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Dr. Christian Sauer, Manager Engineering & Planning, Airframe Related Components Services, Lufthansa Technik AG

Dr. Roland Thévenin, Senior Expert Composite, Airbus

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Atlantis waits in the Kennedy Space Center Vehicle Assembly Building just before its final trip to the launch pad. The upcoming liftoff on the STS-135 mission to the International Space Station will be the last for a shuttle orbiter.



JIM WISE/ANST

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COVER STORIES

Atlantis stands ready at Kennedy Space Center's historic Launch Complex 39A for its last flight—set for liftoff on July 8—and the last flight of the shuttle era. The unique spacecraft has shaped human spaceflight for three decades, and will continue to do so for decades to come—starting with this upcoming last cargo delivery to the International Space Station. The valedictory STS-135 mission will buy another year for private companies to ready their commercial shuttle follow-ons, and enable a robotic refueling experiment that could create a new space industry. Coverage of the shuttle's last mission, and the vehicle's enduring legacy, begins on page 56. William G. Hartenstein/AW&ST photo.



32 Israeli manufacturers pursue electrically powered UAVs that combine ease of handling and economy with extended range.



30 Boeing's strategy in bidding for the USAF refueling tanker contract was to partially underwrite the development.

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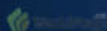
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BOEING CONCEPT

CREATIVE FINANCING

 Airports are turning to new sources of revenue to shore up finances, reports our airports maven, James Ott. Pittsburgh International has earned millions from timber harvested on its grounds, and Elmira-Corning in New York is licensing natural gas extraction on airport land. Read more at

AviationWeek.com/timber

MRO SOCIAL

 The Teardown Report, which highlights MRO-focused social media discussions and topics from the week, debuted on our MRO blog, Turnaround Time. The Teardown Report will appear each Friday. Join the conversation at AviationWeek.com/mroblog

TANKER TALK

 News broke this week that Boeing projects it will be responsible for \$300 million over the contract ceiling for the KC-46A (see p. 30). Senior Pentagon Editor Amy Butler asks on our Ares blog whether low-balling development contracts is the new industry strategy, and readers weigh in. AviationWeek.com/ares



LOCKHEED MARTIN

LIGHTNING ROD

 Is Lockheed Martin's F-35 executive reorganization a sign of weakness? A tacit admission of error? Butler posted the new appointments to our Ares blog and critics—and defenders—of the Joint Strike Fighter had at it. AviationWeek.com/ares

PARIS AFTER DARK

 This year's Paris air show may be over, but our editors and bloggers still are analyzing the developments, orders and deals made at Le Bourget. Also, check out the aircraft order tracker. To read more, see page 49 and go online. AviationWeek.com/paris



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FROM THE WEB

Comments from readers
on AviationWeek.com

Re: International Editor Robert Wall's Ares blog about the Nimrod retiring:

AWACS notes:

One ancient airframe replaced by another ancient airframe. Will U.K. defense planners/procurers never learn?

DTT's Bill Sweetman responds:

Pigs might fly. The R1, when it was new, was so secret that photos were not released... The Swedes took photos of Badgers, Blinders, Nimrods and RJs with equal-opportunity abandon.



Marcase says:

The Nimrod's recce kit is not Plug & Play, but if its airframe was such an issue, surely reinstalling the equipment—rumored to be superior to that of Rivet Joint—into an off-the-shelf (civil) jet could've been a feasible option.

The AW&ST article: "Udvar-Hazy to Boeing: Do Not Re-engine 737" drew a broad range of responses:

From Len Hobbs:

There is no verifiable data which support a conclusion that ANY new airframe would out-perform a re-engined 737—NONE! Udvar-Hazy is feathering his own nest, and has every right to try. However, his opinion on this subject is about as relevant as Donald Trump's.

And 123xyz:



Why should Boeing follow an Airbus stop-gap product with yet another stop-gap product? They did that with the NG, and like Udvar-Hazy said, its origins date back to the '60s.

Aircraft Man points out:

Boeing has a problem. There is no easy option... a complete new undercarriage is probably needed.



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

FEEDBACK

SENSE MORE THAN CENTS, PLEASE

Mark Cioffi's Viewpoint "Motion is Better? There's No Proof" (AW&ST June 13, p. 58) is laudable in calling for more research into flight simulation. However, he states that wide-field visual systems will allow the perception of motion. True, but since most simulator training is conducted "in the weather" with no visual reference, it is difficult to understand how such a system would be able to induce the brain into believing it was moving.

He also states that non-motion simulation is 50% cheaper, therefore "would allow the purchase of more simulators, giving more pilots more sim time." The real attraction is that it is cheaper. All it would mean is that pilots would receive exactly the same amount of sim time in a less-capable device.

Guy Wroble
DENVER, COLO.

STICK TO FUNDAMENTALS

In "Cleaner Skies?" (AW&ST June 20, p. 70), arguably a central development weakness in the current pursuit of next-generation aircraft is their design optimization around fossil fuel consumption. To that extent, EADS's unducted rotor application, for example, would be the "Prius" of the civil airline fleet. But its airframe technology is centered on weight and drag reduction in service to the engine, when the fundamental focus might be on breakthrough propulsion powering high-speed aerodynamics. The unducted fan approach is efficient as far as bypass is concerned, but it represents a step back regarding thrust.

Aircraft may be among the last human machines to burn fossil fuel and still plod along at sub Mach 1. In hypersonic and spaceflight domains, the most significant constraint to increased travel speed/distance is the chemical rocket. In both cases, it is fundamental science, not technology, that is the more appropriate object of revolution.

Matt Andersson
CHICAGO, ILL.

STRATEGIC STANDOFF

While reading "Conventional Contest" and "Missile Machinations" (AW&ST June 13, p. 34-35), it occurred to me that during the Cold War, Russia and the U.S. had missiles aimed at each other to establish a mutually assured destruction scenario. Modify that in

regard to Iran and North Korea. Place about a half-dozen intercontinental ballistic missiles split between the two and inform them that they are in the cross-hairs. We could then drop most of our ballistic missile defense development.

Walter Monnier

ALBUQUERQUE, N.M.

REDIRECT F-35 ENTHUSIASM

"Pitch for a Pardon" (AW&ST June 27, p. 35) again addresses Lockheed Martin F-35 variants. The Pentagon needs to face reality: Building three variants is an admirable technological tour de force but a monumental waste of money. The A and B versions should be scrapped in favor of the more-capable C. Who, outside of some theoretical think tank, needs a short-takeoff-and-vertical-landing aircraft that will be using traditional air bases for more



than 99% of its missions? Look back to the U.S. Marines Corps' Harriers to see the future. Hardware will always be essential, but focusing on the best variant will free money to be invested where the needs are highest: cyberwarfare.

Antonio Camargo
SAO PAULO, BRAZIL

LEGAL TO A FAULT?

"Digital Deluge" (AW&ST May 23, p. 42) makes me wonder if we've become such a litigious culture that we are now hamstringing our defense. Gauging unintended damage due to cyberweapons is one thing, but to mire present and near-term responses to cyberattacks based on "legal obstacles" is criminal in my opinion. How would our effort to defeat Nazi Germany in World War II have been delayed or nullified if our leaders worried about the legalities of the strategic bombing campaign? Congress and the Pentagon need to put the legality of cyberwarfare into perspective.

Kevin A. Capps

CORONA DEL MAR, CALIF.

Kenneth R. Possenriede has been appointed VP-treasurer and **Leo S. Mackay, Jr.**, VP-ethics and business conduct of the *Lockheed Martin Corp.*, Bethesda, Md. Possenriede succeeds **John McCarthy**, who has retired. Mackay succeeds **Alice M. Eldridge**, who has been named VP-associate general counsel for enterprise legal initiatives. Possenriede was head of financial activities for the company's Electronic Systems and Space Systems. Mackay was VP-corporate business development.

Gary J. Vroman has been named executive VP for High Performance Forgings and Castings at *ATI Ladish* of Pittsburgh. He was president/CEO of Ladish before it was acquired in May by Allegheny Technologies Inc.

John T. Shelander (see photo) has become senior business development manager of *Nortech Systems'* Aerospace Systems operations in Blue Earth, Minn. He was a sales and marketing executive with Logix Engineering, Advantek Inc., Agere Systems and the Lockheed Martin Corp.

Giorgio De Roni has been appointed CEO of Mumbai, India-based *GoAir*. He was an executive of Italy-based Air One.

Janine Nyre has been named VP of the *Northrop Grumman Corp.*'s Radio Frequency Combat and Information Systems, Rolling Meadows, Ill. She was director of radar warning receiver programs.

Charles Hughes (see photo) has become business development and strategy director of U.K.-based *Marshall Aerospace*. He came from Cobham plc and had worked at Rolls-Royce Military Aerospace.

Greg Potter has been appointed Los Angeles-based Western U.S. marketing manager for *Universal Avionics*, Tucson, Ariz. He has held sales positions at Hughes Helicopters, Goodyear Aerospace and Rockwell Collins. Potter also is president of the Southern California Chapter of the Professional Aviation Maintenance Association.

Tony Lefebvre has been named senior vice president/chief operating officer of *Spirit Airlines*. He was senior VP-airports, customer service and inflight. Lefebvre succeeds **Kenneth McKenzie**, who has joined Airbus North America.

Francis Lee (see photo) has become

general manager of *Dallas Air-motive's* regional turbine center in Singapore. He was general manager of Rolls-Royce's turbine center there and had worked in engine maintenance repair and overhaul for the Hawker-Siddeley Group.

Thomas J. Masiello is among seven *USAF* brigadier generals who have been selected for promotion to major general. He is director of special programs for the undersecretary of defense for acquisition, technology and logistics at the Pentagon. Others are: **Earl D. Matthews**, director of command, control, communications and computer systems at U.S. Transportation Command Headquarters, Scott AFB, Ill.; **Robert P. Otto**, director of intelligence, surveillance and reconnaissance capabilities under the deputy chief of staff for ISR at *USAF* Headquarters at the Pentagon; **John W. Raymond**, vice commander of the 5th Air Force and deputy commander of the 13th Air Force, Pacific Air Forces, Yokota AB, Japan; **Darryl L. Roberson**, commander of the 455th Air Expeditionary Wing of Air Combat Command (ACC), Bagram AFB, Afghanistan; **Anthony J. Rock**, director of the *USAF* Iraqi Training and Advisory Mission of U.S. Forces Iraq, U.S. Central Command/commander of the 321st Air Expeditionary Wing of ACC in Baghdad; and **Jay G. Santee**, principal director of the Office of the Deputy Assistant Secretary of Defense (Strategic Capabilities) in the Office of the Assistant Secretary of Defense (Special Operations/Low-Intensity Conflict and Interdependent Capabilities) and Office of the Undersecretary of Defense for Policy at the Pentagon.

John H. "Jay" Gibson, 2nd (see photo), has been appointed VP-special missions for the *Hawker Beechcraft Corp.* of Wichita. He was VP-finance and contracts for government business organization and is a former assistant Air Force secretary for financial management.

Jerry "Bart" Graham has become Huntsville, Ala.-based executive direc-



John T. Shelander



Charles Hughes



Francis Lee



John H. Gibson, 2nd



John Obermeier



Jack Kennedy

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tor of advanced programs in the business development department of *Aerojet*. He had worked for the Miltec Corp. and NASA Marshall Space Flight Center.

U.S. Army Lt. Gen. (ret.) **Jeffrey Sorenson** has been appointed vice president/partner within the Washington-based *A.T. Kearney's* Public Sector, Aerospace and Defense (A&D) Practice. His final Army assignment was as chief information officer.

Troy Padgett has been named director of airport products for the *Oshkosh (Wis.) Corp.* He was VP-sales for Crash Rescue Equipment.

John Obermeier (see photo) has become program director in the geospatial intelligence group of *TASC Inc.*, Chantilly, Va. He was with the U.S. National Geospatial-Intelligence Agency.

Jonathan Walker has been appointed sales estimator for *Comlux Aviation Services* of Indianapolis. He was a materials buyer for Applied Composites Engineering and had been a planner/buyer for Bombardier Aerospace.

Pat Kenna has been named director of internal evaluation for *JetFlite International*, Long Beach, Calif. He was president of Elsinore Aircraft Services and Martin Aviation and has been a regional VP for Signature Flight Support.

Jack Kennedy (see photo) has become VP-sales for *M/A-COM Technology Solutions*, Lowell, Mass. He was its director of global distribution.

Matthew Wright has been appointed general manager at *Landmark Aviation's* Scottsdale, Ariz., fixed base operation and maintenance, repair and overhaul facility. He was general manager of Atlantic Aviation. ☐



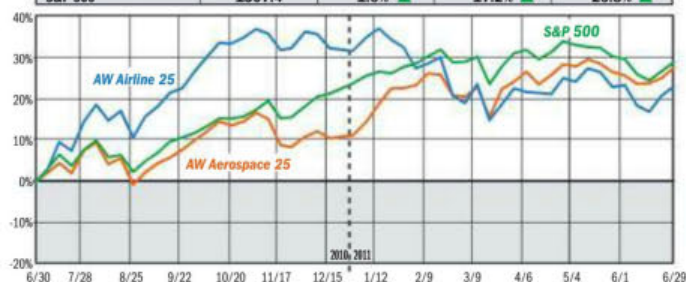
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AW&ST/S&P Market Indexes

(as of 6/29/2011)

PERCENT CHANGE

MARKETS	INDEX VALUE	WEEK AGO	YEAR-TO-DATE	YEAR AGO
AW Aerospace 25	1449.9	1.9% ▲	21.1% ▲	25.7% ▲
AW Airline 25	1002.8	1.8% ▲	14.1% ▲	21.5% ▲
S&P 500	1307.4	1.6% ▲	17.2% ▲	26.8% ▲



COMMENTARY

As Defense Budgets Fall, All Is Not Lost

Avonics supplier **Rockwell Collins** consistently registers one of the highest rates of internal R&D investment in the A&D industry. But CEO Clay Jones, a former U.S. Air Force fighter pilot, answers emphatically in the negative when asked if defense contractors should pony up more of their own money for cutting-edge research to offset declines in government funding. "There is no argument to be made in this environment for pure company-funded R&D to sell into military markets," he says.

With the defense industry having prospered greatly from years of largesse when George W. Bush was president, some might find it appropriate for companies to give back now that the government has fallen on hard times. But shareholders are having none of it. "I'm going to invest millions of dollars [in technology] hoping the Pentagon will buy it and Congress will fund it?" Jones asks. "I don't know how you do it."

That was a sentiment repeated by a number of industry leaders at the recent Paris air show. "There is so much uncertainty in Congress that it makes it difficult to put your neck out and invest a lot of money in a program that may get canceled," says **Parker Aerospace** President Bob Barker. Indeed, Republicans on Capitol Hill are now signaling they would support deeper cuts to military budgets—beyond the \$400 billion already targeted—if that is what it takes to protect unaffordable tax cuts.

All is not lost, however. Jones and some of his peers note that Pentagon planners could save a lot of money simply by leveraging more commercial technologies, a concept pioneered four decades ago by then-Deputy Defense Secretary David Packard. Avionics used by U.S. Army Black Hawk helicopters, for example, are derived from a common system developed by Rockwell for everything from light turboprops to commercial widebody jets. **Honeywell Aerospace** President Tim Mahoney notes that his company is investing substantial sums to develop dual-use technologies. So is Parker Aerospace, whose mechanical actuators are used on both commercial and military aircraft. "The technology is fungible," explains Don Washkewicz, CEO of parent company **Parker Hannifin**.

A thornier challenge is a dysfunctional system that funds programs one year at a time. "If I get a contract from **Boeing** or **Airbus**, I know for the next 3-5 years how much I need to produce," says **Goodrich** CEO Marshall Larsen. "Then I can plan, get economies of scale and buy raw materials in bigger quantities. You can't do that in government programs because they don't give you the visibility." Yet proposals for multi-year budgets have been stymied for decades by congressional appropriators, who are unwilling to cede their annual oversight of spending.

But the sky is not falling. "We believe net worldwide defense budgets over the next 3-4 years are going to be flat," notes Jones. "That is a heck of a lot better than the [downturns] we've had in our commercial business." ☺

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.

