The commercial crew program is important to the International Space Station program," Gerstenmaier testified. "We need redundant crew transportation and rescue capability as soon as possible."

Since the accident the Soyuz vehicles have been upgraded with digital flight computers that replace the analog versions in use for 30 years, at a weight savings of 70 kg. But in general, Russia has followed its traditional path with the Soyuz, making only incremental changes to address issues that crop up during operations and sticking with the tried-and-true approach typified in the continued use of the same launch site inaugurated by Yuri Gagarin on the first human spaceflight in 1961. The next likely change will be cutting the trip time between the Baikonur Cosmodrome and the ISS from 34 orbits over two days to four orbits in under 6 hr., a trajectory already demonstrated with Russia's Progress cargo vehicle (*AW&ST* Aug. 6, p. 14).

China, too, has followed an incremental path in developing the Shenzhou spacecraft that carries its astronauts to orbit. Essentially a Chinese upgrade of the basic Soyuz configuration of orbital, landing and service modules, Shenzhou has flown nine times, four of them with crews beginning with Yang Liwei on his October 2003 Shenzhou 5 solo mission. The most recent flight—Shenzhou 9 in June, with the nation's first female space traveler among its crew of three—demonstrated that astronauts could manually dock with the Tiangong-1 mini-space station, after the unmanned Shenzhou 8 demonstrated manual docking in October 2011. Between the two missions Chinese engineers made more than 400 changes in fault modes and procedures, including 100 related to the manual controls (*AW&ST* June 25, p. 34).

Shenzhou 10, originally built in case there was a problem with Shenzhou 8 and 9, is tentatively set to launch next year with another three-person crew and another manual docking on the manifest. China's stepwise approach to the fundamentals of human spaceflight is leading toward the deployment of a small space station in 2020 (*AW&ST* June 25, p. 18).

Like NASA, the European, Japanese and Canadian space agencies will continue to rely on Russia's Soyuz vehicle for access to their facilities on the ISS until a U.S. commercial crew vehicle is available. Canada and Japan have no orbital spaceflight vehicles in development, but Europe may find its hardware helping to send humans to orbit and beyond someday.

One of ATK's selling points for the Liberty launch system is the human rating on its heritage components, including the

"I think we need NASA to give us a cost and schedule estimate that is based on more realistic budgetary assumptions, so we can see what is most likely to actually happen, something we require for all of NASA's other major programs," says Rep. Donna Edwards (D-Md.).

Gerstenmaier testified that Boeing, Sierra Nevada and SpaceX collectively are covering only 10-20% of the development costs of their vehicles with internal funds. Even at that surprisingly low level of private investment, given past administration claims about the prospects for a private space economy, there is no guarantee that the commercial crew vehicles will be cheaper than the Soyuz seats NASA is using today.

In its planning for the commercial crew vehicles, NASA is budgeting the roughly \$62 million a seat it pays Russia for Soyuz transportation and training, Gerstenmaier says. Given the pace of commercial crew development, the agency will need to negotiate at least one more purchase of Soyuz seats to cover the period between summer 2016 and the shift to U.S. commercial crew vehicles. That, in turn, will require an extension of the congressional waiver in missile-proliferation law that allows NASA to buy space hardware from Russia to support ISS operations. And Soyuz lead-time considerations mean negotiations with Russia must start next year if the vehicles are to be ready when the current contract expires.

Ariane V. Although the big European rocket has never flown humans, it was designed to fly the planned Hermes spaceplane and was considered safe to launch humans from the outset. Even though the Liberty was not selected for CCiCap funding, ATK says it probably will compete for NASA human rating with Liberty anyway.

NASA has also been in discussions with the European Space Agency (ESA) about building the service module for the Orion multipurpose crew vehicle under development for government-run exploration missions beyond low Earth orbit. Designed to ride behind the four-seat capsule that Lockheed Martin started developing for NASA under the Constellation program, the service module will carry propulsion, power, avionics and other systems the crew needs to operate in space until shortly before reentry.

ESA has been looking for ways to advance the technology that went into the Automated Transfer Vehicle (ATV) the ISS partnership uses for station resupply under barter agreements that also include U.S.-provided transport for European astronauts. Many of the systems in the ATV could be adapted to the Orion service module, which has been deferred in development because of other demands on NASA's flat budget.

The idea faces opposition among the ESA member states, some of which would rather see Europe develop a more distinctive spacecraft. France has pushed for a "Versatile Autonomous Concept" (VAC) that would evolve ATV technology into a multi-mission platform able to conduct robotic

spacecraft servicing, orbital debris removal and ultimately conduct robotic exploration at Mars (AW&ST April 2, p. 43). However, the VAC would cost at least €700 million (\$900 million), which does not appear to be available. As a result, ESA may be forced to work with NASA on the Orion service module or a portion of it (see p. 44).

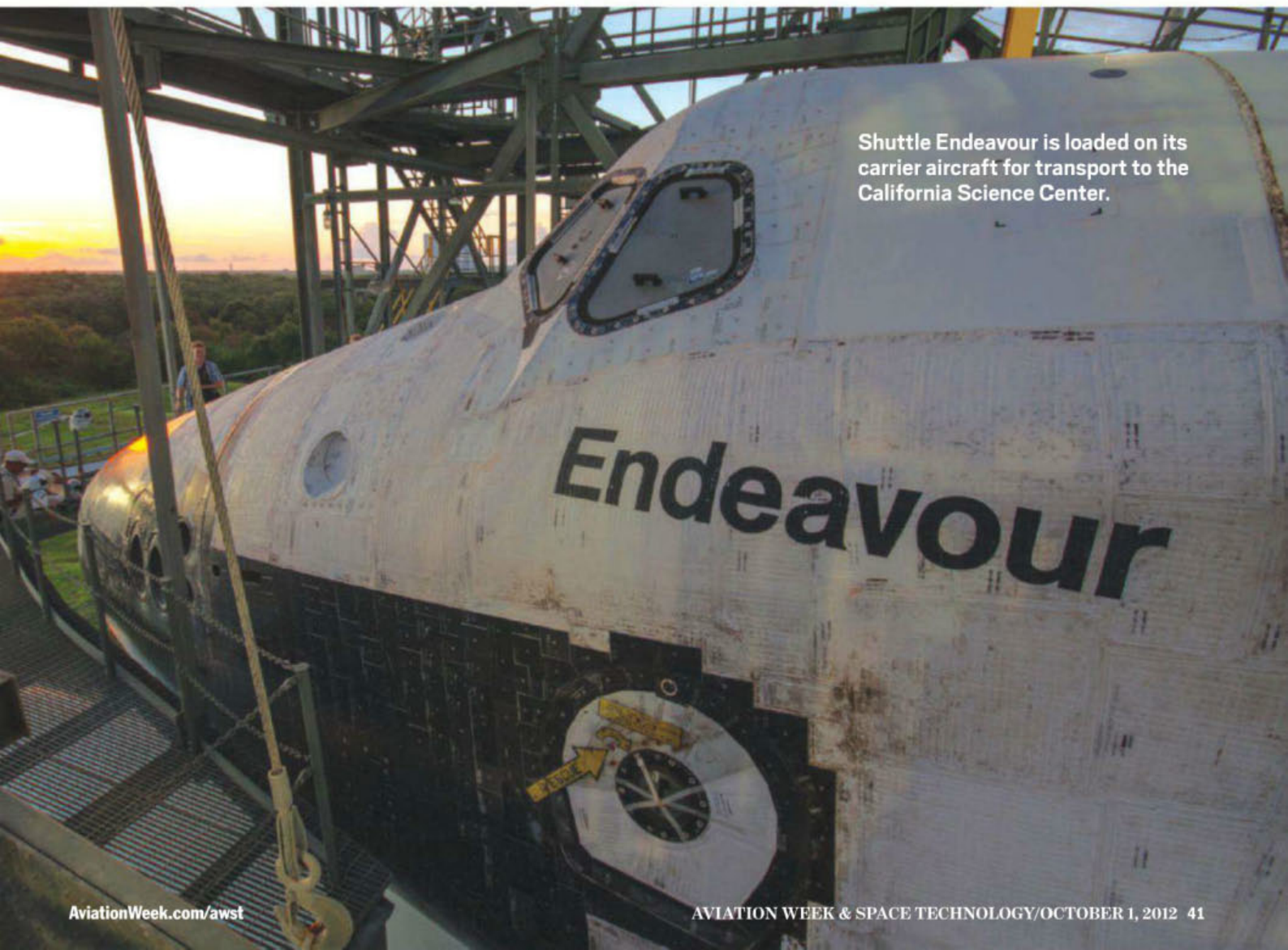
India, too, is struggling with its next steps in space. While development of an indigenous upper-stage engine for its Geostationary Space Launch Vehicle has hit snags, success with its Polar Space Launch Vehicle and the Chandrayaan-1 robotic lunar orbiter had led some Indian space leaders to advocate an ambitious effort to fly humans into space.

The Indian Space Research Organization has experimented with subscale reentry vehicles as part of that work, but lack of government support recently forced ISRO to drop long-range plans to send humans to the Moon as a follow-on to the planned Chandrayaan-2 robotic lunar landing. An orbital human vehicle program remains on the table, but without final government approval (see p. 43). ☛



Two spacecraft are taking humans to low Earth orbit. At least seven more are in development.

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Shuttle Endeavour is loaded on its carrier aircraft for transport to the California Science Center.

Bartered Away

Europe's ATV likely to live on as Orion service module

Amy Svitek **Paris**

After four years of flawless performance shuttling cargo and fuel to the International Space Station (ISS), Europe's most sophisticated spacecraft appears destined to serve as a subsystem aboard NASA's next deep-space exploration demonstrator.

In late September the third of five Automated Transfer Vehicles (ATVs) was set to complete its six-month mission at the ISS, with an undocking

technology in exchange for keeping the lights on in Europe's Columbus research module is, not surprisingly, cost: "The barter element was cheaper than the cost of ATV-6," ESA Director General Jean-Jacques Dordain said during the Berlin air show last month, nine weeks ahead of a key meeting of ESA ministers who, in November, will set the agency's budget for the next several years.

"It is also a way to do development

ambitious barter-element proposal. Dubbed the Versatile Autonomous Concept (VAC), the ATV-derived spacecraft could be capable of orbital debris collection and in-space servicing missions.

VAC cost estimates, however, range from €700 million to in excess of €1 billion, making the VAC unlikely to survive next month's budget talks.

"We have to please the participating states. And we have to please NASA," Dordain says, though he stresses the barter element must do more than simply hand over existing technology to ESA's most valued partner. "It must be good for the future also, because it could not just be a dead end or a one-off which will have no future."

Conceived and designed more than 15 years ago, ATV has features that make it unique compared with other resupply vehicles: The versatile cargo tug docks autonomously with the ISS and also provides extra crew quarters and engine power for the space station.

Woerner says despite the high cost of

The ATV is designed to haul up to three times the cargo of Russia's Progress freighters, which routinely deliver 2.5 tons to the ISS.

maturing ATV technology into something like the VAC, Germany would like to see it evolve into something more than a service module. Last month, DLR awarded Astrium a €15 million contract to conduct preparatory work for the center's Deutsche Orbitale Servicing (DEOS) project, a robotic spacecraft concept that would develop an operational in-orbit servicing system.

In addition to servicing missions, DEOS could be used to deorbit old satellites.

In the meantime, if ESA adopts the service-module proposal next month, its development could afford European industry an opportunity to keep skills sharp until a more advanced technology effort is funded, says Volker Schmid, head of ISS utilization at DLR.

"The integration and work with the U.S. in that respect is certainly a new thing, with all the testing which might be done through a cooperative approach," he says. "From the technology standpoint, it is not quite a development like ATV was in the past—from the very beginning to a fully new vehicle—but it's a kind of adaptation, which has challenges and difficulties." ☐



from the orbiting outpost before burning up in Earth's atmosphere during a controlled, destructive reentry. Although two additional ATVs are slated to launch in 2013 and 2014, respectively, production of the vehicle—arguably one of Europe's most forward-looking and successful technological feats—has already ceased, with no clearly defined follow-on in the works.

Rather than evolve the Astrium-built spacecraft to conduct even more technologically challenging missions, for now the European Space Agency (ESA) is proposing to use ATV-derived technology in a propulsion module that will power NASA's Orion Multipurpose Crew Exploration Vehicle (MPCV), an in-kind contribution valued at roughly €450 million (\$580 million) that would cover Europe's share of ISS common operating costs through 2020.

The argument for bartering ATV

activities and maintain some industrial capability," Dordain says of the Orion propulsion-module proposal.

Germany, as Europe's largest financial contributor to the ISS, appears content with the plan, so long as groundwork is laid for a future ATV-derived capability in November.

"In space we don't have to invent everything new every day, but we should use our heritage to make some progress in some special areas," says Johann Dietrich Woerner, head of the German Aerospace Center (DLR). "To use the ATV as a basis for the development of a service module, which at the same time can be used for different goals, is a very good step forward."

France—which has threatened to end participation in ISS beyond 2015 in order to pay for other priorities, including development of a next-generation launch vehicle—favors a more

Mission Incomplete

High costs, sagging budgets delay Indian human missions

Jay Menon New Delhi

India's ambitious human spaceflight programs are moving in a skewed phase for want of requisite technologies and capabilities.

The country has shelved plans to undertake a manned mission to the Moon in the near future, and the launch program of the first manned mission in space is delayed. As a result, any chance of India becoming the fourth nation with an indigenous human spaceflight is also slipping into the future.

"As of now, we do not have a program to launch a human spaceflight over the next five years," says K. Radhakrishnan, chairman of the Indian Space Research Organization (ISRO). "We are also yet to get approval from the government for the manned mission."

The state-run Indian space agency once planned to send a two-member crew on an orbital mission by 2014-15, at an estimated cost of 124 billion rupees (\$2.8 billion) (*AW&ST* May 5, 2008, p. 31). However, although India has started developing critical technologies for its human spaceflight mission, final government approval has lagged.

"A human spaceflight is a complex mission requiring a host of things, such as a heavy rocket, reentry vehicle, space capsule, space suits, environmental control, life-support systems and an escape system for the crew at the launch pad and during the flight to be safe in the event of a mishap," says Radhakrishnan. "Though we have identified critical technologies for such an ambitious project, we have to build the capabilities for undertaking such a challenging mission."

The slowdown in orbital spaceflight dampens India's ambitious long-term goals in space as well. Following the successful 2008 launch of the Chandrayaan I robotic lunar orbiter, ISRO proposed launching a manned Moon mission by 2020. But that now seems to be a distant dream.

"There is no immediate plan for a manned mission to the Moon," says V. Narayanasamy, a minister in the prime minister's office. "The work on the Indo-Russian joint project, Chan-



Indian sailors recovered the Space-capsule Recovery Experiment from the Bay of Bengal on Jan. 22, 2007, but the Indian human-space-flight program has languished since that early effort.

drayaan II, is in progress, . . . but Chandrayaan II does not envisage [a] manned lunar expedition."

Chandrayaan II will include an unmanned orbiter, a lander supplied by Russia and a rover module to be developed by India for scientific exploration of the lunar surface. ISRO is aiming to launch the unmanned mission within a couple of years.

An ISRO official, D.P. Karnik, tells Aviation Week that a manned lunar mission is not in the cards for the near future and could only take place after ISRO succeeds in its proposed orbital human spaceflight program.

"In the first place, we require a qualified vehicle with which a man can be sent to the Moon," he says. "We are currently aiming to have a manned spaceflight program. A manned lunar mission will come much later."

The latest orbital spaceflight mission plan envisages sending a two-person

crew in a 3-ton spacecraft to low Earth orbit for about a week. "Once the project gets the final approval, it will take at least six to seven years for the launch," says a space department official. ISRO had initially hoped that it would be able to launch the mission in 2016.

"With human life at stake, there is no room for error at any stage of the flight mission," Radhakrishnan says. "Though we had successfully conducted a 12-day space capsule recovery experiment using a lower-orbit rocket in January 2007, we have to work on a full-fledged project on mission mode for the human spaceflight at a revised cost."

Ajele Lele, an analyst at the Institute for Defense Studies and Analyses here, dubs the deferral of India's manned Moon mission a "step in the right direction."

"A manned mission has more difficulties than advantages," Lele says. "It is better to develop a robotic mission that is more useful and has more output than a manned mission, which is only about fanfare."