Weekly Market Performance

Closing Prices as of June 29, 2011

Company Name	Current Week	Previous Week	Fwd. P/E	Tot. Ret. % 3 Yr.	Tot. Ret. % 1 Yr.
AEROSPACE & DEFENSE					
AeroVironment Inc.	34.80	34.51	27.2	28.0	60.1 ▲
Allegheny Technologies Inc.	64.29	59.91	17.9	14.7	47.4 ▲
Alliant Techsystems Inc.	70.20	70.35	8.4	-30.6	13.8 ▲
BAE Systems plc	5.10	4.98	7.5	-17.5	6.7 ▲
Boeing Co.	72.72	72.12	16.0	20.8	18.6 ▲
Bombardier Inc. 'B'	7.05	6.89	17.3	-1.8	42.8 ▲
Cobham plc	3.38	3.33	9.8	14.8	1.2 ▲
Curtiss-Wright Corp.	31.52	31.73	11.9	-27.2	9.6 ▲
DigitalGlobe Inc.	25.33	24.04	67.3		-3.7 ▼
EADS NV	32.94	31.53	22.1	94.7	36.6 ▲
Elbit Systems Ltd.	47.69	48.82	10.0	-10.7	-15.0 ▼
Embraer-Empresa Brasil ADR	30.08	30.57	15.5	21.3	47.5 ▲
Esterline Technologies Corp.	75.18	75.35	15.0	52.6	58.4 ▲
Finmeccanica SpA.	11.82	11.74	6.4	-37.7	0.3 ▲
FLIR Systems Inc.	32.83	32.80	18.0	-18.8	13.3 ▲
General Dynamics Corp.	73.90	73.36	10.3	-4.9	29.4 ▲
General Electric Co.	18.56	18.56	13.1	-21.2	32.7 ▲
GKN plc	3.66	3.41	11.1	58.5	101.5 ▲
Goodrich Corp.	93.60	92.67	16.8	108.6	43.3 ▲
Harris Corp.	44.69	45.00	9.2	-5.5	9.7 ▲
Hexcel Corp.	21.36	21.09	19.7	10.7	37.7 ▲
Honeywell International Inc.	58.62	57.01	14.1	27.7	54.0 ▲
ITT Corp.	58.13	57.22	12.0	-3.0	32.0 ▲
Kratos Defense	11.74	11.74	20.8	-40.1	11.8 ▲
L-3 Communications Hldgs. Inc.	86.93	86.21	10.0	1.2	25.5 ▲
Lockheed Martin Corp.	80.37	80.01	10.5	-10.2	12.1 ▲
Moog 'A'	43.04	41.46	14.7	15.6	33.5 ▲
Northrop Grumman Corp.	68.81	66.51	10.1	24.9	43.7 ▲
Orbital Sciences Corp.	16.73	16.85	17.6	-29.0	6.1 ▲
Parker-Hannifin Corp.	86.92	86.54	12.1	28.9	59.1 ▲
Precision Castparts Corp.	161.93	157.55	19.0	68.7	57.5 ▲
Raytheon Co.	49.07	49.12	9.7	-5.3	4.8 ▲
Rockwell Collins Inc.	60.84	61.10	14.3	34.5	16.3 ▲
Rolls-Royce Group plc	10.19	9.71	14.3	85.8	12.8 ▲
Safran SA	42.57	41.98	15.0	155.2	31.1 ▲
SAIC Inc.	16.87	16.67	11.8	-18.9	0.8 ▲
SIFCO Industries Inc.	16.30	16.33		64.4	50.5 ▲
Singapore Technologies Eng.	2.42	2.30	17.9	27.2	-4.3 ▼
Spirit Aerosystems Holdings	21.25	21.36	10.5	10.8	11.5 ▲
Textron Inc.	23.21	22.68	16.6	-49.8	37.3 ▲
Thales	41.86	41.00	12.4	-14.1	11.2 ▲
TransDigm Group Inc.	88.86	86.89	19.3	212.7	74.1 ▲
Triumph Group Inc.	98.73	96.78	11.7	111.5	48.5 ▲
United Technologies Corp.	86.47	85.44	15.3	51.1	36.2 ▲

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AIR TRANSPORT

Boeing Loses Round

In a 21-page ruling, a National Labor Relations Board (NLRB) administrative law judge rejected "in its entirety" Boeing's motion that he dismiss the case challenging its decision to build a second 787 final assembly factory in South Carolina. As a result, the full case will be heard in arguments likely to last into the fall. The International Association of Machinists and Aerospace Workers (IAM), which prompted the case, praised the ruling. A Boeing official said it was "not unexpected." Judge Clifford H. Anderson rejected the company's contention that the case need not proceed because no damages have been sought. It is too early for them, he responded. He also dismissed Boeing's claim that comments made by CEO James McNerney about a hostile union environment in Seattle could not be construed as unlawful threats against the IAM. And Anderson rejected Boeing's claim that the South Carolina factory is providing "new work," not taking jobs from the IAM in Seattle. But Anderson noted Boeing's contention that NLRB "policy and precedent must be clarified or changed." However, the full NLRB must do that, he said.

Another Order

China is buying 88 Airbus A320s with 42 going to the Industrial and Commercial Bank of China's leasing operation, with the rest to be allocated by the China Aviation Supplies Holding Co. Deliveries are planned from 2012-15. Meanwhile, Airbus says it is boosting A320 rudder production at its Hafei Airbus Composite Manufacturing Center joint venture with Chinese partners. The goal is to satisfy half of Airbus's single-aisle rudder requirement from that facility.

Fuel Prices Ease

A 60-cent-per-gallon decline in the spot price of jet kerosene since April has reduced airline industry costs by \$8 billion on an annualized basis, says JP Morgan analyst Jamie Baker. That should cushion airlines if a slowdown in economic growth causes demand for air travel to weaken.



RONALD ADAM

Canadian Regulator Stops Airlines' Cross-Border Deal

Inflammatory accusations by Canada's Competition Bureau have forced Air Canada and United Continental Holdings to suspend a proposed joint venture on cross-border services intended to mirror immunized accords already enacted by the two carriers and many of their Star Alliance partners.

The proposed arrangement, unveiled in October 2010 just after United and Continental formally merged, was expected to be effective early in 2011, and had been approved by the U.S. Transportation Department. But then Canada's Competition Bureau became involved.

Bureau officials say they were first made aware of the proposed joint venture when the airlines issued a press release on Oct. 7, 2010, and that talks started about six months ago. During those negotiations, the bureau voiced several concerns it says could not be resolved so it opted to bring the issue before the Competition Tribunal, a separate adjudicative agency that considers complex business arrangements, including mergers.

The impetus for the lawsuit is a fear of higher fares stemming from the joint venture's dominance of cross-border service, which the Competition Bureau says will create a monopoly in 10 hub-to-hub markets and dominate nine more city-pairs with market shares ranging between 34% and 99%. A request for revenue sharing, joint scheduling and pricing, coordinated inventory management and reciprocal access to frequent-flier programs further exasperates the agency, which claims these elements meet the definition of a merger under Canada's Competition Act, and so breach ownership rules.

Air Canada and United Continental "strongly disagree" with each accusation, noting that similar arrangements have been recognized for producing "enhanced benefits to customers." As it stands, the lawsuit is now at its procedural stage and little is expected to happen until next year. Until then, though, Air Canada and United Continental have suspended all aspects of the joint venture, although this should not affect either carrier's services or code-share benefits.

Biofuel-Borne

KLM has completed a commercial flight powered by a 50-50 blend of biofuel and kerosene. The June 29 flight between Amsterdam and Paris is a precursor to broader use of such fuels starting in September. KLM used cooking oil-derived biofuel, but says it is open to other source material.

AEROSPACE BUSINESS

AIA To Promote A&D Role

The Aerospace Industries Association of America (AIA) is launching a campaign to promote the aerospace and defense industries' role in the U.S. economy, calling attention to "the critical role of aerospace and defense in the welfare and the future of our nation," says AIA President and CEO Marion Blakey. She notes in a speech at the Aero Club in

Washington that the U.S. needs export-control reforms to further development of unmanned aerial systems (UAS). While the FAA and industry stakeholders already are negotiating the issue of UAS use of civil airspace, what is not being addressed, she explains, are export controls that are keeping small- and medium-sized companies from increasing exports for fear of criminal liabilities. Blakey adds: "Largely unaddressed are the rules that block the export of American UAS. We can't afford to have the emergent UAS industry fall prey to the same shortsighted export restrictions that all but killed the U.S. commercial satellite industry."

Saab Expands U.S. Footprint

Saab's move to buy Sensis Corp. strengthens the company's activities in air traffic management, and



expands Saab's footprint in the U.S., where it has been eager to grow. The \$155 million acquisition comes with the potential of \$40 million more to be paid by 2014 depending on how Sensis performs.

Slicing Overhead

Lockheed Martin is planning to cut 1,500 of 28,000 workers from its aeronautics division, which operates largely in Fort Worth, Marietta, Ga.; and Palmdale, Calif. The move comes on top of recently announced plans to release 1,200 workers from the space sector. "Bold and responsible action is necessary to meet customer expectations and reduce our costs. We are realigning the organization to be more efficient and agile, and a reduction in force will enable us to meet the requirements of our changing business environment," says division head Ralph Heath.

DEFENSE

F-35 Tests Keep Up Pace

After lagging through much of 2010, flight testing of the Lockheed Martin F-35 Joint Strike Fighter significantly exceeded plans for the first six months of this year, with aircraft logging around 450 flights versus an aim of 378. Test points accomplished in the first half of 2011 exceeded 3,350, versus a goal of 2,996. All three variants surpassed test plans, with the previously problematic short-takeoff-and-vertical-landing F-35B logging 170 flights and 1,572 test points through June 28 against plans for 138 and 1,072, respectively. The F-35B program also logged 116 vertical landings.

Truck Ready for Laser Tests

Boeing has completed integration of the U.S. Army's mobile High Energy Laser Technology Demonstrator (HEL TD), which mounts a beam-control system on a tactical truck. The HEL TD will be delivered to the Army-managed High Energy Laser Systems Test Facility at White Sands Missile Range, N.M., where the weapon-power Solid State Laser Testbed Experiment (SSLTE) is being installed and will begin functional tests in 2012. After initial pointing and tracking trials with a low-power surrogate laser in the fourth quarter, HEL TD will be linked to the SSLTE's

Fast-Track Launch From Wallops To Deliver Imagery

U.S. forces in Afghanistan and Central Asia will be able to supplement the tactical imagery they receive from airborne sensors with data from the Pentagon's first Operationally Responsive Space (ORS-1) satellite, launched June 29 after a 30-month development.

An Orbital Sciences Corp. (OSC) Minotaur 1 launch vehicle carried the spacecraft aloft from Pad 0B at the Mid-Atlantic Regional Spaceport on Wallops Island, Va. Liftoff of the four-stage solid-fuel vehicle, which uses surplus Minuteman ICBM motors as its first two stages, came at 11:09 p.m. EDT, and the spacecraft separated 12 min. later en route to its 400-km, 40-deg. operational orbit. After a 30-day checkout period, the U.S. Air Force will take over control of the satellite in support of U.S. Central Command (Centcom), which requested the capability to supplement tactical overhead imagery collected by aircraft over Central Asia.

Developed under a Pentagon initiative to demonstrate that application-specific spacecraft can be designed and built quickly, ORS-1 carries a version of the Senior Year Electro-Optical Reconnaissance System (Syers) 2A that flies on the U-2 reconnaissance aircraft that Centcom already uses for tactical intelligence. Goodrich builds the Syers 2A sensor, and integrated it onto an ATK satellite bus originally developed for the TacSat-3 demonstration program.

This was the fourth Minotaur I launch from Wallops Island, where work is nearing completion on an adjacent launch complex for OSC's kerosene-fueled Taurus II vehicle that is expected to conduct commercial cargo missions to the International Space Station (AW&ST April 4, p. 52).

Northrop Grumman high-power solid-state laser and fired against targets to demonstrate the capability to counter rocket, artillery and mortar projectiles, as well as unmanned aircraft.

Hellads Moves Ahead

General Atomics Aeronautical Systems has been awarded an almost \$40 million contract to build a high-power laser weapon demonstrator. The U.S. Defense Advanced Research Projects Agency's High Energy Liquid Laser Area Defense System (Hellads) program aims to demonstrate a complete 150-kw weapon system weighing less than 5 kg/kw, making it small enough to be installed on tactical aircraft such as bombers or gunships. General Atomics' 24-month contract covers fabrication of the laser segment and its integration with beam control, thermal management, power and battle management segments to produce a demonstrator weapon.

Broadband Plan Revised

LightSquared has revised its blueprint for a broadband wireless network as the final report on interference testing shows its original deployment plan is "incompatible with aviation GPS operations." The report by a technical working group formed by LightSquared and the U.S. GPS Industry Council says LightSquared's plans to deploy 40,000 high-power terrestrial transmitters across the U.S. "would result in a complete loss of GPS operations below 2,000 ft. above ground level over a large radius" from

metropolitan areas. The final report was submitted to the Federal Communications Commission on June 30. "For the originally defined LightSquared spectrum deployment scenarios, GPS-based operations are expected to be unavailable over entire regions of the U.S. at any normal operational aircraft altitude," the working group's aviation sub-team concluded. LightSquared now plans to begin service using only the lower of its two 10-mhz-wide frequency blocks.

Joint Use for Airfields

The Chinese air force says it will open six airfields to joint military and civil use between now and 2015. The airfields, which are not identified, join 63 military facilities that the air force has made available for civilian use since the 1990s. Military flying takes up 23.51% of China's usable airspace, says the air force. Civil traffic uses 32%, it says, without accounting for the rest. The statement is evidently aimed at fending off criticism that the air force's stranglehold on the country's airspace is holding back economic development, particularly because not enough space is available for scheduled commercial air services.

Correction: A quotation in the *Washington Outlook* column of June 27 (p. 22) was attributed incorrectly. It was Phillip Straub, Garmin International's vice president of aviation engineering, who likened LightSquared's broadband wireless plan to starting "a lawn mower in a library."



BY MICHAEL MECHAM

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COMMENTARY

Transparent Gains

PPG sees lower operating costs in new window-making process

The Paris air show was dominated by airplane and engine orders—enormous numbers of them. But suppliers were generating their own news, including PPG Aerospace's introduction of a process for making cockpit and cabin windows that the company says saves weight and lightens life-cycle costs.



PPG is a leader in a crowded field of aircraft transparency—or window—manufacturers. Its recent innovations include introduction of electrochromic windows on the Boeing 787 that permit passengers and flight attendants to control the amount of sunlight entering the cabin with a twist of a dial while still not completely obscuring views to the outside, a far cry from the all-or-nothing approach of a pull-down shade.

At Le Bourget, PPG revealed an advanced transparency material that another long-time customer, Gulfstream, is launching on passenger windows for its G650 long-range business jet. Called Opticor, the material is laminated to stretched acrylic for Gulfstream to create an outboard surface PPG says resists crazing—minute cracks that typically spread inward from a window's edge—and maintains optical clarity longer than current surfaces. Opticor has been under development for about four years at PPG's Glass Business and Discovery Center in Harmarville, near Pittsburgh, and at the company's Huntsville, Ala., transparency factory.

Anthony Stone, director of new business development, calls Opticor the first major change in transparency plastics for aviation in 50 years, going back to the days when the industry learned how to take basic

acrylics, which are still applied in non-pressurized rotor and general aviation aircraft, and stretch them under pressure and heat to attain the strength necessary for pressurized cabins.

Stretched acrylics are formed into windows from flat sheets using heat and vacuum that allow them to be contoured in a single direction. PPG's new plastics are poured into a mold. "They set up like Jell-O," says Stone. "Opticor can be cast to shape, so we don't need a flat sheet and vacuum to shape it." For airframe designers, this quality should open the possibility of using more complex shapes for windows. The stiffness of Opticor coatings also are less subject to cabin pressurization bulging in cruise, which interferes with an airframe's aerodynamics, he says.

While its initial application in the G650 is for passenger windows, the new transparency process also is applicable for cockpit panes. The large G650 windows (above) are laminated to stretched acrylic for added stiffness and are assembled with an inboard coated glass panel that can be heated for antifogging.

Stretched acrylic transparencies typically have service lives of 3-4 years, Stone says. Opticor's are projected to be 7-8 years. Windows deteriorate not because of higher exposure levels to

ultraviolet radiation in cruise, but due to factors on the ground. Jet exhaust fumes at airports, cleaning agents, aircraft washes and scratches from foreign objects are what do them in, he says. A big threat to longevity is crazing. If not replaced promptly, crazes will eventually penetrate the window, causing it to depart the airplane.

Besides longer service life, PPG says Opticor is 10% lighter than standard transparencies. The windows also are clearer, although Stone says, "We don't claim it as an advantage."

The material's resistance to burning in both vertical and horizontal tests is a safety bonus. In a fire, it does not produce the toxic chemicals that stretched acrylics do, he says.

PPG has been talking to airframers about the process for several years and has completed tests of the new plastic's mechanical, optical and thermal characteristics. "We've finished the characterization tests and are now in long-term aging effects," Stone says. "Commercially, we have something that we can deliver." ☼

NORDAM TAPPED BY AIRBUS

There was more window news in Paris. In a new five-year contract, Airbus named the Nordam Transparency Group as its supplier of cabin windows for the A320 family, including its New Engine Option program that led all orders at the show. Nordam will fulfill the "multi-million-dollar" contract with its trademarked Nordex 188 stretched acrylic. The work will require 15 new employees at its Tulsa, Okla., factory and is due to begin Jan. 1, 2012. At peak annual production, 60,000 panes will flow out of Tulsa.

Nordam began working for Airbus 30 years ago providing wing-tip light lenses, which it now makes for A320s, A330s, A340s and the A380. Its first window contract came on the A380. But while that is a big airplane, the A320 contract, especially after the 1,200 order bulge that Airbus has gained with the New Engine Option, is the bigger deal.

"We are happy to say, we are the cabin window provider for the world's largest aircraft, the A380, and now the world's fastest-growing aircraft family, the A320," says Chief Operating Officer Hastings Siegfried. ☼



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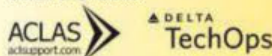
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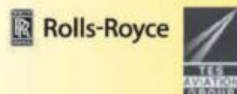
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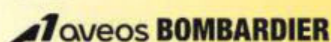
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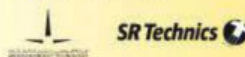
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COMMENTARY

MRJ SUPPORT BY BOEING

Once the Mitsubishi Regional Jet (MRJ) enters service, operators who need engineering and spares support will have their phone calls answered, at least initially, in a somewhat unexpected location: the Boeing Operations Center in Long Beach, Calif.

Handling MRJ customer calls at the 24/7 ops center is one of a number of services Boeing will provide under a first-of-its-kind customer support and services agreement it recently signed with Mitsubishi Aircraft Corp., developer of the MRJ and a subsidiary of long-time Boeing strategic supplier Mitsubishi Heavy Industries.

For Mitsubishi, the attraction seems obvious. Customer access to an established, world-class support organization could be a major differentiating benefit for Mitsubishi and its customers in a crowded regional jet market. "With this agreement, Mitsubishi Aircraft will be able to deliver profit-enhancing support

and a competitive boost to our customers," Hideo Egawa, president of the Japanese OEM, said in announcing the deal at the Paris air show.

For Boeing, the deal represents a significant step in expanding its support and services business to non-Boeing equipment.

Much of Boeing's previous experience supporting other OEMs' aircraft has involved hosting data on its web portal or delivering maintenance documents through its Boeing Maintenance Performance Toolbox. The Mitsubishi deal represents the first time Boeing has signed a strategic agreement with another aircraft manufacturer, according to Craig Savio, director of e-commerce for Boeing Commercial Aircraft.

"We have, over the past five or seven years, been thinking about supporting other OEMs' aircraft," Savio told Aviation Week. "If we're going to grow our service business like we've been challenged to, this is something we could

consider," he said. "This is an essential part of our strategy in the services business, to be platform-independent."

In addition to the operations center, Boeing will help Mitsubishi set up a service and maintenance web portal modeled after MyBoeingFleet.com and a Boeing-hosted, but Mitsubishi-branded airplane health management system, Savio said. Boeing also will provide field service engineering expertise for MRJ's customers at entry into service and spares provision support, he said.

To get up to speed on the MRJ, Boeing field service engineers and support staff will participate in MRJ's flight-test program. First flight is scheduled for 2012 and entry into service in 2014.

To date, Mitsubishi has 70 firm and 60 option orders for the MRJ, the biggest customer being U.S.-based Trans State Holdings, which had 50 firm and 50 options. Launch customer for the MRJ is All Nippon Airways, also the launch customer for the Boeing 787. ☐

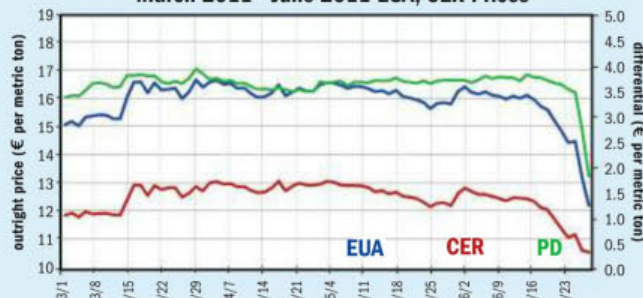
EU carbon credit prices dramatically crashed at the end of June to lows not seen since the start of the global economic downturn in 2009 as the emergence of a new policy proposal to increase energy efficiency in the 27-member state bloc combined with widespread fears over the Greek economy to push the value of emissions permits down.

Front-year December 2011 delivery EU Allowances (EUA) crashed from €16.52 (\$23.46) June 14 to €12.23 per metric ton June 24, touching a two-year low during intra-day trading June 24 of €11.85 per metric ton, with carbon traders characterizing the fall in prices as an all-around drop in confidence in the Emissions Trading System (ETS) as buying demand from naturally short electricity utilities dried up after mid-June.

On the surface, many carbon market players say the 2011 EUA price collapse was brought on by a June 17 vote in the EU Climate Change Committee on a set of new regulations that tacitly approved European Investment Bank (EIB) plans to auction 30 million metric tons of European Commission-owned EUAs before year-end and more in 2012. The EIB wants to auction the EUAs from the so-called NER300 pool of unused carbon credits before the end of the ETS Phase II in December 2012 to help the EC raise €4.5-9 billion to fund carbon capture and storage and renewable energy development in the EU.

The market players say any EIB auctions of EUAs before the end of 2011 and into 2012 would create an unnecessary short-term surplus of carbon credits in an ETS with which many power companies and industrial manufacturers required to comply with the CO₂ emissions cap-and-trade scheme are already comfortably complying. They are doing so because of the European Commission's free allocation of permits to many of them, a practice that is set to partially end in 2013 when

Daily Emissions Price Assessments March 2011 - June 2011 EUA, CER Prices



PD = Price Differential, euros per metric ton
EUA = European Union Emissions Allowances for December 2011 delivery
CER = U.N. Certified Emission Reductions for December 2011 delivery
Source: Platts Emissions Daily

energy generators will be required to buy all their EUAs at auctions run by various member states and the EC.

But as the price collapse unfolded, the carbon market players reached consensus that the immediate reason for the loss of confidence in the ETS was due to plans the EC announced June 22 for the EU to meet its long-standing target to increase the bloc's energy efficiency by 20% by 2020.

Previously, the wider-EU market was under the impression that the energy efficiency goals—which would cover the energy usage of power plants and industrial manufacturers—would be voluntary for many companies. But the EU Energy Commission draft proposal indicated the strictures would be mandatory.

Russell Dinnage/Platts/London

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BY FRANK MORRING, JR.

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COMMENTARY

Salty Spray

Cassini dust data suggest subsurface sea

Direct analysis of the material in the spectacular ice geysers erupting from fissures at the south pole of Saturn's moon Enceladus have buoyed scientists' belief that there is a liquid-water ocean under the moon's frozen surface. Measurements with the Cassini probe's cosmic dust analyzer found evidence of an "ocean-like" composition in the relatively large grains of ice near the moon's surface, adding weight to earlier suggestions that the geysers are produced from a liquid-water layer between the moon's rocky core and its frozen mantle. The water dissolves salts from the core, and blasts them into space when one of the

surface fissures—called the Tiger Stripes—near the moon's south pole cracks open, releasing water vapor and ice into the vacuum beyond. Earlier measurements of Saturn's E-ring, which is made up of ejecta from the Tiger Stripes, found some salt in the material that suggested a link to a subsurface sea. But small ice grains from Enceladus sampled there and at some distance from the moon were very low in salt, obscuring the connection. If the plumes were frozen from the beginning—literally ice geysers—most of the salt would have been frozen out.

The Max Planck Institute for Nuclear Physics at the University of Heidelberg, Germany, supplied the cosmic dust analyzer on Cassini. The Heidelberg science team used the instrument's time-of-flight mass spectrometer to measure freshly ejected grains of ice that hit the detector target during three flybys in 2008-09. Striking at speeds of 15,000-39,000 mph, the ice was vaporized and its constituents analyzed with a device developed at the University of Kent in Canterbury, England, that used electrical fields to separate and measure them. Known as the dust analyzer, it detected high levels of the sodium and potassium that

indicate these were generated by the evaporation of liquid salt water. "There currently is no plausible way to produce a steady outflow of salt-rich grains from solid ice across all the Tiger Stripes other than salt water under Enceladus's icy surface," says Frank Postberg of the Heidelberg team and lead author of a paper on the findings published in the journal *Nature*. Postberg and his team calculate the water layer begins about 50 mi. below the surface, and spews water vapor into space at the rate of 400 lb. per sec., with a smaller weight of ice grains going along for the ride. To do so requires large reservoir surfaces for evaporation, they believe, because otherwise the vents would freeze over and shut down the geysers. Separate measurements by Cassini's ultraviolet imaging spectrograph in 2010, when this visible-light image (above) was collected, found the geysers shoot out water vapor at 5-8 times the speed of sound on Earth, which helps explain the lower salt levels in ice sampled at greater distances from the moon.

Since Cassini found the geysers in 2005, scientists have considered Enceladus another possible site for life in the Solar System, and the latest discoveries will increase interest in sending a probe

to the moon in the future. "This finding is a crucial new piece of evidence showing that environmental conditions favorable to the emergence of life can be sustained on icy bodies orbiting gas giant planets," says Nicolas Altobelli, project scientist for Cassini at the European Space Agency, which is partnering with NASA and the Italian Space Agency on the mission. ☛

CATCHING PLUTO

Astronomers are savoring the flexibility they have gained by flying the world's largest infrared (IR) telescope following a June 23 Pluto occultation that required an 1,800-mi. dash to a sweet spot for viewing over the mid-Pacific Ocean. NASA's Stratospheric Observatory for Infrared Astronomy (Sofia), a Boeing 747SP modified to carry a 2.5-meter IR telescope, used a High-speed Imaging Photometer (HIPO) to make the observation, which occurred when Pluto passed before a distant star. "Because we were able to maneuver Sofia so close to the center of the occultation we observed an extended, small, but distinct brightening near the middle of the occultation," says the mission's science team leader, Ted Dunham of the Lowell Observatory in Flagstaff, Ariz. HIPO's sighting gives scientists pressure, density and temperature profiles of Pluto's thin atmosphere. "This change [of brightness] will allow us to probe Pluto's atmosphere at lower altitudes than is usually possible with stellar occultations."

Pluto's shadow travelled 53,000 mph across a mostly empty stretch of the Pacific, so intersecting the occultation could only be done in a moving observatory like Sofia, he says. To make it happen, Dunham's science team relied on multiple photographs of Pluto and the star taken by a colleague from the U.S. Naval Observatory in Flagstaff. Data from those observations were fed to collaborators at the Massachusetts Institute of Technology, who refined them to create flight coordinates for Sofia's cockpit crew, which was operating the 747SP at 45,000 ft. After the aircraft received the best spot for the occultation, the crew still had to wait 20 min. for permission from air traffic control to change its flight plan. Sofia's arrival at the center of the shadow was made with little time to spare. ☛



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COMMENTARY

Win Some, Lose Some

Mixed messages from Obama on aviation

In the span of one week, President Barack Obama praises an aerospace supplier for contributing to the U.S. manufacturing base—then slams tax incentives that have helped sustain the aircraft industry during tough times. Visiting Alcoa's Davenport Works in Iowa, Obama said, "Almost every airplane in the world has some kind of Alcoa product in it."

But back at the White House, Obama went after tax write-offs for business aircraft: "Before we ask our seniors to pay more for health care, before we cut our children's education, before we sacrifice our commitment to the research and innovation . . . it's only fair to ask an oil company or a corporate jet owner that has done so well to give up a tax break that no other business enjoys." He suggested most voters would agree, but aviation "alphabet groups" were apoplectic.

The Aerospace Industries Association of America (AIA), the General Aviation Manufacturers Association (GAMA), the International Association of Machinists and Aerospace Workers and the National Business Aviation Association (NBAA) all complained, pointing out that aircraft lead U.S. industrial exports. AIA President Marion Blakey calls the president's turnabout "odd," adding, "Disparaging comments from the president regarding business jet users are not conducive to promoting jobs, investment and economic growth." GAMA president Pete Bunce says, "General aviation manufacturers can help the president meet his export goals, but not if this damaging rhetoric continues." ☹

BLOCK AND TACKLE

The biz av community was already upset with Obama over the administration's plan to dismantle the Block



'I don't think that's real radical. I think the majority of Americans agree with that.'

PRESIDENT OBAMA

UPI/LANDOV

Aircraft Registration Request program, which allows owners to withhold aircraft registration numbers from online flight-tracking programs. Congressional opposition may be growing to the switch, which was proffered as promoting "transparency." Pat Roberts (R-Kan.) and Mark Begich (D-Alaska) corralled 26 Senate signatures on a letter complaining to Transportation Secretary Ray LaHood and describing the program as "essential" to aircraft operators' "security, privacy and business competitiveness." Days earlier, the NBAA and the Aircraft Owners and Pilots Association filed a notice in federal court to try to block the administration's move. ☹

CONFIDENTIALLY

Meanwhile, contractors breathe a sigh of relief over not having to disclose to

whom they make political donations. Word emerged in the spring that a potential new executive order from the Obama administration would require federal contractors to disclose certain political donations made in the two years before they bid for work (AW&ST, May 16, p. 21). But late last month, the Senate Armed Services Committee approved language in its version of the fiscal 2012 defense authorization that would prohibit the collection of information on political contributions as a part of the contracting process. The House Armed Services Committee adopted similar language in its version of the annual legislation, which the House has already passed. ☹

LOGGERHEADS

Budget politics continues to dominate debate on Capitol Hill, and the Senate has agreed to stay in session this week, rather than proceeding with a scheduled July 4 recess. Sen. Daniel Inouye (D-Hawaii), the chairman of the Senate Appropriations Committee, says defense and war costs have grown 74% since 2001, when the government was running a \$128 billion surplus. Now, with the government deep in debt and struggling to decide whether to increase the debt ceiling, negotiations are deadlocked over domestic discretionary spending (which includes items such as the FAA's NextGen and NASA), Inouye complains. "The focus of our deficit talks should not be on domestic discretionary spending, but on the real reason why we are not running a surplus: historically low revenues, soaring mandatory spending and the cost of war," says Inouye, also the leader of the committee's defense panel. "We need an honest debate on how much is needed to preserve our security. But let me say this: We can only substantially cut these programs at our nation's peril." Still, until the deficit logjam is broken, the congressional process of allocating funds is at a near standstill. Sen. Barbara Mikulski (D-Md.), who leads the Senate Appropriations subcommittee that deals with NASA, and Sen. Patty Murray (D-Wash.), who leads the panel overseeing the FAA, say they can't begin drafting their bills until a budget deal is reached. "It's a quagmire," Mikulski says. "It's a fiscal quagmire." ☹

ENDURING PRINCIPLES

CONGRESS, JULY 4, 1776. Declaration of the thirteen united States of America

When in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of Nature's God, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness — That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed, — That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Liberty.

That the Principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Liberty.

That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Liberty.

That the Principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Liberty.

We join all of America in
celebrating the enduring principles
on which our nation was founded.

And proudly salute the men and women
of our armed forces who defend those
principles with courage and honor.

TODAY TOMORROW BEYOND



ALON BEN-DAVID, AMY BUTLER and
ROBERT WALL/LE BOURGET

A major obstacle blocking Israel's purchase of the F-35 Joint Strike Fighter has been cleared, perhaps signaling that the U.S. is relaxing its hard-line approach to exporting JSF technologies that may be crucial to securing additional foreign sales.

The U.S. has been cautious about sharing sensitive technologies for the stealth fighter, but existing program partners and international competitions—such as in Japan—are increasing pressure on it to do so. The breakthrough comes as more international JSF partners near buying decisions. However, the added numbers will likely have only little impact on the debate about the F-35 unit cost, since initial procurement numbers for non-U.S. buyers are relatively small compared to the Pentagon's purchases.

By far the most contentious fight over F-35 technology has centered on Israel, which wants to adapt the aircraft to use indigenously developed electronic warfare (EW) equipment. After strongly resisting this for some time, Washington now has agreed to allow Israeli F-35s to be rewired so that Israeli EW systems can be installed on the aircraft. That would allow Israel to gradually add indigenous EW sensors and countermeasures on its fighters once it receives its first squadron.

With that deal in hand, officials for both the Israeli air force and Lockheed Martin expect the \$2.7 billion contract for the procurement of 19 or 20 F-35As will be signed by early next year.

"I believe that Israel could receive its first F-35s in late 2016," Tom Burbage, Lockheed Martin's general manager of the F-35 program, tells Aviation Week. A senior Israeli air force official, who until recently was concerned about delays in the program, says the schedule agreed upon is "very satisfactory."

The Israeli air force initially presented a long list of unique and costly requirements for the JSF, but it has accepted that its first F-35s will be almost identical to those of the U.S. Air Force, with only Israeli command, control, computers, communications and intelligence (C4I) systems installed in them. The plans to add Israeli EW systems, air-to-air and air-to-ground munitions as well as an external fuel tank, were approved in principle but will be deferred in order to protect

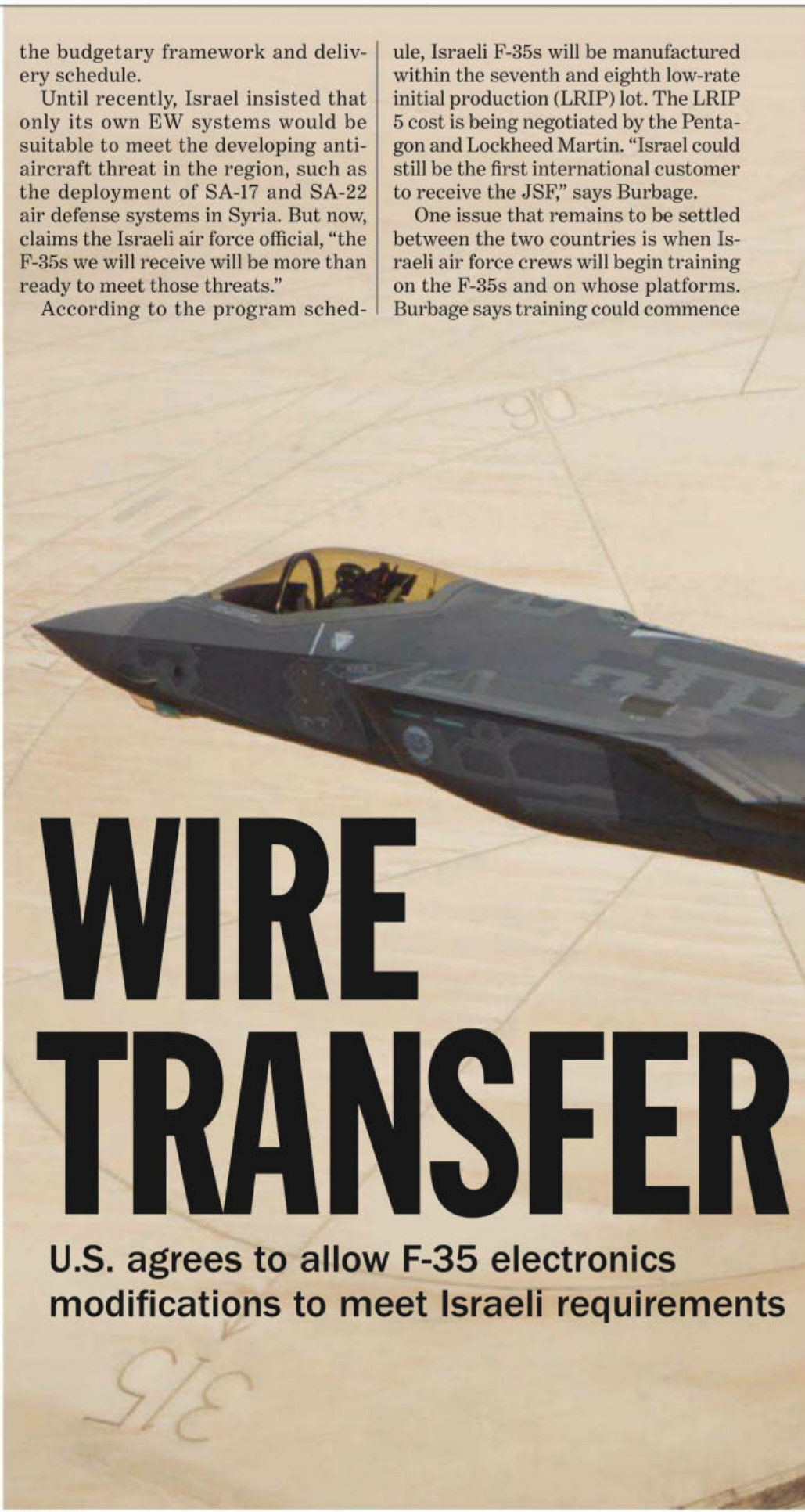
the budgetary framework and delivery schedule.