According to observers, the huge cost and the recent twin failures of India's homegrown Geostationary Satellite Launch Vehicle (GSLV) could be the reasons for the delay in the final government nod for the project. The successful Polar Satellite Launch Vehicle lacks the lift capacity for a human mission, and the GSLV Mk. 2 could lift only a two-person crew. The planned GSLV Mk. 3 now under development should be able to carry a crew of three with capability to spare.

The government trimmed the budget allocation for human spaceflight work in India's current financial year, which ends March 31, 2013, to 600 million rupees (\$10 million) from 980 million in 2011. With dwindling funding and no clear road map, India is said to be weighing its options for collaborating on human spaceflight as well.

Meanwhile, India is focusing on a mission to Mars. The federal government on Aug. 5 gave the go-ahead to launch a Mars orbiter in November 2013. India would be the sixth country to launch a mission to Mars, after the U.S., Russia, Europe, Japan and China.

But former ISRO chief G. Madhavan Nair suggests the country should concentrate more on qualifying the cryogenic engine for the GSLV upper stage and making the manned mission initiative move forward, rather than giving priority to the Mars mission. ☐

Deep-Space Testing

Constellation program holdover Orion may conduct lunar-orbit tests in 2017

Frank Morring, Jr. **Washington**

NASA's Orion multipurpose crew vehicle is on a go-slow development path to free funds for near-term agency objectives, but its first full-scale flight test may send it to the Moon.

Even before that 2017 unmanned flight atop the first version of the government-owned heavy-lift Space Launch System (SLS), a planned 2014 flight test on a Delta IV will characterize radiation levels and cabin-seat g-loading for deep-space flight, as well as the performance of its thermal protection system (TPS) on a high-speed reentry.

NASA planners are pondering just how much data they can wring out of the vehicle's first three flights—including one with a crew planned for 2021—to begin learning how to operate in cislunar space, which is almost certain to be the first human destination beyond low Earth orbit (LEO).

"We have certain objectives that we need to accomplish from a test standpoint," says William Gerstenmaier, associate administrator for human exploration and operations. "We have to do certain profiles on certain things. But could we expand those potential test missions to do more?"

Possibilities include shifting Orion from one Earth-Moon Lagrangian point to another; or conducting a lunar flyaround or orbital mission. NASA's flat budget is so tight that the agency has deferred development of the service module that will carry Orion's propulsion and other systems. But with \$5 billion already spent on the four-seat capsule once dubbed "Apollo on steroids," Gerstenmaier and his colleagues are looking for some return on investment to apply against the missions beyond LEO it was developed to fly.

Lockheed Martin has been the Orion prime contractor since it was conceived as the "crew exploration vehicle" for the now-abandoned Ares I launcher under the Constellation program of deep-space human-rated vehicles. The company has built full-scale engineering articles for extensive ground testing

and delivered the first flight article to Kennedy Space Center for integration and testing in preparation for the 2014 Delta IV mission.

"We're trying to solve 12 of 16 of the top risks," says Cleon Lacefield, Lockheed Martin vice president and Orion program manager. "We're trying to do some kind of risk mitigation with those. That includes the parachutes, the landing system, the guidance and control, the flight computers, the reaction control system, the heat shield, the back-shell heat shield. Plus we're going to do the radiation [measurements] going through the Van Allen Belts, and we do have simulated mass in the seats so we can see what happens during landing."

Under the Constellation program, Orion was intended to serve initially as transportation to the ISS for NASA crews and be scarred for missions beyond LEO. Now, with the introduction of commercial crew vehicles as the preferred route to the space station, Lockheed Martin is focusing on the deep-space mission. Lacefield says the vehicle still can perform the station mission with the addition of the docking system NASA is developing for all vehicles arriving at the U.S. side of the

ISS. The focus, though, is on the early cislunar missions before moving on to visit an asteroid and eventually Mars. Among destinations Lockheed Martin is studying internally are Demos, the smaller of the two Martian moons, and the L2 Lagrangian point over the Moon's far side (*AW&ST* July 2, p. 22).

Lacefield says his program has benefited from changes in NASA oversight growing out of the commercial-crew projects, which are conducted under Space Act procedures that are less restrictive than traditional agency procurements. Lockheed has also embedded NASA engineers in its design and testing work, which gives the agency insight into the company's work progress while Lockheed benefits from their labor in such areas as arc-jet and water-landing tests (see photo). The new approach has also extended to software testing, with dramatic cost-savings.

"They wanted us to do all the software development and software verification and validation activities in a government facility," Lacefield says. "We're doing it in a facility that we have in Denver and a facility in Houston. By staying in those facilities and running those as we would run our company systems, that has increased the output and saved us several hundred million dollars."

On the down side, the dwindling sub-tier aerospace supply base in the U.S. and the low-volume procurements for systems like Orion have created a parts crunch that threatens the flight schedule. Particularly critical is the supply chain for radiation-hardened electron-

Splashdowns with a boilerplate Orion are among tests that may include early flights to Earth-Moon Lagrangian points.



ics Orion will need to fly through the Van Allen Belts on its first test mission, which will take it through two high-apogee orbits to generate near-planetary reentry speeds.

"We have outsourced across all of the electrical components to get the parts that we need by the time that we need to do the vehicle checkout on the pad next March, the electrical checkout," Lacefield says. "We are waiting on those parts to enable us to do the vehicle checkout on the pad in Florida."

That mission will include an incomplete service module, without tanks or engines but with as much structure as possible to begin validating interfaces and other hardware. For the second Orion flight test, scheduled to go in 2017 on an SLS core stage with solid-fuel boosters derived from the defunct Ares I crew launcher, NASA is planning a full-scale Orion with service module, although it remains uncertain just what that will mean or who will build the service module components.

NASA is exploring the idea of working with the European Space Agency to develop an Orion service module based on Europe's Automated Transfer Vehicle. But that idea ran into opposition from some of the ESA partners, and the plan for building the service module remains unsettled.

"Nothing has happened," Lacefield says. "Our contract has not been changed, but we are trying to work with NASA. If the Europeans decided that they would be amenable to this, . . . then we wanted to have the most efficient split that made sense." 🗨️

NASA/SANDRA GIBBS



Biggest Piece

NASA sees low risk in Boeing capsule, but corporate commitment is uncertain

Frank Morring, Jr. **Washington**

Boeing got high marks in the competition for an integrated commercial crew launch system with its CST-100 capsule, a bare-bones vehicle designed to reach the International Space Station on battery power after launch with an Atlas V.

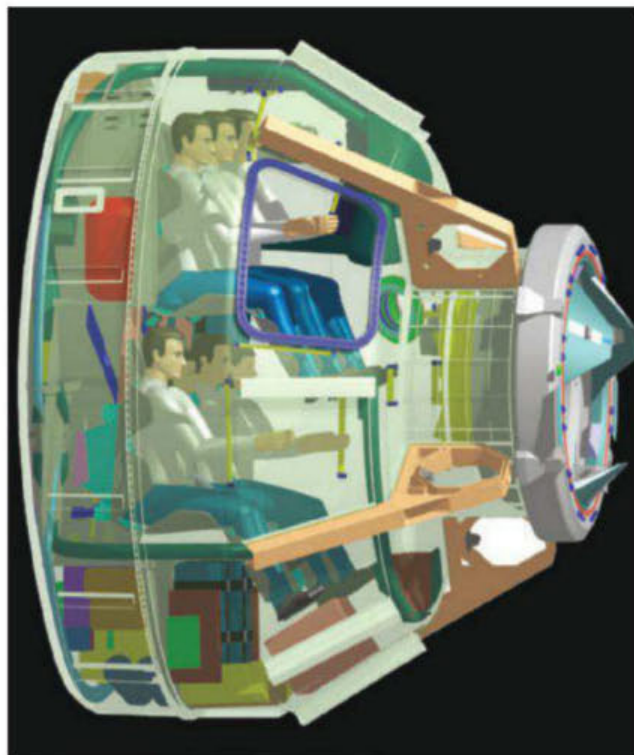
In the just-completed Commercial Crew Integrated Capability (CCiCap) selection, NASA gave the aerospace giant the largest share of the \$1.1 billion in seed money available. But the \$460 million award came with a warning that Boeing's corporate commitment to the project is weak, leaving "an increased risk of insufficient funding" over the life of the Space Act agreement.

Associate Administrator William Gerstenmaier, who heads NASA's human spaceflight mission directorate, discounted Boeing's low investment in his selection of the CST-100 for CCiCap funding.

"While this was only one of 13 goals, I did consider it," he writes in his formal source-selection document. "However, Boeing met all of the other goals and had a strong technical design; therefore, I did not find the lack of significant corporate financial commitment to be a major discriminator in my assessment."

Across the three companies selected—Boeing, Sierra Nevada Corp. and SpaceX—Gerstenmaier says he picked the CST-100 because it scored highest in "level of effectiveness" and "confidence" on its technical approach. "The Boeing [vehicle] is clearly what we would see in more of a traditional program, the kind of layout and the structure and the way things flow," he tells Aviation Week.

The company passed the first of its 19 CCiCap milestones—integrated systems review (ISR)—at a three-day meeting in August. Covering the seven-



BOEING CONCEPT

Boeing's CST-100 crew vehicle passed the first milestone under its CCiCap agreement with NASA.

seat capsule, Atlas V and mission operations on the ground and in space, the review closed some issues left open at preliminary design review (PDR) during the second round of NASA's Commercial Crew Development effort that preceded CCiCap.

"We still had some open trades that we had to go work," says John Mulholland, Boeing vice president and commercial crew program manager. "We had some water landing modes that we were attacking because of its threat on weight, some power-system decisions that we needed to make. We took that time between PDR and the kickoff of CCiCap to go pound those issues flat, so when we got into CCiCap we could really go full force on final design release."

Also included in the first milestone were the results of abort-engine hot-fire tests, wind-tunnel tests, parachute drops and tests of the air-bag system designed to cushion the capsule's nomi-

nal touchdown on dry land. With the ISR milestone complete, Mulholland says, the outer mold line of the capsule is frozen, and the program is on track to deliver its first flight-design hardware—the one-piece lower section of the capsule's aluminum pressure vessel—in “less than 20 months.” Boeing has rented the former space shuttle orbiter processing facility at Kennedy Space Center as the assembly facility for the CST-100 (AW&ST Nov. 7, 2011, p. 34). First flight is scheduled by the end of 2016, and the company is looking for ways to advance that, Mulholland says.

As for the finding that the Boeing home office has not committed suffi-

cient resources to the CST-100, Mulholland argues that “conservative” corporate accounting obscures the in-kind role played by engineers from other Boeing units, including commercial aircraft and those building military fixed- and rotary-wing aircraft.

“Across the company, our business is delivering transportation platforms,” he says. “We bring a rigorous and robust process, because our company is not going to let these programs fail. One of the things that we always focus on is the old approach of ‘test like you fly, and fly like you test,’ so when we lay out a design and development program, it will look the same across all the portfolios.”

While proprietary financial information is redacted from the published versions of NASA's source-selection documents, Mulholland says his program's business case continues to close with the two flights per year to the ISS that NASA anticipated. Like other commercial-crew contenders, Boeing is also looking to stoke new markets in space tourism and alternate destinations such as the inflatable space habitats under development by Bigelow Aerospace.

“We'll close on two NASA flights alone, but we are also in a position of trying to make sure that we're doing everything we can to help the market emerge,” Mulholland says. ☐

Longer Stretch

Despite receiving the smallest NASA award, Sierra Nevada presses on with lifting body

Frank Moring, Jr. **Washington**

Sierra Nevada Corp. drew the short straw in NASA's Commercial Crew Integrated Capability (CCiCap) competition, winning only about half as much of the federal seed money to advance its Dream Chaser lifting-body crew vehicle as its two competitors received for their capsule designs.

At \$212.5 million, the company's award is not exactly chump change, but the \$460 million for Boeing and the \$440 million for SpaceX would go a lot further in wringing out the questions that remain about Sierra Nevada's unique approach to flying humans to space. The half-portion grew out of congressional fears that NASA was spending too much to preserve competition in its commercial crew development effort (AW&ST June 18, p. 26).

Sierra Nevada's Dream Chaser will be reusable, but it will launch at least initially on a one-shot Atlas V rocket.

In his source-selection document William Gerstenmaier, associate administrator for human exploration and operations, says the Dream Chaser design—based on the old NASA HL-20 testbed—poses “significant risks because of design complexity.”

“The winged vehicle offers a lot of advantages, even to customers, in

terms of easier landing—you can land on a runway—lower gs, cross-range from deorbit, that's all called out in the document,” Gerstenmaier says. “But associated with that are more technology hurdles. You've got to look at aborts. They're a little more difficult. You've got thermal protection issues, the heat-shield kind of stuff we dealt with on shuttle protection on orbit, all those things. So there's a lot more complexity with a winged vehicle.”

As a result, the agency cut back on the milestones Sierra Nevada had proposed, commensurate with the lower funding level, and does not expect the Louisville, Colo., company

to pass critical design review under CCiCap. “We kept enough in that we think we'll get really good insight into how well they can handle those technical challenges,” Gerstenmaier says.

Abort-testing is not on the new list of for Dream Chaser milestones, says Mark Sirangelo, head of Sierra Nevada's space systems unit, but the company plans to make a start anyway. The abort system uses the same hybrid-rocket engines designed for in-space maneuvering to fly off a failing Atlas V, which would be the initial Dream Chaser launch vehicle (AW&ST July 2, p. 37).



SIERRA NEVADA CORP. CONCEPT

"We have plans to do a pad abort test in the coming months," Sirangelo says. "Our vehicle has no black zones right now for abort from launch to orbit, and we can abort to a runway anywhere along the way. . . . None of the three of us has done any abort tests so far, and we need to all do that. We have that planned to retire that risk, not as one of the milestones but as work that we're doing separately."

Those hybrid engines, also mentioned in the source-selection document as a technical risk, are based on the rockets that powered the Scaled Composites SpaceShipOne in its successful bid for the \$10 million Ansari X Prize, and those planned for Virgin Galactic's SpaceShipTwo suborbital vehicle. Sirangelo says the Dream Chaser versions have been test-fired and restarted, including in vacuum, and should have no problem meeting the test-fire milestones in the CCIcap plan.

Despite the lower NASA funding, Sierra Nevada plans to go ahead with its bid to fly NASA astronauts to the International Space Station, starting before the end of the year with an autonomous drop test and landing with a full-scale engineering article that has already undergone captive-carry tests. Ultimately, Sirangelo and his corporate colleagues believe, the capabilities of their vehicle will outweigh today's risks.

"With the hybrid motors, if we don't use them on abort, they give us a tremendous capability to fly on orbit," he says. "So we can actually go up to several hundred miles above the space station and do work. That's a really robust capability that allows us to consider potential servicing missions for things for NASA for other purposes, and to use the vehicle for other purposes."

Also on the list of potential advantages of the Dream Chaser over the Boeing and SpaceX capsules is the high level of reuse Sierra Nevada expects from each vehicle—25-30 missions each, according to Sirangelo. The optimistic outlook for the Dream Chaser's commercial potential is shared by Gerstenmaier and the CCIcap source-selection board that advised him.

"These significant technical advantages could result in a larger customer base for [Sierra Nevada] than a capsule design and more capability for users," Gerstenmaier writes. ☼

First Up

NASA sees cargo role giving SpaceX Dragon a commercial-crew cost and schedule edge

Frank Morring, Jr. **Washington**

NASA believes its previous and upcoming commercial cargo missions to the International Space Station give Space Exploration Technologies Inc. (SpaceX) the best chance of transporting a human crew to the space station first, but the brash startup is not a sure bet to win the commercial crew race.

While company founder Elon Musk says he will fly a crew to the station before the end of 2015—earlier than any of his competitors—his main NASA customer is a little more cautious.

"There are some systems that are acceptable in cargo that may not be acceptable in crew," says William Gerstenmaier, associate administrator for human exploration and operations. "There's obviously a lot of stuff that needs to be added in terms of life support; there's some cooling that needs to be there, humidity control, atmosphere monitors. There are a lot of other little subtle things that have to be there. So they've got the good basic capsule design, but I think there's still a little bit of work for them to do in those other areas."

Still, in his formal source-selection document, Gerstenmaier found that the SpaceX proposal for the Commercial Crew Integrated Capability (CCIcap) program "provides the earliest crewed demonstration flight under a credible schedule at the lowest development cost." On that basis, NASA awarded the Hawthorne, Calif., company \$440 million in federal seed money to continue work on the crew version of the Dragon capsule that reached the ISS in May, and is scheduled for at least one more return trip before the

end of this year (*AW&ST* May 28, p. 35).