Until recently, Israel insisted that only its own EW systems would be suitable to meet the developing anti-aircraft threat in the region, such as the deployment of SA-17 and SA-22 air defense systems in Syria. But now, claims the Israeli air force official, "the F-35s we will receive will be more than ready to meet those threats."

According to the program sched-

ule, Israeli F-35s will be manufactured within the seventh and eighth low-rate initial production (LRIP) lot. The LRIP 5 cost is being negotiated by the Pentagon and Lockheed Martin. "Israel could still be the first international customer to receive the JSF," says Burbage.

One issue that remains to be settled between the two countries is when Israeli air force crews will begin training on the F-35s and on whose platforms. Burbage says training could commence



WIRE TRANSFER

U.S. agrees to allow F-35 electronics modifications to meet Israeli requirements

U.S. AIR FORCE

in 2016, but it is for the Pentagon to decide which aircraft will be made available for Israeli training.

Facing a series of tectonic shifts in the region, some perceived as threatening, the Israel Defense Forces (IDF) are drafting a new work plan for 2013-17. The underlying assumption of the plan is that the dramatic changes in the Middle East could turn peaceful neighbors to the country's south, such as Egypt, and to the east, such as Jordan, more

hostile to Israel. The IDF consequently aim to build a larger, more flexible force that will be capable of dealing with more than the traditional northern front of Syria and Lebanon. The Israeli air force claims to be the only service with that flexibility, and it calls for accelerating the plan to procure 75 F-35s by 2030.

In the coming years, the air force will begin decommissioning dozens of its aging fighters, such as F-16A/Bs and

F-15A/Bs, and with only 20 new F-35s, its fighter fleet will reach its lowest point ever.

However, there is strong competition for funding. Israeli ground commanders argue that because of the potential threat that the giant and modern Egyptian army would be turned against Israel, it is necessary to establish an additional mechanized division, equipped with Merkava tanks and the new Namer armored personnel carrier. The production of the Merkava-based Namer was moved to General Dynamics Land Systems in the U.S. in order to enable Israel to procure them using U.S. military aid funding, the same funding source used to acquire the F-35s.

Still unclear is whether the U.S.-Israeli deal means Washington is recognizing that it needs to be more pragmatic in terms of JSF technology controls to secure international deals. Program officials do note that any foreign buyer will have the same level of stealth with which the U.S. will operate.

A key test of how much the technology transfer approach has changed will come in Japan, which recently issued a request for proposals for new fighters. Japan has specified a high degree of technology transfer and work on the program, with an expressed interest in a domestic assembly line. U.S. Air Force Maj. Gen. C.D. Moore, deputy director of the JSF program, says the government is working closely with Lockheed Martin and engine provider Pratt & Whitney to put together an attractive deal. However, he also points out that Japan has ranked capabilities as the most important source selection criteria, even ahead of industrial participation and life-cycle cost.

Australia and Italy are expected to be among the next countries ready to commit to buying JSFs, likely placing their first contracts as part of next year's LRIP 6 package. Turkey is expected to come soon after. Although the Norwegian government recently put forward a proposal to buy the first four F-35s of its larger procurement, the actual contract for that deal may not be signed for another three years.

Meanwhile, Denmark is planning a fighter competition and is expected to make a choice quickly. Pending elections in Copenhagen could even see an acceleration of the competitive time line. The F-35 would face stiff competition from the Boeing F/A-18E/F, Saab Gripen and Eurofighter Typhoon. ☐

The Israeli air force could start fielding F-35 Joint Strike Fighters as soon as 2016.



Training Ground

M-346 may have cost edge over T-50 to win Israel's trainer procurement

ALON BEN-DAVID/TEL AVIV

As the tight race between Alenia Aermacchi and Korea Aerospace Industries in Israel's trainer competition approaches the finish line, the Israeli air force appears to be favoring the Italian M-346 over KAI's T-50 Golden Eagle.

"Both are excellent platforms," a senior Israel air force official tells Aviation

we are offering the Israeli industries."

The Israeli air force will formally issue a request for proposals next month. It is expected to call for 30 trainers to be assembled in Israel by a joint venture of Israel Aerospace Industries and Elbit Systems. The air force will not procure the trainers directly from the manufacturer, but will rather buy flight

to increase U.S. content on its M-346, in part with an eye on the massive U.S. Air Force T-X program (see p. 53).

The two rivals are considering the Israeli selection as a precursor to the T-X competition to replace the T-38, although the battle lines there are still forming and BAE Systems will also enter its Hawk advanced jet trainer. "Clearly, an Israeli selection of the M-346 will in some way influence the campaign for the T-100 in the U.S.," said Giordo, using Alenia's nomenclature for the M-346 in the U.S. bid.

Maj. Gen. Ido Nechoshtan, commander of the Israeli air force, flew one of the three M-346 prototypes in Italy in June, and other senior officers have gathered experience both on the Italian and South

KOREA AEROSPACE INDUSTRIES



The Korean T-50 (above) is in a dogfight with the Alenia M-346 in Israel's trainer competition, but it may lose out because of cost and political considerations.

Week. "But the Italian offer seems more attractive in terms of costs."

Apart from cost and performance, several air force officials indicate the improving political and military ties between Israel and Italy could tilt the decision. In the last two years, Italy's embattled prime minister, Silvio Berlusconi, has become the closest—and almost only European—ally of his Israeli counterpart, Benjamin Netanyahu, and the countries' two air forces have accelerated their joint exercises.

"Political considerations are important," says Giuseppe Giordo, CEO of Alenia Aeronautica. "But more important are the characteristics of the aircraft and the industrial cooperation that

hours from the joint venture.

The selected trainer will replace the Israeli air force's aging A-4N Skyhawks and F-16A/Bs, which now serve as advanced jet trainers for qualified pilots. It is meant to prepare pilots to operate the advanced F-16I and F-15I as well as the F-35 Joint Strike Fighter.

The contract marks the first time in decades that the air force will procure a non-U.S. aircraft. Israel's close ties with the U.S. would give KAI an advantage, since its offering has greater U.S. technology content. However, Lockheed Martin, which worked with KAI on the design and development of the T-50, is not an official partner in the proposal for Israel. What is more, Alenia is trying

Korean trainers. "The T-50 is more similar to an advanced F-16," one officer tells Aviation Week. He adds that "the M-346 is much friendlier to an inexperienced pilot." The T-50 also has the advantage of supersonic speed, compared to the transonic M-346.

Alenia's trainer has been selected by the Italian and Singaporean air forces, although a deal with the United Arab Emirates is on hold. The T-50 is operated by South Korea's air force and was selected recently by Indonesia. The two aircraft are competing to meet a Polish air force requirement for 16 trainers; BAE Systems withdrew from that competition because of Warsaw's interest in a high-end system with light attack capabilities. ☐

Beyond Boeing

Alenia plans consolidations, headcount cut

ANDY NATIVI/PARIS

Reaching a production agreement with Boeing is a cornerstone for a broader strategic plan for Alenia that includes a further round of internal reorganization beyond the one now under way.

The current effort involves cutting the headcount by 1,000 and the integration of key functions—procurement, information technology, marketing and human resources—in three separate companies, Alenia Aeronautica, Alenia Aermacchi and Alenia North America, as part of Finmeccanica Group.

Alenia CEO Giuseppe Giordo says talks with unions in the next few weeks are aimed at consolidation of Alenia's production plants, and a merging of the three Alenia operating companies is also under consideration.

Other goals include reducing the number of Alenia's Tier 1 suppliers as part of a broader effort to improve supply chain efficiency. Steps already taken have cut €15 million in operating costs, with additional savings of about €110 million targeted for 2013.

Alenia is continuing to invest in the C-27J Spartan, its tactical transport aircraft, which is being produced at a rate of 12 aircraft per year. Given additional orders, Alenia could bump the rate to 15-18 per year by adding additional tooling, he says.

That goal already is under way. Giordo says that three new, as yet undisclosed customers have placed a total of 11 C-27J orders valued at €500 million

and that other campaigns are ongoing.

Working under a preliminary R&D contract from the Italian air force, Alenia has started working on a concept for a Special Operations/gunship variant of the Spartan in a program named Pretorian.

The air force's preliminary requirement calls for a kit package that can be retrofitted in existing airframes as a roll-on/roll-off system. The requirement includes electro-optical/infrared sensors from Finmeccanica's Selex Galileo and electronic warfare systems, in particular a communications/intelligence (comint) capability.

In addition, a new weapons system will be needed for the gunship role. For this, discussions have begun with Alliant Techsystems, but officials stressed they are at a preliminary stage. In essence, the air force wants a multimission modular weapons system for Pretorian.

The aircraft will be somewhat of a hybrid, not the pure gunship concept studied by the U.S. Air Force Special Operations Command. Pretorian is to be proposed for international sales.

Beyond the C-27J, Alenia Aeronautica officials are pursuing other air force programs, including a multirole surveillance and intelligence platform. This idea has been previously proposed but was frozen by a lack of funding. Fallout from the Libyan operations has begun to thaw those talks. Indeed, the air force is committing its sole sigint (signal intelligence) airborne asset in that campaign,

an old G.222 VS. The operations have heightened the need for a more modern aircraft.

To find a solution, Alenia is teaming with Israel Aircraft Industries (IAI) in competition with Lockheed Martin. This teaming arrangement is an element of a wider strategic agreement, which also consists of training aircraft for the Israeli air force. The candidate trainer is the Alenia Aermacchi M-346.

Also included is a MALE (medium altitude long-endurance) unmanned aerial vehicle. Giordo says the projects build on R&D investments Alenia has already made in UAVs and could progress to the fielding of a new unmanned aircraft. That vehicle's first customer would be the Italian air force.

The partnership with IAI allows Alenia to counter the joint U.K.-France development of a MALE, an initiative that is, so far, purely binational, even if both Germany and Italy have asked that it be opened to other European countries.

Evidently Alenia prefers to pursue a solution with IAI instead of trying to join the EADS-led Talarion MALE project.

Also noteworthy is that while Alenia is teaming up with IAI on a new MALE, sister company Selex Galileo has unveiled its 650 kg (1,430 lb.) Falco EVO, which is to occupy the upper echelon of the tactical UAV market, close to the Predator A class.

Selex Galileo has also signed an agreement with an IAI competitor, Elbit, to provide the Gabbiano SAR/ISAR T20 radar for the Hermes 450 UAV. The larger Selex Galileo Hermes 900 is to receive the more powerful Gabbiano T200.

Gabbiano deliveries are to start by year-end for undisclosed customers. Gabbiano so far has been selected for installation on both fixed- and rotary-wing maritime patrol aircraft as well as for coastal applications. ☐

Alenia has preliminary R&D under way for the Italian air force of a special operations/gunship version of the C-27J called Pretorian.



MOD Mod



Britain to gain Joint Forces Command to champion key capabilities

ROYAL AIR FORCE

ROBERT WALL/LONDON

The power structure in the U.K. Defense Ministry will undergo sweeping changes under a series of reform proposals aimed at curing years of poor planning and weak program oversight. But there is growing concern that some of the reformist zeal could backfire and erode skills to manage major projects.

The government has rolled out a series of acquisition reform steps and last week added a far-reaching proposal to overhaul management structure and power relationships within the ministry. More changes are ahead, as well. Bernard Gray, head of defense material, is developing a new Material Strategy, which should shake up how projects are managed. The goal is to reduce bureaucracy and make oversight more stringent, while also curbing life-cycle costs.

But industry officials warn that Gray's drive to change the Defense Equipment and Support organization has ruffled feathers within the establishment. They fear his aggressive style could cause experienced personnel, who would be key to implementing any changes, to depart.

Just tackling parts of the organization focused on equipment would not have been sufficient, though, to deal with all the problems the defense establishment faces, notes Defense Secretary Liam Fox. "None of our positive vision for the future can be achieved if we don't tackle the drivers of structural financial instability and the institutional lack of accountability throughout the [Defense Ministry]," he tells the Reform think tank in London. And, he adds, it is "essential to deal with the very structures which allowed the Ministry of Defense and

its budget to become so dysfunctional."

The proposals sent to Parliament are based on work by a panel headed by Lloyd's Chairman Peter Levene that considered changes needed within the Defense Ministry. The proposals call for a reduction in senior ranks to streamline decision-making, but also for retaining key personnel in positions longer—around five years—to properly exercise program oversight. Although Fox has so far detailed only high-level plans, legislators across the political divide have largely supported the proposed changes.

A pivotal recommendation among the 53 spelled out by Levene's Defense Reform Unit, and endorsed by Fox is the establishment of a Joint Forces Command, a four-star-level organization. The goal is to create stronger advocacy for disciplines with cross-service utility that may not be championed by a single service, such as cybersecurity and intelligence, surveillance and reconnaissance.

"Cross-cutting or enabling military capabilities (such as intelligence, surveillance, targeting, acquisition and reconnaissance, and command and information systems), which act as the operational 'glue' between the services are not organized and managed as coherently or effectively as they could be," the 86-page Defense Reform Unit report states. Elements of special forces and the defense intelligence establishment should be folded into the new command, with the Defense Ministry urged to look more broadly into what changes may be useful.

In some areas, the panel agrees that lead services may still retain responsibility for joint capabilities.

Another important change is to elevate the position of the chief of defense material to the Defense Board, the ministry's high-level strategic decision-making body that now is chaired by the defense secretary. The elevation of the chairmanship from the permanent

British defense reform efforts are aimed in part at avoiding wasting money on derailed procurements, such as that of the now-canceled Nimrod MRA4.

undersecretary to the defense secretary itself was also recommended by the reform task force.

At a more detailed level, the panel also urges greater work with industry in supporting military equipment, greater reliance on science and technology advice to underpin acquisition decisions, and earlier involvement of test and evaluation to help control costs.

The role of financial planning is being elevated, too. The ministry's head of finance will sit on the high-level Defense Board and chair the Investment Approvals Board.

Perhaps some of the biggest changes loom for the service chiefs. They are being kicked off the Defense Board—where only the chief of defense staff will remain as a uniformed adviser—and instead are told to focus on running the Army, Royal Air Force and Royal Navy, respectively.

Service chiefs will be given high-level strategic capability targets they need to achieve but will also have more tactical control to reach those. Within that scope, they will have greater flexibility in allocating their budgets—moving resources, for instance, between personnel or modernization needs as they deem necessary to meet objectives. One goal is avoid services committing to programs with unrealistic cost estimates, since now they must cover any overruns within their budgets.

But the Defense Reform Unit recognizes that on some major programs, cost overruns may be unavoidable. In order to avoid crippling a service financially, the group suggests that a contingency reserve fund be created.

The service chiefs also are to draw up command plans to detail how they would meet strategic goals. Although those would be updated annually, the report by Levene's group states that major changes in direction should be reserved for the Strategic Defense and Security Review, conducted first last year and now put on a five-year cycle. ☐

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Chinese Watch

Conflict in the South China Sea is generating demand for maritime patrol aircraft

LEITHEN FRANCIS/SINGAPORE

China's military build-up and increased assertiveness over its claims in the South China Sea is eliciting a strong response from Southeast Asian nations, which could turn this area into one of the most heavily patrolled on Earth.

Recently there has been a spike in hostile incidents in the region. For example, Chinese vessels cut the cables of Vietnamese oil surveying ships and Chinese personnel reportedly erected posts on a shallow reef about 125 nm from the Philippine province of Palawan.

China is claiming nearly all the South China Sea, including the Spratly and Paracel Islands, as its exclusive economic zone (EEZ), pitting it against Brunei, Malaysia, the Philippines, Taiwan and Vietnam.

increase its personnel to 15,000 from 9,000 and vessels will at least double to 520 from 260. And by 2015 the force's aircraft fleet will increase to 16 from nine, it reports.

China is also about to launch its first aircraft carrier, the refitted ex-Ukrainian Varyag. And it has developed the Shenyang J-15 Flying Shark fighter, a copy of the Sukhoi Su-33 naval fighter.

Vietnam has been boosting its capabilities too. Defense Minister Gen. Phung Quang Thanh says Vietnam has six Kilo-class diesel-powered submarines on order from Russia. Vietnam also has 12 Sukhoi Su-30MK2 fighters on order for delivery in 2011-12, according to Russia's Interfax news agency, citing unnamed officials.

Breaking from its tradition of buying

agent, Associated Defense Industries Corp., to market the Twin Otter Guardian 400, a high-gross-weight version exclusively for military and government use.