"I think there are advantages of having flown cargo, but then there's a statement in the document where I caution that we need to know how they're going to transition from cargo to crew," says Gerstenmaier.



FRANK MORRING, JR./AW&ST

SpaceX's commercial crew Dragon is nearly identical to the cargo version. Pod positioning has changed since this mockup was built.

That will not be too big a problem, Musk says with typical bravado. A lot of the work has been done, he says, and the rest can be completed within the time constraints laid out in the company proposal.

"We actually already have much of the [environmental control and life support] system working, even for cargo missions, because we are required to take biological cargo to and from the

space station,” Musk says of the \$1.6 billion commercial resupply services NASA contract his company entered after demonstrating Dragon’s ability to dock with the ISS. “And some of the experiments actually have very tight temperature requirements, so we have very good thermal control of the Dragon interior. It’s accurate to within about 1C.”

Still to come are lithium hydroxide (LiOH) canisters to scrub carbon dioxide from the atmosphere, along with humidity control and high-pressure air to maintain pressure in case of a leak.

The primary external difference between the cargo version of the Dragon and the crew version will be a pusher-type launch-abort system mounted in four pod-like bulges around the circumference of the capsule. They will be powered by four redundant pairs of SpaceX-designed SuperDraco hypergolic engines that have been test-fired to full thrust and duration, says Musk.

A mockup of the crewed Dragon has the abort-system pods mounted at 90-deg. intervals around the capsule (see photo, p. 47), but Musk says that is being redesigned with an asymmetric configuration to address heating concerns.

Crew seats are “pretty close to the flight design,” he says, with individually molded liners able to accommodate astronauts as tall as 6 ft. 6 in. While docking will be autonomous using the NASA system in development at Johnson Space Center, pilots in the seven-member crews will be able to take control in emergencies or for special-purpose maneuvers such as inspection flyarounds, says Musk.

Although some of the companies building the next generation of crew vehicles are experiencing difficulty obtaining components from a dwindling aerospace supply base in the small lots they require (see p. 44), Musk says his company’s philosophy of building as much as possible in-house mitigates the problem. Workers are currently reconfiguring the factory floor for efficiency and to keep activities requiring cleanliness away from heavy machining and other dirty areas.

“As far as engines and primary structure go, raw metal comes in and engines and rockets come out,” Musk says. “We do have suppliers of smaller components, but all major subsystems are made at SpaceX. It’s harder and more painful in the beginning, but it pays off long term.” ☛

Fourth Place

Weak showing in commercial crew bidding may point ATK toward satellite launches

Frank Morring, Jr. **Washington**

ATK Aerospace Systems and its partners have not given up on the Liberty launch vehicle they proposed as the next route to the International Space Station for NASA astronauts.

NASA rejected the company’s proposal as insufficiently detailed compared with the three it ultimately selected for Space Act agreements. But the Liberty partnership offered to

stage that ATK developed for NASA’s abandoned Ares I crew launcher, with an Ariane 5 main stage serving as the launcher’s upper stage.

Riding atop it would be an all-composite version of the Orion multi-purpose crew vehicle Lockheed Martin developed to ride on the Ares I, and continues to build for the planned heavy-lift Space Launch System (see page 44). But NASA evaluators found

the partnership’s plans for combining all of the elements too vague.

The “proposal did not include enough data to understand the spacecraft baseline configuration that would serve as the starting point, the system changes planned to bring this spacecraft to the Liberty baseline or how heritage systems will be modified and integrated to enable a [crew transportation system] capability,” wrote Associate Administrator William Gerstenmaier, who selected the CCIcap winners in his role as chief of NASA’s human

exploration and operations mission directorate.

Gerstenmaier also noted that ATK’s “significant financial investment” compared to the other bidders “gave me confidence in the company’s commitment to this activity.” That commitment may continue, says the ATK executive in charge of the effort.

“We are regrouping, circling the wagons, looking at what makes the most sense,” says Kent Rominger, a former space shuttle commander who is ATK’s vice president for strategy and business development and the Liberty program manager.

While the partnership’s focus may shift to other applications for the big rocket, which was conceived as a way



The ATK/Astrium Liberty launch system would carry crews in a composite version of the aluminum pressure vessel built for NASA’s Orion.

spend “an order of magnitude” more of its own money on development than the competition, and it may use its deep pockets to continue the work on its own. Ultimately the Liberty team might find itself launching some of the commercial crew vehicles that beat it out in NASA’s Commercial Crew Integrated Capability (CCiCap) contest.

Like SpaceX with its Falcon 9 rocket and Dragon capsule, ATK proposed a new launcher and crew capsule. The Liberty rocket would be a combination of the five-segment solid-fuel first

to transport 44,000 lb. to low Earth orbit, it has not given up on the capsule either. Originally built as a proof-of-concept article, the composite version of the aluminum Orion would use many of the same internal systems.

"We are very seriously looking at proposing on the certification phase," Rominger says, referring to NASA's plan to run a parallel human-rating process as the CCiCap vehicles are developed (AW&ST Sept. 17, p. 16). "And when you look at the vehicle as a satellite launcher, too, it holds a lot of promise."

For the capsule, ATK would dispense with life support and other systems needed for long-duration deep-space missions, although Rominger says it probably would carry solar arrays like the Lockheed Martin version. The biggest technical question mark is probably the launch abort system, he says.

"We're not using the launch abort system that Orion is using, which has flown," Rominger says. "We're using a modified version of NASA's MLAS [Max Launch Abort System]. We've taken NASA's version and simplified it."

ATK worked with NASA's Langley Research Center on the MLAS prototype, which used the company's solid-fuel rocket motors to power a side-mounted propulsion system. It was tested in flight from Wallops Island, Va., on July 1, 2009, with a simulated spacecraft (AW&ST July 13, 2009, p. 17).

While Gerstenmaier has told Congress the three winning CCiCap bidders—Boeing, Sierra Nevada and

SpaceX—have contributed 10-20% of the cost of their vehicle development, Rominger says ATK and its partners have been willing to match the government almost dollar for dollar.

"Nobody else was even close in terms of the amount of industry investment that we brought," he says. "I would guesstimate an order of magnitude investment [over the competition]. We were really offering NASA a cost-sharing."

In its reevaluation of the program, ATK will also consider whether it

now we're taking a hard look and saying 'no, it looks like satellites are probably the best first mission for us now.'"

Still, with Boeing and Sierra Nevada launching on Atlas V at first and considering themselves "launch vehicle-agnostic" after that, "we'd love to be spacecraft-agnostic," says Rominger. Those decisions will be driven in large part by the cost of launch vehicles.

ATK says it has achieved significant cost savings in a just-completed value-stream mapping exercise at the Promontory, Utah, facility where it builds the multi-segment solid-fuel rocket motors that would drive the Liberty first stage. A more competitive launcher market would be attractive to all users, including the government.

"What we hear from these commercial companies is they believe that there's a market for their spacecraft that's beyond the government's need," says Gerstenmaier. "They believe there's a commercial sector market for that, so even though one of these companies may provide services only to NASA for their ISS activities, the others may have another market to go to. Then I have the advantage on the government side [of] another contractor that I can go back and pick up to go provide services later for some future activity, if we decided to extend, for example, space station beyond 2020." ☼

"The capability basically spans from kind of a medium-level Atlas V all the way through the capabilities of the Delta IV Heavy"

would make sense to develop the Liberty rocket as a launcher for satellites, while holding open the possibility of lofting crews at a later date with its human-rated hardware.

"The capability basically spans from kind of a medium-level Atlas V all the way through the capabilities of the Delta IV heavy, into all orbits," says Rominger. "Our original plan was always we're flying crew; we're doing the human-rated—safety-wise the most difficult requirements-wise mission to meet first—and then we'll back into the other missions. Obviously right

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Outliers

U.S. government is not only backer of commercial crew vehicle plans

Frank Morring, Jr. **Washington**

NASA's deep pockets have always driven human spaceflight developments, and they continue to do so even as the U.S. agency backs away from the government-owned vehicles that typified the first 50 years of human spaceflight.

While most of the commercial crew vehicles under development in the post-shuttle era got their starts with NASA seed money, a couple of companies are seriously working on crew vehicles without a major role for Uncle Sam.

equivalent of the American Air Force MOL program, the Manned Orbiting Laboratory," says Art Dula, a longtime space entrepreneur from Houston who is listed as founder and CEO of Excalibur Almaz, which operates under the oversight of the U.K. Space Agency (UKSA). "While the Manned Orbiting Laboratory didn't get to flight hardware, the Russian secret equivalent of it did, with three space stations and nine successful orbital flights by the reentry vehicle."

Dula says his company has acquired

ly developed for the European Space Agency's Automated Transfer Vehicle to outfit the Russian structures.

Dula has a long history working with Russian space companies, going back to the early days of the post-Soviet Russian Federation. His company management includes a couple of cosmonauts, and its list of advisers includes George Abbey, who helped oversee the merger of the U.S. and Russian government space-station efforts as director of Johnson Space Center and a staffer on the old White House Space Council.

Dula says Excalibur Almaz has raised \$49 million to reach this point, and is working on "bridge" financing to market its wares. The company has an "expedition" model for financing its operations, with the customers paying for the outfitting and use of the space assets. Dula cites a study he commissioned with Futron Corp. that suggests there are a few dozen potential customers with the funds and interest to buy tickets.

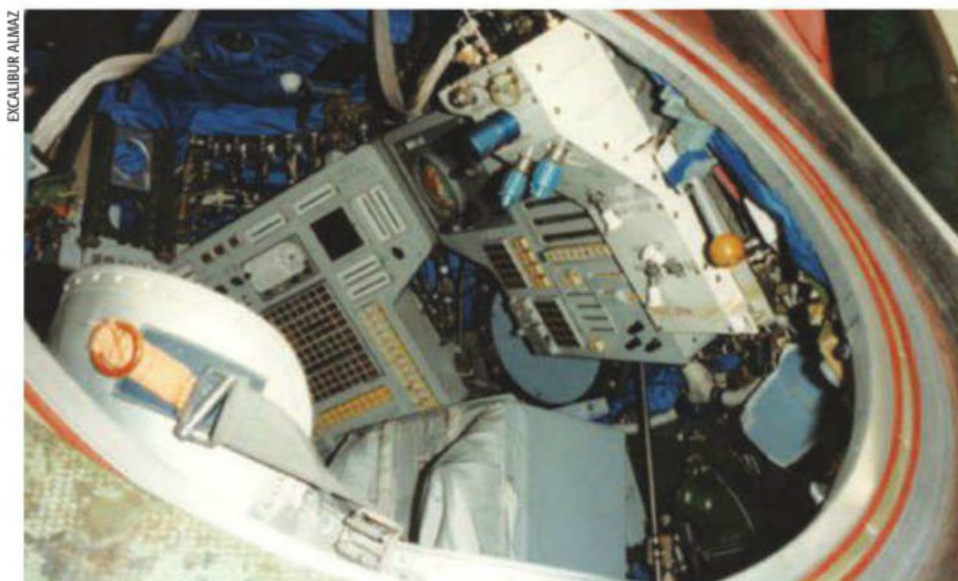
"Do they need a telescope?" he says. "Do they want to mount a tether to drag on the lunar surface to pick up

EADS Astrium will upgrade avionics in this surplus Soviet crew vehicle for Excalibur Almaz.

surface samples, do they want to do scientific work in zero gravity? We're just building the expedition."

Blue Origin received \$25.7 million from NASA in the first two rounds of the Commercial Crew Development effort, but did not bid on the Commercial Crew Integrated Capability (CCiCap) round that distributed \$1.1 billion among Boeing, Sierra Nevada and SpaceX. It declined comment on whether it will take part in the human-rating competition NASA is running in parallel with the CCiCap development.

In May, company officials said Blue Origin is at work on separate vehicles for two different flight profiles. The New Shepherd suborbital vertical-takeoff-and-landing spacecraft would fly space tourists and scientific researchers and return to a powered landing. An unnamed seven-seat orbital capsule would use the Atlas V to reach space initially, although the company has plans "several years in the future" to build its own partially reusable launch vehicle to propel its human space vehicle to orbit (AW&ST May 7, p. 29). ☐



They are as different as night and day. Secretive Blue Origin is drawing on the deep private pockets of Amazon.com founder Jeff Bezos to build human spacecraft for the prospective orbital and suborbital markets, carefully concealing his company's activities from prying eyes at a closed factory near Seattle and a remote test site in West Texas.

Swashbuckling Excalibur Almaz is openly promoting its plans to upgrade 40-year-old Soviet human-spaceflight vehicles for tourist flights to cislunar space, inviting visitors to kick the tires on their venerable hardware at open houses in their Isle of Man headquarters.

"Originally they were the Russian

five "reentry vehicles" and two of the Salyut-class orbital stations, and has obtained assurances from their builder—the now-private missile-manufacturer Mashinostroyeniya—that there is enough of a supply base left to refly them if a market emerges. That market, says Dula, would be privately funded trips to lunar orbit or an Earth-Moon Lagrangian point, where at least one of the stations would be pre-positioned.

Technical details are sketchy. Excalibur Almaz is working with Busek Space Propulsion of Natick, Mass., to obtain Hall-thruster technology to move the stations to cislunar space, Dula says. EADS Astrium of Bremen, Germany, will adapt systems original-

Morphing Model

Low-fare carriers change strategies to broaden their customer bases

Jens Flottau **London**

When asked about the future of the low-fare airline industry, Vueling CEO Alex Cruz has a simple answer: "We will grow and the legacy carriers will shrink." But that is only the short version of a more complex story.

While most low-fare carriers are continuing to grow, strategies and behavior patterns are changing, particularly in Europe. EasyJet is introducing assigned seating and has started selling its tickets through global distribution systems (GDS). Vueling Airlines, Norwegian Air Shuttle and others are actively pursuing connecting traffic, and Norwegian plans to launch long-haul flights next year.

"We are evolving the low-cost model," said Ali Sabanci, CEO of Turkish low-fare carrier Pegasus Airlines, on the sidelines of the World Low-Cost Airlines Congress here last month. "Only

Turkey's Pegasus Airlines will order at least 40 new aircraft—more than it now operates—to help it grow capacity to Russia and the CIS.

two years ago, 'GDS' was a swear word."

By introducing new possibilities for the model, airlines are trying to gain access to a broader customer base. EasyJet's drive to GDS cooperation, for instance, is aimed at attracting more business travelers. Vueling has enough frequencies at its Barcelona base to enable a large number of natural connections—passenger streams to which it would otherwise not have access.

EasyJet's decision to introduce assigned seating can also be seen as a move to draw corporate travelers. Trials on selected routes have shown that the boarding process does not take any longer than the previous open-seating procedure, says EasyJet's customer and revenue director, Cath Lynn. But the airline now can achieve higher yields and ancillary revenues by offering seats at the front of the aircraft to passengers

buying the most expensive tickets.

Some changes are also being forced on low-fare carriers. The industry has always reduced capacity in the winter, but not to the extent it does today. Whereas previously it tended to fill seats by reducing fares, that is now

last winter from 40% the year before; and Norwegian dropped its by 28% in 2011, from 27% the previous year.

As networks grow, the low-fare airlines find themselves in more direct competition with each other. When Hungarian national carrier Malev collapsed in January, Wizz Air immediately widened its already significant presence at Budapest Airport and Ryanair opened a new base. Following the closure of BMIbaby in September, Monarch Airlines, FlyBe, Ryanair and Jet2.com went in to pick up abandoned routes at East Midlands Airport.

One current low-fare success story is Spanish carrier Vueling, which is thriving in spite of its home market's economic weakness. Vueling benefits greatly from industry consolidation. At its main base in Barcelona, its biggest competitor, Spanair, went bankrupt in January and ceased operations. EasyJet has announced the closing of its Madrid base and Ryanair has also re-



KEITH GARNETT

often no longer a viable strategy, given the sharp rise in fuel prices. Instead, airlines park more aircraft in the winter.

Ralph Anker, who runs the network analysis website anna.aero, says Ryanair reduced capacity last winter by 38% from the preceding summer season. The reduction had been only 30% a year earlier. Other low-fare carriers cut winter capacity further as well—EasyJet lowered its capacity last winter 34% from summer levels, compared to 28% in 2010; Vueling cut capacity by 44%

duced capacity into Spain, albeit from a very high level.