The request for proposals (RFP) for long-range maritime patrol aircraft will be issued soon, a Philippine Air Force official tells Aviation Week, without elaborating. Some aircraft makers have already made product presentations, says the official. The RFP is likely to specify that the aircraft be new, have two engines and at least 8-hr. endurance, he adds. When asked if the purchase depends on foreign government funding, the official says the Philippine government has the budget. But he says if the aircraft are from the U.S., for example, it could "be through FMS [foreign military sale program] where we get some support from different funding platforms of the U.S."

Aircraft known to be in the competition include: ATR 42MP, Hawker Beechcraft King Air 350ER, Indonesian Aerospace CN-235, Viking Air Twin Otter and Bombardier Q-series.

The Philippine government disclosed in June that it will allocate 40 billion pesos (\$920 million) to upgrade the military. Philippine Air Force chief, Lt. Gen. Oscar Rabena, has said publicly that 14 billion pesos will be earmarked for the air force, which will use it to buy the maritime patrol aircraft as well as radar equipment and utility helicopters.

Brunei has a requirement for two maritime patrol aircraft. It was assumed Piper Seneca Vs would be ordered because the government's investment firm, Imprimis, owns Piper. But other aircraft are said to be under consideration as well.

The Malaysian Maritime Enforcement Agency (MMEA) plans to issue a tender no later than next year for wet-leases on fixed-wing aircraft, says Director General Amdan Kurish. The aircraft must cover Malaysia's EEZ, extending 200 nm out to sea, as well as do search-and-rescue missions as far as 400 nm away, he says. MMEA plans to pay for a set number of flight hours each week, so it is up to the service provider to propose how many aircraft are needed, says Amdan. But he anticipates a minimum of four.

Malaysia has largely relied on the air force's four Beechcraft King Air B200 maritime patrol aircraft, but is now considering larger aircraft with more range and loitering time. A study is under way and a request has gone to the U.S. for information on the Lockheed Martin P-3, says a Malaysian air force official. ☐

AIRBUS MILITARY CONCEPT



Vietnam is scheduled to receive three C-212-400 maritime patrol aircraft this year.

Other countries' aircraft and vessels are free to pass through the air space or waters of another country's EEZ. But if one wants to do military exercises, permission has to be sought. Also, the country that lays claim to the zone owns any oil, gas or mineral deposits.

The massive oil and gas deposits under the South China Sea are potentially a key resource for China, which needs energy to power its economy.

The recent news of hostile incidents has coincided with a report in the state-run *China Daily* that the country's maritime surveillance force will by 2020

Russian equipment, Vietnam has ordered three Airbus Military C-212-400 maritime patrol aircraft for its marine police force. Though the purchase was never officially announced, the Swedish Space Corp. states that the aircraft will be delivered this year after the company's MSS 6000 maritime surveillance system is installed. Delivery of the first aircraft is said to be imminent.

Vietnam's navy, meanwhile, is developing a dedicated air wing and has ordered six Viking Air Twin Otter 400 maritime patrol aircraft for delivery in 2012-14. And Viking has appointed a Philippine sales

Cyber D-Day

Some experts warn that large-scale digital raids are imminent

DAVID A. FULGHUM/WASHINGTON

Cyberoperations against the U.S. thus far have been largely confined to reconnaissance and mapping. But full-scale attacks may not be far off.

Recently confirmed Defense Secretary Leon Panetta says there's good reason to believe a sneak cyberattack on the country's key power supplies is likely. Moreover, an FBI cyberexpert says the only reason cyberjihadists have not unleashed a major strike is a lack of terrorist leadership focus on organizing the efforts of Middle East hackers.

Technologically savvy and religiously motivated irregulars are at hand, according to an Oxford University study called "The Engineers of Jihad," says

recruiting engineers. So there is a base within the extremist movement . . . that could be trained in the area of cyberattack [and reconnaissance], and that is of concern."

That theory is supported by the CIA.

During his confirmation hearings, Panetta, the former CIA chief, told Congress there is a "strong likelihood that the next Pearl Harbor [could be] a cyberattack that cripples" U.S. electrical power grids and pipelines as well as security, financial and government systems.

Already, cyberintrusions are used against the U.S. with such persistence that they have a name—advanced per-

plant malicious code [bots] for use later, potentially enabling an attacker to crash or manipulate key computer networks," Ford says. "That kind of information infiltration . . . is the Holy Grail of cyberwar."

Another cyberspecialist, James Mulvenon of Defense Group Inc., agrees, and says intelligence, surveillance and reconnaissance (ISR)/cyberscouting is the modern equivalent of World War II's top-secret code-breaking operations.

"There is nothing that would make [Chinese officials] give up this source of real-time insight, strategic intentions and commercial transactions," Mulvenon says. "We really haven't seen a lot of cyberattacks, but we have seen a lot of cyberespionage. They are interested in how you can differentiate targets and methods so that they can continue cyberespionage attacks" while convincing other nations to curb the use of cyberattacks through international agreements and treaties.

The U.S. is responding to the threat. New government guidelines would allow the military to test its cybertools on foreign networks to ensure that the defenders know what routes and connections to take in a military emergency. The intrusions would be designed as passive tools without embedded time bombs that could be released later. The various cyberpackages would have established reconnoitered routes through a foe's cyberdefenses, tailored to create specific effects. While preemptive attack has not been approached, the new rules let U.S. agencies defend the U.S. with retaliatory attacks to block digital assaults and begin disabling foreign servers.

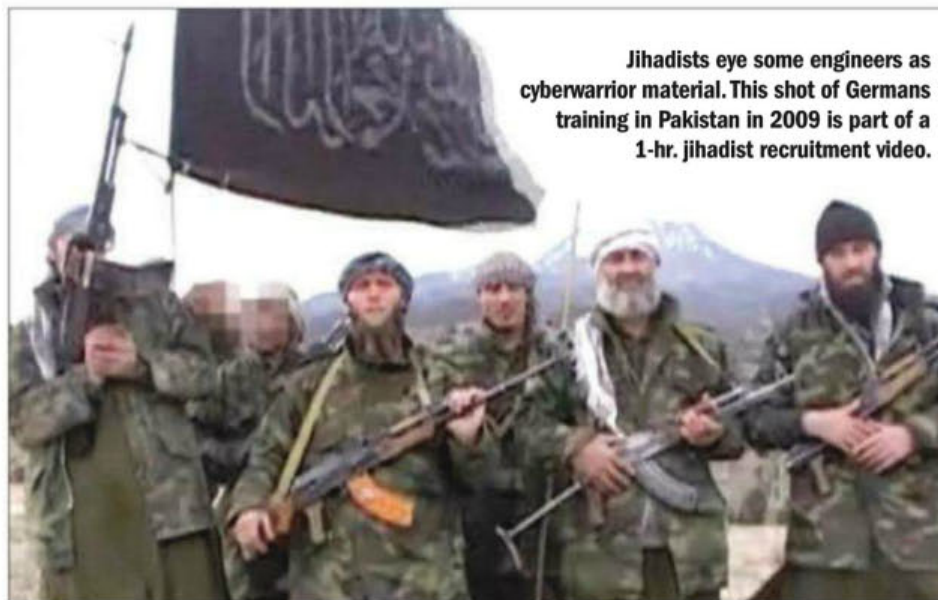
Veteran cyberwarriors already have their doubts about the government guidelines, however.

"This is not going to work like it is stated," says a senior aerospace industry official. "Every adversary prepares for 'zero-day' attacks. The key is going to be the ability to conduct real-time network topology assessment. You can build and deploy all the bots you want, but if I make a hardware or software change or reconfigure the network, these 'resident evils' might be negated."

Moreover, not everyone agrees that the Chinese cyberthreat is government-instigated.

"Though hackers attack the U.S. and Chinese Internet, I believe they do not represent any country," commented Cui Tiankai, China's vice foreign minister, before meeting with U.S. officials in Hawaii.

Jihadists eye some engineers as cyberwarrior material. This shot of Germans training in Pakistan in 2009 is part of a 1-hr. jihadist recruitment video.



DPA/LANDOV FILE PHOTO

Steven Chabinsky, deputy assistant director of the FBI's cyberdivision.

"They found that a disproportionate amount of people in the jihad were engineers of one type or another at both the planning and operational suicide bomber levels," Chabinsky says. After examining a group of nonmilitant engineers they found some common threads. "They were very results-oriented, unlike scientists," he says. And, "they were more likely to be conservative in outlook and religious. Some of the jihadist leaders recognized that and started

sistent threat (APT).

"Though we usually cannot definitively identify the originator . . . pretty much everyone understands APT comes from the People's Republic of China," says Christopher Ford, director of the Hudson Institute's Center for Technology and Global Security. More important, "APT has been devoted to spying" and could be laying the groundwork for an escalation from cyberspying to cyberwarfare.

"The very access that is now used to steal information could be used—or perhaps already has been used—to im-



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"The international community ought to come up with some rules to prevent this misuse of advanced technology. We hope [the U.S.] can step-up communications and cooperation on this with other countries [and that] this advanced technology is not used for destructive purposes."

Some U.S. officials and analysts see the current environment of network anarchy as an opportunity to set up rules, establish norms of behavior, define punishment for cyber-sins and establish a

path for extradition of offenders. Others see it as a trap that allows unfettered, uncontrolled spying without an effective mechanism for enforcement of any agreed-upon rules. Mulvenon, for example, says Beijing wants cyber-arms control that has no verification and enforcement regime for government abuses, but that lays down lots of rules about how civilian and commercial use of the Internet should be conducted.

On a personal level, "in the U.S., you

can't roll back the entitlement that a lot of people feel about the network," Mulvenon says. On the international stage, he doubts that any agreement resembling a nuclear treaty could succeed. "In cyber we face an environment of instability. There is an inability to calculate the certainty of effects. None of the certainty of effects associated with nuclear warfare is available in cyber. Even the people that built Stuxnet weren't sure of its effect. It's leaking out all over the place."

Price of Entry

Boeing is betting it will make up losses in USAF tanker development with future sales

AMY BUTLER/WASHINGTON

Only months after selecting Boeing as its KC-46A contractor, the U.S. Air Force has learned that the company intended from the outset not to develop the KC-135 replacement at the agreed-upon \$4.4 billion target—or, even, the \$4.9 billion contract ceiling.

Its bidding strategy was to partially underwrite the development, knowing it would be on the hook for cost over the ceiling price. "Boeing decided to invest its own capital to win the tanker contract," says Lt. Col. Jack Miller, Air Force spokesman. Perhaps this should come as no surprise, as the company's commercial airliner business often takes risks in developing an aircraft, intending to pay itself back in production orders.

Use of this strategy in the defense market, however, is unusual. Typically, the government pays for nonrecurring engineering, often under a cost-plus contract with little financial risk to the contractor. However, the Pentagon is showing no signs of backing off of its recent embrace of fixed-price development work, which places more financial risk on the contractor and limits the government's liability for contract overruns.

It remains to be seen whether this fixed-price defense contract environment will lead more companies to take this tack. Two major forthcoming competitions—the Air Force's CVLSP support helicopter and T-X jet trainer (see p. 53)—could be low-price shootouts, much like the KC-46A competition.

Bloomberg broke the news last month that Boeing may have to pay \$300 million over the contract ceiling to develop the KC-46A. Neither Miller nor Bill Barksdale, a Boeing spokesman, would confirm that figure. But, one Air Force official says if the out-of-pocket cost is \$300 million, "it may be the best \$300 million Boeing spends all year."

The tanker win officially stunted years of efforts by rival EADS to secure a U.S. final assembly facility for its Airbus commercial airliners. The Chicago-based company has managed to maintain a grip on a decades-long refueler business with the Pentagon. And, it is garnering government money to update its 767 product line with a digital 787 flight deck, which could spark more commercial sales.

Only time will tell if this gamble is a brilliant business strategy that keeps the 767 line humming profitably for decades beyond projections or if this long-fought program drains its defense business of talent and money for years owing to unforeseen technical hurdles.

Boeing notified the Air Force two months after winning the KC-46A contract that the project would exceed the \$4.4 billion target cost, forcing the government to spend an extra \$500 million on the work. "Boeing revealed, post-contract award . . . that during source selection it proposed a ceiling price for the EMD [engineering and manufacturing development] contract that is less than its actual projected cost to execute the contract,"



Miller says in a statement. The development contract includes delivery of the first 18 aircraft by the end of the fourth quarter of fiscal 2017.

Boeing doesn't see the strategy as risky. "We expect to make money on the KC-46 tanker program," says Barksdale, in a statement. "The KC-46 contract opens additional opportunities including potential U.S. and international tanker sales and related services for decades to come." Pricing for U.S. production options has been negotiated, but those options have not been exercised. The Air Force intends to buy 179 KC-46As, and international campaigns await.

Barksdale and Miller both decline to identify the projected price of the KC-46A development at completion. Barksdale also declines to say how many of the tankers must be produced for the company to break even.

Boeing's next earnings call with investors is later this month, and this may be when the company discusses how it will

Therefore, international agreements would be hard to define and almost impossible to enforce.

"From what we know about Russian and Chinese cyberdoctrine, they agree with us about system-attack tools constituting cyberweaponry," Ford says. "But, [they] also seem to consider the category of cyberweapons to include electronic communications [and] political ideas considered threatening to the government. Controlling cyberthreats means foreclos-

ing the Internet's utility as a transmitter of political and social ideas."

Cybertreaties are attractive because they offer clarity, "but they are big, ugly and slow to negotiate," says Martha Finnemore, a scholar of international relations at George Washington University. "As fast as cybersecurity is evolving, it is hard to imagine keeping up with technological change."

A more likely model would be "grafting" rules about cyberbehavior onto

existing architecture like the "laws of war," Finnemore says. "It follows logically from a course of behavior that has already been accepted."

But, she says, cyberrules will be more analogous to public health.

"Too many citizens do not wash their hands, or they do sleep with pigs and cause pandemics that kill people around the world," Finnemore says. "You need to change what people do at the micro-level." ☛

The KC-46A platform, a Boeing 767-2C, includes a cargo door, an enhanced flight deck with 787 cockpit displays, auxiliary body tanks for added fuel and refueling features.



BOEING CONCEPT

take a charge for the development work. Barksdale calls the KC-46A bid "aggressive but responsible."

So far, Boeing's stock price has not reflected concern from investors. "It is one program. It is a bit of a surprise, clearly, but in the broader context of everything else going on with the company and the stock, it doesn't have the weight or bearing" to influence its price, says Byron Callan of Capital Alpha Partners. He notes that this risk is currently under Boeing's control; the company made a choice to expose itself financially to win the contract. By contrast, if there were a technical or management problem in development, the effect on stock price would likely be more direct, he says.

"There is some development work to do there . . . that is well-understood work," says Dennis Muilenburg, president of Boeing Space and Security. "Nothing is risk-free, but we understand the risks [and they are] very manageable."

"This 'news' is not a surprise—in fact,

I would be surprised if it were not happening," says David Berteau, director of the Defense-Industrial Initiatives Group at the Center for Strategic and International Studies. "The Air Force set up the request for proposals so that in order to win, the winner would almost be required to take a loss in EMD."

This strategy does not violate acquisition law or regulations, Miller says. "There is no legal barrier that prohibits an offeror from pursuing a below-cost proposal strategy."

One industry official notes that as Boeing priced its risk for the KC-X competition, analysts assessed the cost of losing—financially and strategically. And, perhaps that cost exceeded the money required to underwrite development for the program. By contrast, Boeing did not opt for a below-cost pricing strategy in bidding for the Small-Diameter Bomb II contract for the Air Force last year, and it lost to Raytheon. That program, however, hardly carries the strategic value of KC-X for the company.

The Air Force's programmatic goal and low-price, fixed-price request for proposals was seemingly perfectly aligned with Boeing's strategic goal and willingness to pay to win and underwrite the development. It is this serendipity that prompts the industry executive to note that perhaps the strategy to finance KC-46A development is more of an anomaly than indicative of a trend to come with fixed-price work in the future.

"Everyone is scratching their head as to how Boeing is going to do this," he says. "You can't bid something that is a loss leader."

Barksdale notes that KC-46A development work is on schedule. The Air Force did not comment on schedule performance. Miller points out that the Air Force will "ensure Boeing delivers according to the contract," including all 18 deliveries in full production con-

figuration and ready to go to war. Miller and Barksdale did not answer questions about whether Boeing was seeking to recoup development costs via contract revisions or engineering change proposals.

At last month's Paris air show, before the strategy was acknowledged, Chris Chadwick, Boeing Military Aircraft president, said that "unequivocally" no engineering change proposals have been requested on the contract. "This is a program [where] we don't want change," he told Aviation Week. "We feel very confident we will perform on this program."

While the government has been successful with the fixed-price contract in establishing a predictable price with the KC-46A deal, any hopes of using incentive structures to encourage lower pricing were either naive or nonexistent. At Le Bourget, Air Force acquisition chief David Van Buren noted that in his three years in office he has "not seen . . . a company underrun the target. I'd like to see some companies underrun and earn some profit" through incentives, he said.

Barksdale stops short of saying Boeing is capable of achieving the \$4.9 billion ceiling, let alone an underrun. "The fixed-price incentive contract structure clearly incentivizes [exploring] ways to improve cost performance so as to benefit from the sharing mechanism," he says.

The Air Force embarked on plans for a new tanker nearly 10 years ago. In the interim, it endured a bloated leasing and personnel scandal, the protested and overturned selection of EADS in 2008 and multiple false starts at a competition. So, perhaps coming in at the contract ceiling is good enough to get tankers delivered. "Overall, this is about what I expected, and I think it is exactly what the Air Force expected," Berteau says. "The real test here is whether the Air Force and Boeing can resist adding requirements. That's going to be *real* news if they keep that up." ☛



MicroB UAV from BlueBird Aero Systems is an electric-powered drone that weighs less than 1 kg.