Cruz says Vueling had a watchlist of airlines that might pull out of the market and reaction plans in place in case that occurred. "We cannot afford not to respond fast," he says. As a consequence, the airline has seen traffic expand by more than 20% in recent months. Cruz says Vueling has lower unit costs than EasyJet and he sees "more room to cut."

Vueling expects more growth poten-

tial as it develops its Barcelona base. Cruz is also keen to build connecting traffic there, the share of which was about 10% before the summer and is rapidly increasing. He argues that it is fine to offer connections for low-cost carriers as long as the schedule is built on point-to-point traffic and the airline takes advantage of natural connections only. But he will not tolerate new routes that are based on connecting-traffic revenues.

As Vueling opens up more bases in European countries outside of Spain, Cruz sees it becoming more pan-European. "We have to start connecting the dots," he says. As part of its expansion plans, Vueling is seriously considering an order for the CS300, the larger version of the Bombardier CSeries. "The

CSeries will be the new narrowbody in town for a long time," Cruz believes. "It is a very attractive aircraft."

Vueling is in the process of placing an order for at least 60 aircraft; it will decide in the next few months if it will order the Airbus A320NEO, Boeing 737 MAX or Bombardier CSeries.

Bombardier is offering a 160-seat version of the CS300, which is designed for 149-seats in a legacy airline layout. The manufacturer might have to add a second overwing exit on each side of the aircraft to accommodate rapid disembarkation regulations in emergencies. Cruz believes the CS300 will still be a comfortable aircraft with 160 seats, though. Vueling, which has given the three manufacturers clear specifications for cabin and seat configuration,

has been very pleased by the outcome.

The Vueling CEO also points out that the Canadian government is keen on helping out with the financing of Bombardier's aircraft.

Vueling operates a fleet of Airbus A320s and when it began the order campaign last year, Cruz thought it would choose between the A320NEO and the 737 MAX. Bombardier's offer came to the table later.

Another European LCC about to reveal a major aircraft order is Turkey's Pegasus Airlines. "We are already there, but I would like to announce it in my own country," CEO Sabanci says. The carrier is deciding between the A320NEO and the 737 MAX, he says, and it will buy more than 40 aircraft, the size of its current fleet.

Stretch Goals

787-8 lessons pay dividends for -9, but risk and caution remain

Guy Norris **Los Angeles**

Boeing is understandably cautious when it comes to using the words "promises" and "787" in the same sentence, but with a little more than three months to go before the start of final assembly of the first stretched version, it is already projecting a far smoother development path ahead for the 787-9.

The derivative has hit the 85% design drawing release point while assembly of all the large subassemblies for the first aircraft is beginning. All this is happening as Boeing marks the first anniversary of the initial 787-8 delivery to launch customer All Nippon Airways and comes as deliveries hit 25 aircraft.

However, Boeing is not fooling itself and knows that both the progress on the 787-9 and the accelerating deliveries of the 787-8 remain silver linings of a dark cloud still hanging over the company and its revenues after years of delays and problems. The bottom line is that deliveries still have a long way to go to match the rising production tempo and that, if the history of the 787 is anything to go by, Boeing would be wise to expect the unexpected when it comes to development of the stretch.

It is due to the hard-won experience on the 787-8, though, that progress on the extended fuselage variant is edging ahead of schedule, says vice president and chief project engineer for the 787, Mike Sinnett. "From a production standpoint, all the major structural pieces are in initial build. In a lot of cases, we're early. It's a significantly different spot we're in than we were with the -8," he says.

While always intended to be a transformational aircraft for the operators, the 787 has ended up transforming Boeing in more ways than was ever anticipated. Beyond launching it on the path to more electric, more composite aircraft and modular assembly processes, the 787's huge development

costs made its leaders gun-shy over opting for the New Small Airplane instead of a reengineered 737 in the face of competition from the A320NEO. Similarly, Boeing's product development office continues to burn the midnight oil over the potentially costly 777X project. Memories of expensive triage for the 787 lurk in the shadows as Boeing weighs pivotal wing and engine decisions for the next generation of its larger sibling.

Industrially, the rescue effort also expanded Boeing's production footprint for the 787 well beyond that originally planned, with unexpected factory acquisitions in South Carolina and Utah. But it is now the same much-maligned production system that is starting to crank out 787s to a build standard that, according to Sinnett, is actively contributing to the better-than-expected performance of the first batch of aircraft to enter service.



Pegasus, originally a charter airline, turned to scheduled flying in 2005. It has averaged 41% annual growth in the past five years. Sabanci thinks the airline has much potential for further development in the Turkish domestic market, as the middle class and disposable income are growing. It can triple capacity on domestic routes in the next few years and still not offer too many seats, he says.

Internationally, Pegasus is focusing on Russia and the Commonwealth of Independent States (CIS). "We need to send the low-cost virus to these countries," Sabanci says. But he complains about government protection, of which incumbents such as Turkish Airlines and Aeroflot are taking advantage. "We would like to fly to Moscow and

St. Petersburg, but they are a no-no for us. The regulators still have a romantic relationship with the national carriers," Sabanci says.

Also enjoying growth in the Middle East, Air Arabia has nonetheless been forced to alter its strategy due to the uprisings in the region, particularly in Egypt. The airline, based in Sharjah, the United Arab Emirates, is shifting capacity growth away from its two bases in Morocco and Egypt as it waits for the market to return. "Our focus will be on Russia, the CIS and Africa," Air Arabia's CEO Adel Ali says.

The airline opened a base in Alexandria, Egypt, several years ago. The Egyptian operation is comprised of three aircraft, two of which are fly-

ing out of Alexandria and one out of the Red Sea resort towns of Sharm-el-Sheikh and Hurghada. Air Arabia Egypt was supposed to have grown to seven aircraft as part of the initial ramp-up and was planned to grow to around 20 units within five years.

Air Arabia had planned to set up a subsidiary in neighboring Jordan, but it shelved those efforts with the outbreak of the Arab Spring last year, and Ali says the decision will not be revisited soon.

Other markets have proven more lucrative than expected. Saudi Arabia has opened up its air transport market significantly in the past several years and Air Arabia now serves six destinations in the country with 70 weekly frequencies. ☛

"We are getting cleaner aircraft. When we designed it with an all-composite wing and fuselage, we were conservative," he says. "Then, as we started looking at weight-reduction changes and we rolled in things like the improved wingbox and the results of full-scale fatigue and static tests, this allowed us to be less conservative." The result is, "we're seeing some level of surprise that it is performing as well as it is. You always want to talk yourself into thinking that something is not quite right, but its performance is basically spot on," Sinnett adds. "There was a misconception in part because of the weight challenges early on. People expected the initial aircraft would be heavy, and maybe they are by a little bit, but even the early aircraft are performing to specification."

Structural block-point improvements progressively introduced to the -8 between Line Nos. 7 and 70 are paying

dividends, particularly when it comes to the predicted empty weight of the -9, says Sinnett. "We have a very robust baseline and we've learned a lot of lessons. We're ecstatic with where we are with weight. When we hit firm configuration, we locked in on a number and we've just come down on that. As in any new aircraft design, at every turn there's a risk and an opportunity. On the -8, after firm configuration the weight grew, but the -9 is a more stable design that builds on the experience of the -8 in terms of structural static and fatigue."

The 787-9 is 206 ft. long, or 20 ft. longer than the -8, with two five-frame stretch sections on either side of the wing. Although seating up to 290 passengers in a three-class layout, compared to 250 in the standard version, the -9 is designed to fly up to 8,500 nm, or 300 nm further than the -8. Maximum takeoff weight (MTOW) is just over 50,000 lb. more for the stretch and currently set at 553,000 lb. Boeing has managed to keep the weight target fixed since the firm configuration freeze in 2010, before which the MTOW was around 545,000 lb.

Another advantage the -9 development has over the -8 is

Boeing's ramp-up of 787 deliveries, including the first to United Airlines in late September, puts it on track to hit the target of handing over at least 42 787s by year-end.

that "people are more familiar with the material," Sinnett adds. Additionally, the results of structural testing following the design improvements to the wing box and side-of-body have built confidence in the underlying capabilities of the composite primary structure. This has allowed Boeing to trim original design margins that Sinnett says now appear to have been somewhat "over-cautious."

Sinnett also confirms that, contrary to widely published reports this summer, the hybrid laminar flow control (HLFC) system developed to reduce the empennage drag of the 787-9 has not been dropped. The feature, which is the first form of passive HLFC to enter commercial airline service, is "still on the baseline," he says. Final assembly of the first 787-9 is expected to begin in Everett early in the first quarter of 2013, with first delivery to Air New Zealand slated for early 2014. ☛



New Beginning



EMBRAER CONCEPT

Myanmar bans import of older aircraft to protect its opening transport market

Leithen Francis **Singapore**

The suspension of commercial trade sanctions against Myanmar, coupled with a push by the country's civil aviation department for the operation of newer aircraft, is leading state-owned Myanmar Airways to renew its fleet and expand internationally.

Myanmar Airways has signed a lease with GE Capital Aviation Services (Gecas) for two Embraer 190s for delivery in November and December, says Gecas.

The aircraft, built in 2008, will be on seven-year leases and will be in a 100-seat economy-class configuration, Myanmar Airways Managing Director Than Tun tells Aviation Week. The carrier also considered the Bombardier CRJ900, before deciding on the Embraer aircraft, he notes.

Than says the E-190s will replace the airline's Fokker F28-4000s. "Next year, we will stop flying the F28s," he says. According to the Aviation Week Intelligence Network, the airline's three F28-4000s average 30 years old. Than says that while the F28 is a good aircraft, the civil aviation department has introduced new regulations requiring that all commercial aircraft in the country be no older than 25 years and banning the import of aircraft older than 20 years.

An industry executive involved in aircraft maintenance says the new

regulations were introduced because the civil aviation department knows the opening of Myanmar's economy to the outside world will lead to the establishment of new airlines, and the authority wants to avoid a situation where lessors start "dumping a lot of old aircraft into Myanmar."

The new regulations are a problem for Fokker, because many Fokker aircraft—including some Fokker 50s and Fokker 100s—are more than 20 years old. Myanmar has traditionally been a strong market for Fokker.

Myanmar Airways, however, has already replaced its Fokker F27 turboprops with one ATR 42 and two ATR 72s. Than says it has put in a request to the transport ministry for more ATR aircraft for next year. The ministry allocates the budget for aircraft leases and allocation.

Meanwhile, Embraer has agreed to station a field representative in Myanmar, says Than, and will help the airline source some foreign pilots, such as training captains. Myanmar needs six captains and six first officers for its two aircraft, he says, and it plans to retrain some of existing pilots to operate the new type. It also must train 24 engineers to support the Embraer aircraft, he adds.

The E-190s will be primarily used for domestic services, but also to launch short-haul international ser-

vices. It plans to operate to Gaya, India, and Chiang Mai, Thailand, starting in December. Gaya, an important pilgrimage place for Buddhists, is also a destination that Myanmar Airways International (MAI) serves. Myanmar Airways owns 20% of MAI; local financial institution Kanbawza Bank owns 80%.

Myanmar Airways will use two newly leased E-190s for domestic flights and to launch short-haul international services.

Since 1993, Myanmar Airways has left international services to MAI, which has six Airbus A320s and operates from the commercial capital Yangon to Singapore; Bangkok Suvarnabhumi; Gaya; Kuala Lumpur; and Guangzhou, China, says a MAI official. The airline is negotiating with overseas aviation authorities for permission to operate its A320s from Yangon to Tokyo Narita and Seoul Incheon, says the official, adding that it will operate the flights via Bangkok and Kuala Lumpur. MAI also has plans to add more aircraft, though the official declines to elaborate on that.

Than says MAI will continue to serve international markets and Myanmar Airways will differentiate its service offering by focusing on domestic operations, while its international flights will be limited to serving small overseas cities within range of the E-190.

Myanmar has experienced a huge increase in inbound tourism and business traffic following the suspension this year of U.S. and European commercial trade sanctions against it. The suspension also makes it less dependent on its political ally China.

Late last year, Myanmar President Thein Sein halted construction indefinitely of the Myitsone dam, a China-backed project that affects the Irrawaddy River in Kachin state and would flood an area the size of Singapore.

China's influence in pushing Chinese aircraft sales to Myanmar also appears to be waning. Than says Myanmar Airways no longer plans to take delivery of two Commercial Aircraft Corp. of China ARJ21-700s. China announced in June 2011 that the carrier had ordered the two aircraft. The airline still operates three Chinese-built Xian Aircraft MA60 turboprops. ☼

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Could the JSF Problem Be Fixed With Competition?



U.S. AIR FORCE

In October 2001, when the U.S. Defense Department awarded Lockheed Martin the contract to develop the Joint Strike Fighter, it looked like the deal of the century for the company and its customer. In the largest defense procurement in history, Lockheed would produce three variants of one stealthy design to replace the mixed and aging fleets of three U.S. services, saving money and time.

Eleven years in, the deal still looks pretty good for Lockheed, but less so for its customers, including the eight international partners. In 2001, they expected by 2020 to be operating a large fleet of stealthy “fifth-generation” fighters.

Instead, the cost to develop and produce the aircraft has grown to \$330.5 billion, far more than the original \$177.1 billion estimate (both in 2012 dollars). Projections of operating and support costs for the F-35 have escalated far beyond the estimates of 2001, and fielding is years behind the original schedule. In fact, 11 years in, the exact timings—and capability levels—for initial operation of the three variants are still uncertain.

Before going farther down this cracked and broken path, the Pentagon needs to take a hard look at the consequences. On schedule and affordability, the JSF program is already a failure. In terms of capabilities and the long-term benefits of commonality, the jury is still out. And even if the F-35 delivers on everything it promised, the world has changed since 2001.

One problem is the lack of competition. Including the F-22, Lockheed will have been the sole U.S. producer of all-new fighters for 50 years by the time a “sixth-generation” aircraft comes along—no earlier than 2030—with significant consequences for the industrial base.

Faced with an ill-defined, but unacceptable trillion-dollar sustainment cost estimate for the F-35 fleet, the new tough-talking leader of the joint program office is considering abandoning the contractor-run support system and opening it to competition, including from government depots.

That might work long term, but it would do little to help

warfighters stay ahead of threats through the 2020s. By 2021, U.S. forces will be operating only a fraction of the 2,400-plus F-35s they plan to buy. The bulk of U.S. fleets will comprise the same F-15s, F-16s and F/A-18s of 2001.

Some portion of that force will have been upgraded with the latest radars, avionics and weapons—at a cost that was not anticipated when the F-35 contract was awarded. But, for the most part, their airframes and engines will date back to the 1980s and 1990s, with all the costs and issues that come with age.

One bold plan might be for President Barack Obama or Republican rival Mitt Romney to commit the Pentagon to competing the purchase of its next 300 fighters. It would shake things up, although it is questionable the Pentagon could stage a meaningful competition between the F-35 with its estimated costs and promised abilities and the F-15, F-16 and F/A-18 with known costs and available capabilities. And the value of new tails must be balanced against the impact of reducing F-35 procurement, potentially causing partners to defect, production rates to drop and costs to soar.

But complexity is no excuse for inaction. The Pentagon has begun to act by acknowledging there is a problem and publicly increasing pressure to perform. Step 2, also underway, is to gauge the severity of the problem and come to

“Before going farther down this cracked and broken path, the Pentagon needs to take a hard look at the consequences—and consider some opportunities.”

realistic acquisition and operating cost projections so the U.S. and its partners can decide what they can afford.

There must be a hedge against further problems. The U.S. should keep producing F/A-18s for the Navy, upgrading F-16s for the Air Force and promoting the F-15 and F-16 internationally so a fallback option remains open. Then, the Defense Department must revisit how to evolve tactical aviation through the 2020s and sustain the industrial base to keep competition alive for the next fighter.

The F-35's problems could provide an opportunity to adjust military plans to the new capabilities and realities that have emerged since 2001. Instead of the smooth transition to the fifth-generation fighter force envisioned then, the turbulent, mixed-fleet 2020s could bring a reason to rethink. Some military leaders already say U.S. relies too much on stealth—a technology China is moving rapidly to match. There is nothing to say the U.S. must wait beyond 2030 for the next fighter, or to introduce competition for the F-35. ☛



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