BLUEBIRD AERO SYSTEMS

Tiny Eyes

Israeli OEMs extend capabilities of mini-UAVs

NOAM ESHEL/PARIS

Industry observers often are struck by the rate at which new unmanned aerial vehicles (UAV) of all sizes are making their debut around the world. Even more striking are the technical advances to increase UAVs' tactical and strategic value.

Among the most innovative are Israeli manufacturers pursuing electrically powered systems that combine ease of handling and economy with extended range, as well as advanced-technology payloads and propulsion systems.

For example, BlueBird Aero Systems recently unveiled its latest electrically powered mini-UAVs, including the sub-kilogram (under 2.2 lb.) MicroB, the combat-proven Skylite mini-UAV and the small flying-wing Boomerang, which, powered by fuel cells, has achieved mission endurance of 10 hr.

BlueBird pioneered technologies related to power sources and sensors. In 2008, the company patented an innovative multi-sensor payload called Globe-i, a daylight electro-optic (EO) payload that enables micro-UAVs to observe large areas. Globe-i does this without moving parts, making it lightweight, reliable and affordable.

For miniature UAVs, cameras usually have fixed mounts to accommodate



AERONAUTICS LTD.

Orbiter 3 from Aeronautics Ltd. uses the 5-kg TD-Stamp payload with gyro-stabilized imaging.

size, weight and power restrictions. The Globe-i concept implements multiple fixed complementary metal oxide semiconductor sensors, each in a different direction. Cameras are mounted so each overlaps the one beside it for image continuity. A window of interest (WOI) can be moved continuously between the sensors for a gimbaled effect. Only the WOI is transmitted to the ground via data link. An integrated digital signal processor reads the images and enables scrolling of the WOI by changing window size and zoom factor. The system supports image-processing capabilities such as stabilization and tracking. Globe-i also stores real-time video and high-resolution images.

These features reportedly give micro-UAVs capabilities similar to those of larger UAVs at significantly lower cost.

Sensor-maker Controp unveiled TD-Stamp, a lightweight payload for small UAVs. It offers performance comparable to larger payloads, ranging from 2.8 kg for the dual-EO/infrared (IR) version to 5 kg for dual-EO/IR with laser designation.

Controp develops EO payloads for air, land and naval applications, and introduced Stamp five years ago. Selected as the standard payload for Sky Rider UAVs operated by Israel's artill-

ery corps, the payloads have proved their capabilities in Israel and elsewhere. They can be installed on nose, top or belly mounts of UAVs.

Developments shown in Paris included the new M-Stamp payload, with a day camera, uncooled dual field-of-view thermal camera and a laser designator. It weighs less than 1.2 kg, and is being refined to weigh 1 kg.

A larger EO payload is T-Stamp, which mounts three sensors on a stabilized platform, has a cooled thermal imager with continuous power zoom and CCD camera, and line-of-sight inertial measurement for geo-location of targets.

The Stamp line has been expanded to include daylight high-definition—Stamp-HD—and uncooled infrared—U-Stamp—models, with and without zoom. To enable UAVs to rapidly scan large areas, the D-Stamp day camera has a new scanning mode.

Controp and Aeronautics Ltd. exhibited the 5-kg version of TD-Stamp on the UAV-maker's new Orbiter 3 electric-powered drone. The payload is optimized for vertical-takeoff-and-landing (VTOL) operations, and provides a high-quality gyro-stabilized image. TD-Stamp fills what was a critical gap—providing a lightweight payload with a laser designator for small UAVs.

"The Orbiter 3 Stuas [small tactical unmanned air system] brings to the market capabilities that did not exist," says Ran Carmeli, head of Aeronautics' aerial division. "A field-deployed, 25-kg, electric-powered UAV now delivers the same intelligence, surveillance, targeting and reconnaissance (Istar) output of tactical UAVs of 100 kg and more."

The Picador VTOL drone from Aeronautics provides situational awareness to land and naval forces. Carrying multiple sensors and payloads, the small rotorcraft is capable of Istar missions. Picador carries multiple payloads of up to 180 kg on missions of 5-8 hr., and covers a range of 200 km (125 mi.).

Another VTOL development at Israel Aerospace Industries is the Naval Rotary UAV (NRUAV). Modified with a suite of automatic flight and mission-control systems, NRUAV will deploy autonomously from a ship's deck for 6-hr. missions, flying 120 km from the vessel. The drone helicopter functions like an elevated mast, extending a vessel's coverage over a large area, and providing early warning and detection of aircraft, cruise missiles, surface vessels and undersea activity. ☐

Advanced UAV

China's Chengdu Aircraft Corp. reveals yet another surprise

BILL SWEETMAN and DAVID A. FULGHUM/WASHINGTON

The latest Internet coup for China's aviation-mad corps of photographers shows a new unmanned aircraft with a joined wing and tail that could make it a reconnaissance truck with considerably increased range and payload and better handling at high altitudes.

U.S. analysts are already suggesting that this UAV design—with its 60,000-ft. cruising altitude, 300-mi. radar surveillance range and lower radar reflectivity if it has the right composite structure—could serve as the targeting node for China's anti-ship ballistic missiles. The ASBM threat against carriers finally has U.S. Navy officials worried.

The aircraft was likely photographed on the Chengdu Aircraft Corp.'s (CAC) ramp. Images emerging from Chinese Internet sources show a new design featuring a novel joined-wing layout. In the same size class as the General



The model in the foreground was prominently displayed at China's Zhuhai air show and provides a good view of the new UAV's unique planform.

Atomics-Aeronautical Systems Inc. Avenger, and powered by a single turbofan engine, the new UAV is the most advanced Chinese design seen to date and the largest joined-wing aircraft known to have been built.

The company also makes the J-10 strike fighter, the J-20 stealth fighter prototype and a Global Hawk-like maritime reconnaissance UAV—the Xianglong or Soaring Dragon—which flew in December 2009. CAC officials say it is 45-ft. long, has a 75-ft. wingspan and a 55,000-60,000-ft. cruise altitude. Chinese sources credit it with a 7,500-kg (16,500-lb.) take-off weight and a 3,800-nm range. The bulged forebody accommodates

a high-data-rate satcoms antenna.

Joined wings—a subset of closed-wing systems—comprise a swept-back forward wing and a forward-swept aft wing. In the new Chinese UAV (as in many such configurations) the rear wing is higher than the forward one to reduce the impact of its downwash on the rear wing's lifting qualities. The rear wing has a shorter span than the front's and its downturned tips meet the front wing at a part-span point.

Advocates of the joined wing claim that its advantages come from structurally cross-bracing the front and rear wings. This allows higher aspect ratio while keeping down weight and staying

Internet image of new Chinese UAV—note shrouded landing gear—indicates it may be undergoing near-field radar cross-section or antenna testing.





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An aerial photograph of a coastal city, likely Vancouver, with a large body of water and green hills in the foreground. The sky is a clear, vibrant blue with a few wispy clouds. The text 'come change' is overlaid on the image, with 'come' in a light blue color and 'change' in a dark blue color.

come change

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The CSeries aircraft program is currently in development phase and as such is subject to changes in family strategy, branding, capacity, performance, design and/or systems. All specifications and data are approximate, may change without notice and are subject to certain operating rules, assumptions and other conditions. The actual aircraft and configuration may differ from the image shown.

within flutter limits. Higher aspect ratio reduces drag due to lift, and because the wings are both slender and short-span (relative to a single wing with equivalent lift) the wing chords are short, which makes it easier to achieve laminar flow. Joined wings can also reduce trim drag.

Studies of joined wings date to the earliest years of aviation, but modern work is traceable to aerodynamicist Julian Wolkovitch, who worked with Burt Rutan on an early design study, the Model 58 Predator agricultural airplane (Rutan went on to build a different Predator design), and drew up plans to develop a flight demonstrator based on the fuselage of the Ames-Dryden AD-1 skewed-wing aircraft. However, the project was still unfunded when Wolkovitch died in 1991.

More recently, Boeing used a joined-wing configuration in its contribution to the Air Force Research Laboratory's (AFRL) SensorCraft project, aimed at developing an aircraft capable of car-

BOEING



A Boeing joined-wing, SensorCraft, undergoes testing at NASA Langley's 16 X 16-ft. wind tunnel in 2010.

rying an airframe-integrated, 360-deg.-coverage, high-resolution radar and remaining on station for 30 hr. at 2,000-nm range. A small, low-speed free-flight model—VA-1—with a 14-ft. wingspan, was completed by AFRL in 2003 and test-flown. A model of Boeing's Joined Wing SensorCraft was tested last year in NASA Langley's Transonic Dynamics Tunnel under the USAF's Aerodynamic Efficiency Improvement program. ☼



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Increased airdrop accuracy can avoid civilian casualties caused by off-course payloads.

On Target

Autonomous technology is taking unmanned systems to a new level of capability

GRAHAM WARWICK/WASHINGTON

Advanced autonomous technology has made an unlikely combat debut, guiding aerial cargo drops to more accurate touchdowns close to forward bases in the Afghan mountains, as the U.S. Army continues to push the frontiers of unmanned systems.

Cargo resupply by guided parafoil has become critical because of casualties resulting from Taliban attacks on truck convoys and helicopters, but air-dropped supplies are not landing close enough to the bases, often because they clip the mountains on the approach, and soldiers are coming under fire while recovering payloads and parachutes.

The first operational drops have been conducted using new guidance, navigation and control software developed by Draper Laboratory to increase the accuracy of the Army's 2,000-lb.-capacity Joint Precision Airdrop (Jpads) 2K system. The software allows the guided parachutes to avoid terrain, and each other, on the descent.

"There is really very little autonomy in an unmanned air vehicle," says Andreas Kellas, leader of the autonomous systems business at Draper. "Air drops are fully autonomous from release. There is no link back to the user and it requires pretty advanced guidance to fly for

miles and land with very high accuracy."

Developed in less than a year under a \$1.5 million Army contract, the guidance software includes a digital terrain database that provides a detailed map of the drop area and allows the Jpads to guide itself around obstacles. The system also prevents parafoils from colliding in the air after release en masse from a C-130 or C-17 transport.

"They are dropped in groups from aircraft, have varying weights and descend at different rates, so there is a good chance of collision," Kellas says. A communications link between the systems allows them to share their relative positions and actively avoid each other. The link also allows "wind sharing" to increase drop accuracy.

"Wind is a big driver of accuracy as air drops are under-controlled and under-actuated—it's like trying to land a 747 with only elevators and spoilers. It's very sluggish," Kellas says. Wind sharing allows the lead system in each drop to estimate and communicate the wind to the others, improving their ability to respond and increasing accuracy.

Today, parafoils and guidance units are recovered and reused, but to reduce the exposure of its troops the Army has also developed a one-time-use parachute

and a modular guidance unit. This will allow soldiers to pull out the costly GPS receiver and guidance processor after landing and leave behind the inexpensive chassis, batteries and motors.

Draper is continuing to improve the airdrop system, including modifying the parafoil to add control surfaces and actuators. With its upgraded accuracy, Kellas expects the system to find increasing use in humanitarian resupply and disaster relief.

The Army, meanwhile, continues to step up its use of UAVs in Afghanistan, with plans to deploy three Boeing A160T Hummingbirds early in 2012 carrying Argus-IS wide-area airborne surveillance sensors. Operational demonstration of the unmanned helicopters is a precursor to a formal program to acquire a vertical-takeoff-and-landing unmanned aircraft system, potentially jointly with the U.S. Navy. The Army is looking for a 1,000-lb. payload capability and "near fixed-wing performance," says Tim Owings, acting program manager for Army UAS.

The three A160T demonstrators have been transferred from the Defense Advanced Research Projects Agency (Darpa) and Special Operations Command and modified to carry the BAE Systems Argus-IS in a pod, as well as a signals-intelligence (sigint) payload, electro-optical/infrared sensor and tactical common data link. The Argus-IS will downlink wide-area imagery and provide 10 independent video streams to different users. Sigint will provide target geolocation.

A system enabling soldiers to use handheld computers to request live and archived imagery from a wide range of unmanned and manned aircraft also is being prepared for operational deployment to Afghanistan. Developed by Northrop Grumman for Darpa, the Heterogeneous Airborne Reconnaissance Team (HART) system allows users to request stored imagery or task aircraft sensors to collect new, real-time video.

HART can work with any aircraft, taking downlinked video, geo-registering the imagery and storing or forwarding it to users, says Scott Winship, vice president of advanced concepts for air and land systems with Northrop Grumman Aerospace Systems. Aircraft can work with the system without modification, he says. A rack-mounted supercomputer at the command center receives service requests from users, sends platform or sensor commands to ground control stations and receives, processes and distributes the imagery. ☼

The Game of Risk

Astrium moves the ball for privatizing telecom, remote-sensing services



AMY SVITAK/LE BOURGET

One of Europe's leading space companies is placing a high-stakes bet on governments increasingly outsourcing key space activities. Astrium Services, a division of European aerospace giant EADS, is taking privatization of satellite communications and remote-sensing services further than any other company in the industry so far, spending hundreds of millions on its own and in some cases assuming big risks, sometimes with little or no government backing.

The goal is to capitalize on a broader trend among governments seeking to outsource all things space—from Earth-imaging and commercial communications services to launch and crew transport. EADS's Astrium Services is setting the pace for competitors in Europe and even the United States, where private firms are backed by billions in government contracts to provide commercial remote-sensing services.

Created in 2003 in the wake of a U.K.

SPOT 6, part of a constellation of Earth-imaging satellites built and operated by EADS-Astrium, will provide continuity of high-resolution wide-swath data to 2023.

Ministry of Defense decision to outsource secure satellite telecommunications to the private sector, Astrium Services was initially guaranteed a market for its products, but had to incur the risk of building and launching the British Defense Ministry's large military birds. Dubbed Skynet 5, the constellation includes three satellites currently on orbit and a fourth under construction.

In Earth observation, Astrium is ponying up 100 percent of the financial investment needed for its SPOT 6 and SPOT 7 optical Earth-observation satellites, a follow-on constellation to the French government's legacy SPOT systems that offer high-resolution data at 2.5 meters (8.2 ft.). The company is funding development of the constellation at an estimated €300 million (\$436 million), with no French government participation and no guaranteed buyers

in a geo-imaging market that Astrium Services CEO Eric Beranger says is increasingly constrained by weak financing from governments.

Even worse, Beranger says, is competition from the United States, where the National Geospatial-Intelligence Agency is injecting \$7.3 billion in U.S. imaging satellite operators Digital-Globe and GeoEye for commercial remote-sensing services.

"In Europe we do not have the benefit of such contracts," Beranger told reporters June 23 during the Paris air show here. "But we continue to invest and provide government and private companies with optical and radar imagery capability."

Astrium's competitors are quick to point out that the risk the company has already assumed benefits sister corporations within EADS that build satellites and rockets, including Astrium Satellites and Astrium Space Transportation, which is the prime contractor for the Ariane 5 rocket.

But as Astrium Services seeks to add data relay products to its growing portfolio of commercial space offerings, the company is taking a bigger gamble.

In January Astrium Services beat Italy's Telespazio and France's Eutelsat to land an operations contract with the European Space Agency (ESA) for the European Data Relay Satellite (EDRS) project. The effort, comprising two geostationary payloads—a small, dedicated spacecraft to be built by Germany's OHB System and a hosted payload to be piggybacked on a commercial communications satellite—involves two contracts. One is with ESA for infrastructure development and one is with the EU, which will serve as the anchor tenant for the service, using EDRS for rapid download of data from its Global Monitoring for Environment and Security (GMES) network, which is needed for crisis management and other urgent applications.

EDRS is ESA's fourth public-private partnership, after Avanti Communications' Hylas-1 broadband satellite, Alphasat/Inmarsat 1-XL and the Small Geo/Hispsat AG1. EDRS is budgeted at nearly €400 million, of which three-quarters of the funding will come from ESA as it seeks to stimulate a commercial market for satellite data relay services.

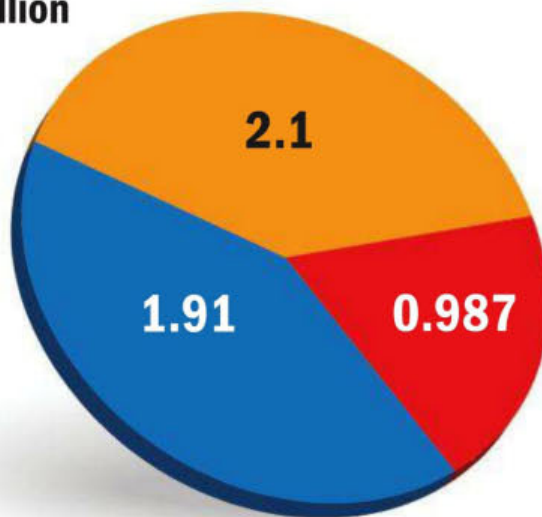
The balance is to be covered by the private sector, putting Astrium Services on the hook for close to €100 million. But despite government backing and Astri-

2010 EADS-Astrium Revenue (€ Billions)

Total = €5 billion

Figures Rounded

- Space Transportation
- Satellites
- Services



Source: EADS-Astrium

Astrium Services took in €0.987 billion (\$1.31 billion) during 2010, and is projected to account for about one-third of EADS-Astrium's revenues by 2020.

um's exclusive rights to sell EDRS products, ESA and the 27-member EU have not guaranteed a government buyer.

ESA Director-General Jean-Jacques Dordain concedes Astrium Services is taking a chance, but suggests the company's core business case—the GMES network—is sufficient to warrant the risk.

"Even though this is not a guaranteed market, this is going to be a very probable, very likely market," Dordain said June 21 at the Paris air show. "They are investing quite a lot of money in EDRS on their side, certainly, and there's this strong likelihood that we're going to have operational services on the side of GMES. And I hope of course there will be services beyond GMES."

But how much European governments will pay for EDRS services, and who will pay for them, remains unclear. While Astrium is free to market unneeded capacity to third-party users, as its Paradigm affiliate does with the U.K.'s Skynet 5, the split between GMES and third-party use is still unknown.

In the meantime, Astrium and its industrial partners continue to hash out work package details behind the scenes. During the Paris air show June 23, ESA abruptly cancelled a planned contract-signing for construction of the satellite

—to be based on Germany's SmallGEO platform—because the parties were still negotiating terms. Johann-Dietrich Woerner, head of the German space agency DLR, says contract details are still being hammered out between Astrium and its industrial partners, which include OHB System and Tesat, a German division of EADS.

"There are some troubles between the different companies concerning their contributions," Woerner said June 23 at the Paris air show. "ESA and DLR today will play the role of the moderator to the different players. We are just asking Astrium services to do their job and we are ready to discuss with the others . . . and find solutions."

But the effort is proving more complicated than anticipated, he said, with primary elements of the project still under discussion.

"There are some different opinions concerning major aspects, how to ensure reliability, because if you want to use EDRS commercially you need a certain reliability," he said, adding that he expects contract negotiations to be resolved in the next four to five weeks.

"If Astrium is not ready there is also the fallback situation to do nothing in a public-private-partnership scheme," he said. "But I think we are ready." ☐



ALENIA AERONAUTICA

Sourcing Switches

Boeing pulls 787-9 stabilizer work in-house

MICHAEL MECHAM/SAN FRANCISCO and ANDY NATIVI/LE BOURGET

Boeing has shifted Alenia Aeronautica to a secondary role for development and production of the composite horizontal stabilizer for the stretched 787-9 as it also broadens the role of its own factories for the new airplane's vertical stabilizer.

The two production moves are not directly connected but they reflect a general drive by Boeing to gain greater direct control over the twinjet's manufacturing processes while strengthening the company's supply base.

"In keeping with our current supply chain strategy, we will do the development work for the 787-9 horizontal stabilizer at our Advanced Development Center in Seattle, including initial production," Boeing said in a statement. "Once the production process has been perfected and stabilized, we will transition the primary stabilizer production to a source yet to be determined,

and to Alenia as a secondary source."

Alenia CEO Giuseppe Giordo says the technical, quality and production issues that plagued the stabilizer have been resolved. That comment seems to reflect an assessment in early June by 787 General Manager and Boeing Vice President Scott Fancher. He said Alenia was delivering "on schedule in terms of quality."

However, Sanford C. Bernstein Research Analyst Douglas S. Harned says that despite the apparent improvement, "we believe Boeing sees this as too little, too late for the horizontal stabilizer."

As one of five major 787 airframe suppliers, Alenia played far more than a typical build-to-print role on the horizontal stabilizer. It participated with Boeing in its design and development, but found that job taxing.

While other airframe suppliers are making the transition to startup activities for the 250-290-seat 787-9 as an ex-

Alenia Aeronautica's Foggia, Italy, factory will have a secondary role in initial production of the 787-9's composite horizontal stabilizer.

tension of their agreements for the standard-sized, 210-250-seat 787-8, Alenia required a new umbrella agreement to address shortcomings with the stabilizer.

Giordo notes that the Foggia plant remains the sole source for stabilizers for the 787-8—the biggest-selling member of the family—and asserts that Alenia is assured 50% production rates for the -9 and 100% rates for the 787-10X, the as-yet unlaunched 320-seat version expected to be Boeing's next aircraft project.

Citing a company policy against commenting on the specifics of contracts, a Boeing official declined to confirm details.

While the stabilizer production has been a sticking point for Alenia, it represents only 25% of the company's revenue stream on the jet, according to Giordo. The more important job is construction of the center fuselage Sections 44 and 46 in a factory in Grottaglie, Italy.

Originally, Sections 44 and 46 were half of a two-part deal for Alenia. The second half was a joint venture with Vought Aircraft in North Charleston, S.C., to integrate them with the center wing box and main landing gear wheel well from Fuji and Kawasaki. That integration task contributed to some of the biggest delivery delays in the program. Eventually, Boeing bought out Alenia and Vought.

In their 787-9 agreement, Alenia and Boeing re-set prices for the first 300 shipsets that have been ordered thus far. The agreement extends total shipset production to 1,022—Alenia projects it could reach 2,700. The accord also resolves all of the 787's technical issues that stemmed from program delays, Alenia officials say.

The Italian partners pledged to commit the additional financial resources, tooling and manpower necessary to sustain Boeing's production ramp-up to seven aircraft by 2012 and 10 aircraft in 2013. Alenia officials say discussions point to 14 aircraft/month production rate beyond 2013, although that is not yet an official goal.

Currently Alenia is producing 3 shipsets/month. Last year it delivered 24 center fuselage sets and 17 stabilizers.

Boeing and Alenia also revised agreements supporting the 767 and 777 program with an open door to Italian participation in "future programs," although

Giordo declined to specify if that might include the New Small Aircraft successor to the 737.

Separately, Boeing has opened a second assembly plant for 787 vertical stabilizers in a 35,000-sq.-ft. factory that is part of its 267,000-sq.-ft. center specializing in machined parts on an 18-acre campus in Salt Lake City.

The composite skins, spars, stringers and miscellaneous parts that Salt Lake City will assemble will be fed to it from Boeing's Frederickson Composite Manufacturing Center near Puyallup, Wash., which shipped its first 787 vertical fin to the final assembly line in Everett in 2007. Frederickson remains Boeing's main integration center for the 787's vertical fin, a role it also plays for the 777.

Boeing Fabrication General Manager Ross Bogue cited "increasing demand for our products and the development of two new airplanes" as the need for the additional manufacturing capacity during the Salt Lake City plant's ceremonial opening last week. Boeing officials point to successful lean manufacturing strategies in Salt Lake City for allowing the company to increase production rates "without adding new brick and mortar."

Fins assembled at Salt Lake City will be returned to Frederickson, which will feed them into the final assembly process.

The Salt Lake City factory is intended to support the 10 aircraft/month production goal, tied to Boeing's decision to open a second final assembly line in North Charleston. While Salt Lake City's output is earmarked for North Charleston, until it gets spooled up Frederickson will fill its initial demand to cover its first two airplanes. The first Salt Lake City tail is due there in the fourth quarter.

The Utah plant is non-union, a source of friction for the International Association of Machinists and Aerospace workers (IAM), which made a point of it in its complaint to the National Labor Relations Board. Machinists at Frederickson are represented by the IAM.

But the IAM's target is the non-union North Charleston plant. Machinists insist—and Boeing denies—it was opened in retaliation for a 2008 IAM strike.

A Boeing official says the Salt Lake City plant "was selected because of its 24-year track record and because of Fabrication [division's] confidence that it will deliver vertical fin assemblies to South Carolina that meet the program's demanding targets for quality, cost and schedule." ☐

Hazy Frontier

Republic's order for the NEO and CSeries depends on Frontier's revival

ANDREW COMPART/WASHINGTON

Republic Airways Holdings plans to acquire 80 Airbus A320-family NEO (new engine option) aircraft and as many as 80 Bombardier CSeries aircraft for its Frontier Airlines low-cost subsidiary, but these deals should include an asterisk.

Frontier is struggling just to remain afloat and Republic might not continue to own it. With the first CSeries not scheduled for delivery until 2015 and the first NEO in 2016, the uncertainty surrounding Frontier and its future ties to Republic makes those orders suspect.

Republic acquired Frontier in 2009 as part of a strategy to expand beyond a regional carrier, fixed-fee flying business it saw as destined for stagnation. But now Republic is engaged in a restructuring of Frontier that Republic CEO Bryan Bedford says is needed to keep the low-cost carrier "viable."

Frontier recently dropped to third in market share in Denver (as measured by passengers carried), with Southwest Airlines surging past it to become number two to United Airlines, and Denver is the stronger of its two hubs. (The other is Milwaukee, the home of Midwest Airlines until its acquisition by Republic and integration into Frontier.)

In the first quarter of 2011, Frontier lost \$55.2 million before taxes, pushing Republic into a loss despite the \$17.6 million pre-tax profit posted by its three regional airline subsidiaries. Such losses at Frontier "are unsustainable and would result in the eventual liquidation of the carrier," Republic says.

During Republic's first quarter earnings conference call in early May, Bedford told analysts that Frontier needed \$100 million in cost-cutting and other annual "financial improvements" to make the low-cost carrier profitable; by mid-June he had raised that figure to \$120 million.

Bedford says Frontier already has made fleet and network changes that will contribute \$25-30 million to that goal. It has pegged another \$25 million in labor cost savings, and came closer to that target in June by reaching an agreement with the Frontier Airline Pilots

Association (FAPA) to amend the pilots' union contract.

In the deal, the pilots allow the airline to defer two upcoming pay raises for five years, cut Republic's matching contributions to 401(k) retirement plans and reduce vacation and sick day accruals.

In exchange, the pilots are slated to get an equity stake in Frontier valued at \$39.3 million, as well as profit-sharing. But that is not all. Republic says it has changed its business strategy to have Frontier "ultimately operate as a separate corporate entity."

Under the amended agreement with FAPA, Republic will maintain separate Frontier websites for all sales, operational and recruitment purposes; further separate the Frontier management structure to include appointing a separate Chief Operating Officer and an independent director of labor relations; and create separate Frontier human

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resources and payroll departments. It also plans arms-length agreements with the regional subsidiaries for use of their aircraft at Frontier, as if the Republic subsidiaries were separately owned and contracted airlines.

Republic also agreed to make a "good faith" effort to reduce its stake in Frontier to 49% by the end of 2014. The subsequent board would include a majority of members who are not Republic Airways affiliates, including one member selected by Frontier pilots.

To even get that far Republic needs to complete its Frontier restructuring. The pilot deal—rushed through the union ratification process in a week—is part of what seems to be a complex series of steps in the effort.

Bedford says the deal with pilots will allow the Republic board to proceed with an attempt to use debt offerings or other financing methods to raise \$70 million for Frontier, which is "critical to fund the airline this coming winter." As of June 29, that had not yet been done.

He also says Republic will be seeking similar amendments to 401(k) plans and vacation and sick pay benefits in other Frontier labor agreements—along with a method for those employees to obtain equity and profit-sharing.

In a way, the Airbus order is part of

the restructuring, too. In the deal with pilots, Republic agreed to place a firm order for 80 narrowbody aircraft for Frontier by Sept. 30. The NEO order accomplishes that, if the letter of intent signed in June is finalized, and it also provides some financial relief for the carrier.

In connection with the Airbus term sheet for the NEOs, Republic amended an October 2009 agreement under which Airbus Financial Services provided a \$25 million loan to Republic and its Frontier subsidiary. Republic has not yet disclosed how it amended the loan, which it had already begun repaying.

Regarding its memorandum of understanding with CFM International to use its Leap-X engine for the NEO, Republic says CFM agreed to a reduction in the overhaul cost of existing engines on Frontier's Airbus aircraft.

Amid all of this restructuring, there is another complication: bad blood between the pilots at Frontier and Republic's regional subsidiaries that could further muddy the waters.

In late June the International Brotherhood of Teamsters won an election to represent all of the pilots employed by Indianapolis-based Republic Airways. The Teamsters already represent pilots at Republic regional subsidiaries

Republic Airlines, Chautauqua Airlines and Shuttle America.

Most Frontier pilots wanted to keep their own representation—their union had opposed even having the vote—and the Teamsters acknowledge creating a unified group will not be easy. The vote's outcome (about 69% of Republic's pilots chose the Teamsters) means FAPA no longer represents Frontier's pilots as a union, but it plans to continue as an organization to give voice to their concerns.

Republic insists the vote will not impact the restructuring of Frontier. By pushing through the ratification so quickly, Republic and FAPA got the contract in place before the union representation vote concluded. But lingering ill feelings from the representation campaign, including a Frontier pilots' lawsuit to try to block an upcoming seniority list integration, may yet cause problems.

The Teamsters are still trying to negotiate a new contract for pilots at Republic's regional subsidiaries, under federal mediation. Pat Gannon, executive council chairman for Teamsters Local 357 at Republic, says the union is aiming to conclude a deal this year. After that it plans to file for contract amalgamation negotiations, after consultation and joint planning among the pilots of all Republic subsidiaries, including Frontier.

When the time comes to talk about a single contract for everyone, "we'll have to evaluate [the FAPA deal] and make a decision about keeping it in place," Gannon says.

Gannon says the Teamsters will try to mend fences. He describes the Frontier pilots as a "good group of guys," which makes him optimistic even though he

Frontier, which brands itself as "A Whole Different Animal," is undergoing a restructuring to avoid extinction. If it succeeds, aircraft like this Airbus A319 might be replaced with A320-family NEOs.

acknowledges it will take time for them to trust that the Teamsters representatives "have the interests of the entire group in mind." Only a truly unified group can be successful, he says.

FAPA President Jeff Thomas, however, says he does not know if reconciliation is possible, and he still describes the union representation vote as a "hostile action" by the Teamsters.

"We're just going to have to see what comes from all this," he says. That is a comment that could just as well apply to the future of Frontier. ☐



Battle Royale

Royal Brunei is suddenly scaling back its international network

LEITHEN FRANCIS/SINGAPORE

Brunei is in one of the fastest growing, most dynamic regions of the world, but it is falling behind its Southeast Asian neighbors and could be destined to become an economic backwater.

Loss-making national carrier Royal Brunei Airlines will stop serving Kuching in East Malaysia starting July 28 and will stop flying to Auckland, New Zealand; Brisbane and Perth, Australia; and Ho Chi Minh City, Vietnam, effective Oct. 30.

It has been serving Kuching and Ho Chi Minh City with Airbus A319/A320s, and Auckland, Brisbane and Perth with Boeing 777-200s leased from Singapore Airlines (SIA). Royal Brunei received its first -200 from SIA in May 2010 and the other five between June and October of last year, replacing its six Boeing 767-300ERs. The carrier originally planned to replace the 767s with Boeing 787-8s, but 787 program delays meant 777-200s became an interim solution. However, -200s are heavier and more expensive to operate than 767-300ERs.

Axing the routes means Royal Brunei may have to return some 777s although that may please SIA, which is preparing to launch a medium/long-haul low-cost carrier using that aircraft type. Royal Brunei's only remaining long-haul destinations are Dubai, United Arab Emirates; Jeddah, Saudi Arabia; London Heathrow and Melbourne, Australia.

Royal Brunei's long-haul strategy has failed. It was serving Australia and New Zealand, hoping passengers would transit through Brunei to its London flights. But there was no way the company could beat other more established international hub carriers in the region at their own game. Royal Brunei lacks the brand cachet and awareness of an Emirates or a Singapore International. It could only generate traffic by competing on price, but low-yield traffic was unprofitable.

The airline says it has about 2,000 employees, but sources familiar with its operations say it has more than that, and far too many for a fleet of only 10 aircraft. They explain that because the government has a policy of promoting zero unemployment, the national carrier is required to employ more people than it needs, making it impossible for Royal Brunei to be a lean, profitable operation.

Management instability is also a concern. Royal Brunei has

had six CEOs in the past 10 years. The airline's CEOs find it hard to get things done because ultimately the government, led by the Sultan of Brunei, is in charge.

Another problem has been bad fleet decisions. The 777-200 lacks the range to serve London non-stop. The flights go via Dubai, putting the carrier in direct competition with Emirates. Royal Brunei's 777s are nine years old on average and have SIA's interior configuration from a decade ago.

In a memo announcing the route cuts, Deputy Chairman Dermot Mannion says, "As we have grown from a regionally focused airline to a long-haul provider, the market around us and the global economy have both changed in significant ways." The pull-back will "position the airline onto a sustainable platform for the future." Mannion's memo suggests Royal Brunei will return to being a regionally focused carrier.

Some within the airline argue it should focus on short-haul operations drawing traffic from across Borneo by, for example, launching flights to Balikpapan, Sandakan and Pontianak. Travelers from such places could transit through Brunei, before flying Royal Brunei to destinations in Europe and Asia. The airline could then use the Borneo network to position itself as the gateway to Borneo, attracting tourists from around Asia and Europe. Borneo includes the Eastern Malaysian states of Sabah and Sarawak, as well as Indonesia's Kalimantan state.

Others argue that Royal Brunei has missed this opportunity. They say Borneo's smaller towns and cities are now well-served by low-cost carriers AirAsia and Lion Air, which feed this traffic into their own international hubs.

Full-service carrier Malaysia Airlines (MAS) has also been transforming Sabah's capital Kota Kinabalu (KK) into Borneo's international gateway. It has non-stop flights from KK to Hong Kong; Kaohsiung (Taiwan); Osaka, Japan; Perth, Australia; Seoul, South Korea; Singapore, Taipei and Tokyo. KK is connected to other cities in Borneo thanks to its turboprop operation, MASwings.

Brunei also has very few tourist attractions compared to Sabah and Sarawak. The kingdom only has a population of 400,000 and, being a strict Muslim nation, alcohol is banned.

Royal Brunei is even finding it difficult to win over Bruneians, let alone market share from neighbors. AirAsia serves Kuala Lumpur-Brunei and also operates from Singapore and from four points in Malaysia to Miri, a Malaysian town bordering Brunei. Many Bruneians use Miri airport to travel overseas.

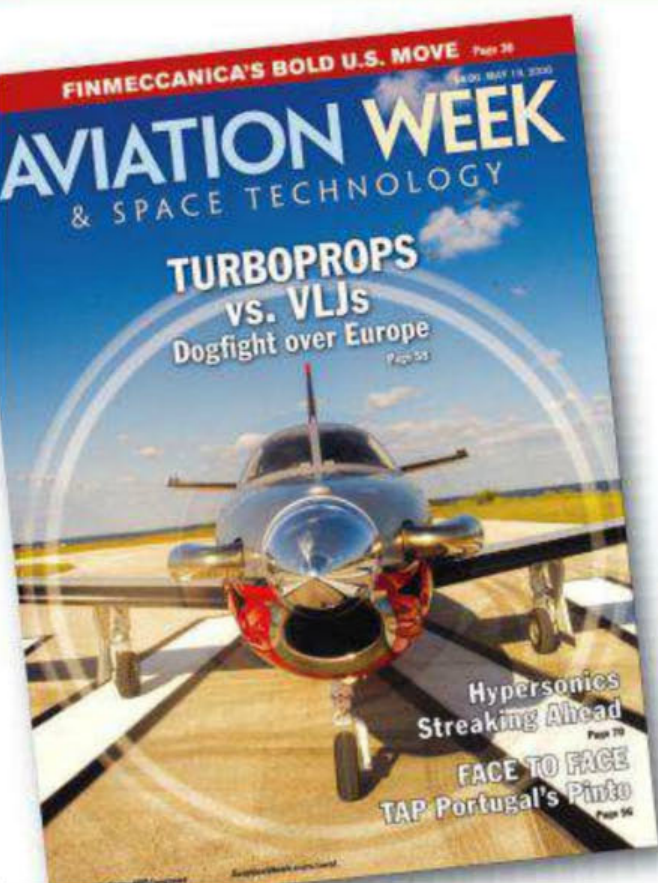
The airline's woes can also be viewed as a symptom of a bigger problem: Brunei's economy is too small and narrowly focused. The government's efforts to diversify it have largely failed. Most revenue still comes from oil exports. Qatar has shown that even a small nation can have a large, successful national airline. But Qatar has a booming financial services sector and unlike Brunei, the country is a business hub for its region. ☛

Given its ongoing problems, Royal Brunei may have to return some Boeing 777-200s to Singapore Airlines.



ROYAL BRUNEI AIRLINES

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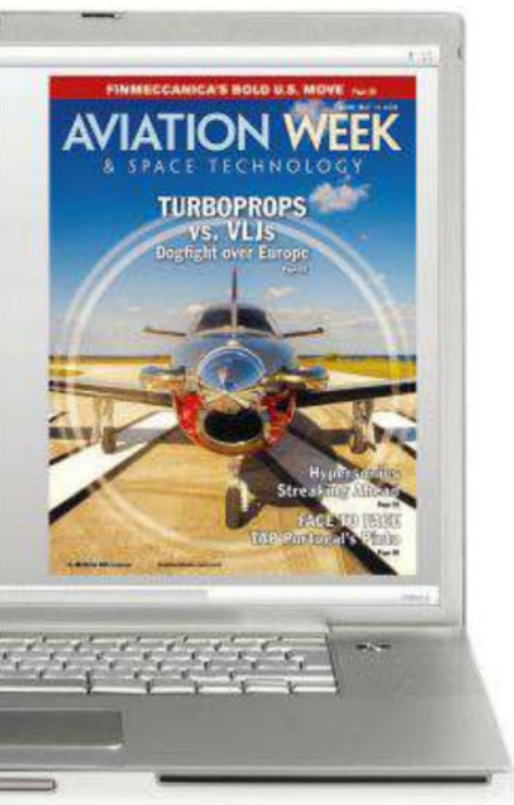
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Conserving Fuel

Alaska Airlines employees' suggestions save millions of gallons of fuel

LEE ANN TEGTMEIER/WASHINGTON

Workers at Alaska Airlines relate to the effects of higher fuel prices when they fill their own cars, so when the airline asked for ideas on how it could save money, they were ready and willing. "Fuel is such a big expense of our businesses, employees were keen to help us save," says Fred Mohr, vice president of maintenance and engineering.

Since Alaska Airlines created the suggestion box for fuel ideas in 2008, it has generated millions of gallons of savings for the airline. Fred Mohr and Gary Beck, vice president of flight operations, co-chair the fuel conservation committee, which bridges the airlines' divisions and cross-pollinates the ideas.

Take auxiliary power unit (APU) use in the air and on the ground. Alaska Airlines targets saving \$2 million annually from shutting down the APU after leaving ETOPS ranges. The airline, FAA and Boeing have been working on this for four years, and Mohr says approval now resides with the FAA. Beck says that once approval is received, all that is needed is a change to pilot procedures.

Reducing APU usage on the ground

is being accomplished by encouraging pilots not to start them after landing, instead hooking up the aircraft to electrical power at the gate. For this to work, the carrier upgraded gates that didn't have the necessary electrical power, and requires stations to submit daily "gate sheets" to verify the power is available. Beck says this initiative saves up to 1.8 million gal. per year.

Speaking of engine efficiencies, the powerplants are washed at every C check and exhaust gas temperature performance is monitored daily to determine if additional washes are needed.

Where the airline fills its tank affects the fuel price, too. The Arctic Tankering Program, which an employee suggested and led, was initiated. Money is saved by abstaining from filling aircraft in the more northern climes, where prices are higher. "We've put a whole round of fuel onboard from Anchorage to Nome," for instance, or filled tanks where the airline just needs to purchase minimal amounts at expensive destinations, says Beck. "This has been very good for us," he adds.

The dispatch group suggested weigh-

ing aircraft 1 hr. before flight to enable more precise fuel quantity calculations. "By not overfueling the aircraft, we can decrease fuel consumption by 230,000 gal. per year," says Beck.

Another operational change, single-engine taxiing, nets a 1.3-million-gal. reduction each year, says Beck. There are several airports in Alaska where this doesn't work, but for airports that can accommodate it, pilots run both engines for 3 min. to cool down after landing, then taxi in on one. The reverse is true before takeoff. The carrier began this project around 2008.

In May, Alaska Airlines announced pilots will use Apple iPads as a Class 1 device for flight operation manuals. This switch could save 20 lb. of paper weight. Beck says the airline would like to move the iPads to Class 2 status in the next year. When asked whether the maintenance department will start using the popular tablet, too, Mohr laughs and says "the rest of the divisions are watching flight ops anxiously," but both men point out that the carrier is being very deliberate about how it applies the iPad.

Alaska Airlines' young fleet includes fuel-efficient Boeing 737NGs, many equipped with winglets.



ALASKA AIRLINES

Airline food and beverage trends influenced the next two ideas.

Flight attendants noticed that many passengers bring bottled water onboard, so they suggested cutting back on potable water to minimize aircraft weight. By eliminating 20 gal. of H₂O per flight, \$350,000-360,000 per year is saved, says Mohr.

Similarly, he says the airline industry doesn't serve as many hot meals on narrowbody flights and that "buy-onboard food" has taken over, which means unused ovens were just adding weight. Maintenance and engineering coordinated with the inflight and marketing departments and decided to remove one oven per aircraft. "At 120 lb. per oven, and 117 aircraft, this represents a significant fuel savings," says Mohr.

From the floor up, passengers will start seeing the effects of the next fuel-saving idea in early 2012. Mohr says the carrier worked with Boeing to find a lightweight carpet for its 737 fleet. Marketing, engineering, inflight, flight ops and maintenance crew worked together to find a type that met not only the weight, but also the burn specs, certifi-

Taking Off

Delta Air Lines moves ahead with JFK T4 construction

BENET J. WILSON/ATLANTA

Even as construction continues on the new Maynard H. Jackson International Terminal here, Delta Air Lines is also in the process of building a new \$1.2 billion facility at New York John F. Kennedy International Airport attached to the existing Terminal 4.

Holden Shannon, Delta's senior vice president of corporate strategy and real estate, notes that T4, operated by JFKIAT, is JFK's premier facility and that the airport is the region's most important. JFKIAT is wholly owned by Schiphol USA and is partnering with the Port Authority of New York and New Jersey to manage T4.

"For a good portion of the New York market, Newark [N.J.] is unreachable.

JFK has historically been the international gateway in the U.S. But it's been underinvested, so the airport has had it in its mission to continue the investment of the terminal side," says Shannon, who oversaw an upgrade at Newark Liberty International Airport when he served in a similar position at Continental Airlines. Delta would like to take advantage of the premier facility, T4, and make it stronger and better, he says. "We believe it's been underutilized in the past 10 years."

T4 was built around the time of 9/11, and as a result, it has virtually been a lost decade in terms of traffic, says Shannon. "So JFKIAT is very happy to have Delta—one of the world's biggest



An initiative to redesign arrival routes and traffic patterns around Seattle, using RNP, could save more than 2 million gal. of fuel annually.

cation, look and maintainability requirements. Mohr says the first new-delivery aircraft will feature the reduced-weight carpet early next year; the first retrofitted 737 will fly with it around January.

The center-aisle carpet requires more frequent changes due to wear, and the installation will facilitate quick updates,

he says. They predict the new choice will save 6,000 gal. of fuel annually.

Needless to say, the electronic suggestion box has more than proved to be worth the effort.

Mohr says that looking for ways to decrease fuel has become part of the airline's culture. It's "part of our DNA." ☛

Green Skies

WASHINGTON

A"huge" effort between Alaska Airlines, Boeing, FAA and Seattle-Tacoma International Airport (SeaTac) involves redesigning its arrival routes and traffic patterns. "Green Skies Over Seattle" would enable pilots to execute optimal profile descents through a gateway, and then using a series of waypoints, turn and intercept a required navigation performance (RNP) or an instrument landing system (ILS) approach, says Gary Beck, vice president of Alaska Air Group, which oversees the airport.

He projects the savings for carriers flying into SeaTac to be 2.1 million gal. of fuel per year and 22,400 metric tons of greenhouse gas emissions, which Beck says is the equivalent of taking 4,100 cars off the road. Alaska and its regional affiliate, Horizon Air, fly more than half of the flights into and out of SeaTac, so it is in their best interest to participate in this project.

Beck would like to see this initiative copied across the U.S. He says it could become a model for the entire national airspace. ☛

and most important airlines—as the primary tenant. The facility, like many others, historically is a little bit oversized on the terminal side relative to the concourse. That was done in anticipation of expansion,” he says. “It created a wonderful opportunity . . . to add gates without adding significant terminal costs.”

Partnering with JFKIAT is another

Delta Air Lines' facility at JFK Terminal 4 is expected to be completed in spring 2013.

reason that adding to T4 is a very economical expansion relative to what Delta would have had to embark upon if it had built a new terminal, says Shannon. “T2 and T3 are chock-a-block full. To build a new facility, we would have had to [alter] our schedule, but for the availability and capacity that's waiting for us at T4.”

Delta is taking what was an overbuilt head house terminal, layering in concrete and creating higher-density ticket counters, says Shannon. “We may possibly add a small stub out one level below for the baggage system,”

he explains. “We're effectively paying for what we use rather than paying for added infrastructure that really would be underutilized.”

Passengers will see a world-class facility when the expanded T4 opens, says Shannon. “It's going to have a train that goes right into the building, as op-

posed to having to cross the street in the elements. It will have VIP services that we don't offer to the same degree today,” he says. He lists more automation, an expanded security checkpoint and first-class concessions as some of the upgrades. Delta expects to open the facility in spring 2013. ☛



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Electric Wars

Air-launched, directed-energy arsenal eyed by Raytheon

DAVID A. FULGHUM/WASHINGTON

Raytheon Missile Systems may have a solution to two of the Pentagon's main stumbling blocks—building militarily effective weapons that do not jeopardize civilians and placing new defense products into service without years of delay from a stunningly bureaucratic acquisition system.

With a key purchase, the company has expanded its potential to quickly develop and field a wide range of directed-energy warheads—primarily designed to destroy enemy electronics—for use on its catalog of air-to-ground, air-to-air and surface-to-air missiles.

Operationally, these non-explosive devices could solve multiple problems facing the U.S. military. They have the potential to avoid inflicting needless casualties, to measure the effects of directed-energy attack and to overcome anti-access and denied-airspace defenses. The last, already being fielded around the world, include medium-range ballistic missiles targeted against ships, anti-satellite weapons, advanced air defenses or cyber- and information-attack devices.

Programmatically, Raytheon's business strategy works around the Pentagon's reluctance to initiate new programs. The company is taking a page from the Navy's acquisition playbook. Adm. Gary Roughead, the chief of naval operations, said during a recent discussion at the Center for Strategic and International Studies that the Pentagon's onerous acquisition rules make it impossible for a new-start program to stay on budget and on cost.

Raytheon's deeper move into non-kinetic weapons was facilitated by its acquisition of Ktech, a company that has specialized in airborne electronic warfare, directed energy and pulsed power, says Mike Booen, Raytheon's vice president for advanced security and directed-energy systems. Booen's division has already developed and demonstrated a high-power microwave (HPM) system that can protect airports and airliners from man-portable air defense (Manpad) missiles.

Raytheon officials will not discuss details of Ktech's expertise, but it is known to include vulnerability assessment of enemy electronic systems, high-power applications, advanced signals generation, antennas, antenna control, frequency management and deployed telemetry.

These capabilities are all needed for the development of airborne weapon systems that can analyze targets and then tailor a beam of radio-frequency or high-power microwaves to upset or even electronically destroy systems dependent on electronics. The beam of directed energy can be varied in width, energy output, modulation and frequency to create precise effects. Such systems also will have feedback monitoring to analyze the impact of these unseen, non-kinetic weapon.

The Pentagon's leadership has indirectly discussed the need for such weapons by pointing to its own vulnerabilities.

"Future conflicts will unquestionably have a cyber dimension," said Deputy Defense Secretary William Lynn, 3rd. "More destructive [electronically based] tools are being developed, but have not yet been used. So we stand at an important crossroads. The level of protection in government and military networks [and the supply of electricity] must be raised. Secure military networks will matter little if the power grid goes down or the government stops functioning. The challenges we face in cyberspace are not amenable to narrow solutions."

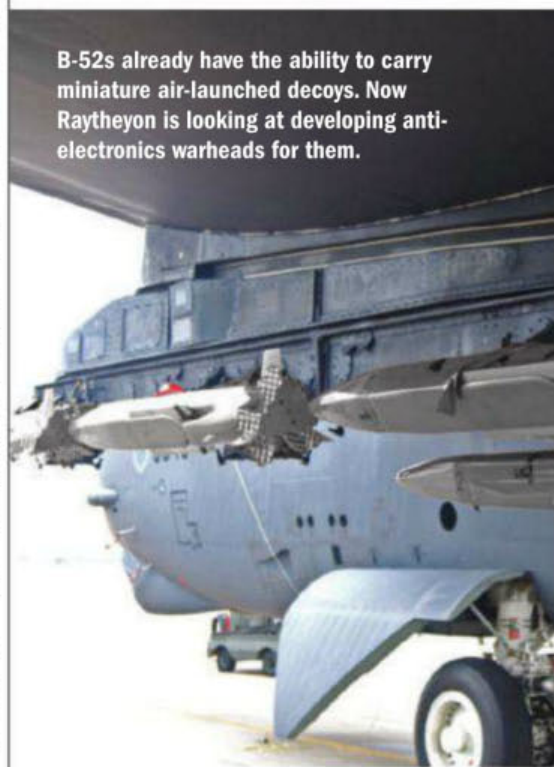
For U.S. operational planning, that means such vulnerabilities would also be the target of a U.S. counter-attack or preemptive strikes on other countries to avoid an imminent cyberattack.

Airframes initially expected to carry Raytheon's new non-kinetic warheads would be the Tomahawk cruise missile; a variant of the high-speed, anti-radiation missile (HARM), and a generic version of the miniature air-launched decoy (MALD-V). The latter is newly redesigned for a non-specific 51-lb. warhead and sized for carriage even by light aircraft, helicopters and unmanned air vehicles.

All these air-to-ground missiles would be designed for use against electronic and "no-collateral damage" targets such as sophisticated command-and-control, communications, weapons storage and intelligence-gathering facilities that may be located in heavily populated areas. They also would be a key element in defeating anti-access and denial of entry capabilities—all based on electronic defenses—being developed by many nations, including China.

The technological heart of the non-kinetic, anti-electronics warhead is an array of high-performance batteries and capacitors, a pulsed-power gen-

B-52s already have the ability to carry miniature air-launched decoys. Now Raytheon is looking at developing anti-electronics warheads for them.



erator and a high-efficiency magnetron developed by Ktech that serves as the "business end" of directed-energy and anti-cyberweapons, Booen says.

While unacknowledged by Raytheon officials, non-kinetic warheads also could be carried by projectiles like the AIM-120 Amraam (advanced medium-range air-to-air missile) and the ramjet-pow-

ered Network-Centric Airborne Defense Element (Ncade), which was designed as an air-launched, boost-phase defense against ballistic missiles. Another candidate would be the ship-based, Rim-161 Standard Missile, which also is an air-and-missile-defense interceptor.

More intriguingly, the ship-launched Standard Missile has been used for a low-orbit, anti-satellite intercept. Other missions for non-kinetic warhead, air-to-air missiles could be the destruction of sensors and communications on enemy combat, surveillance and intelligence-gathering aircraft. The warheads at first are expected to be disposable devices for standoff electronic attack and suppression or destruction of enemy air defenses. They could be fitted to weapons like HARM and MALD, and would likely arm the F/A-18E/F Super Hornet, EA-18G Growler, F-16CJ Wild Weasel and B-52. Tomahawks would be ship-launched.

Later, reusable HPM devices would be sized for the larger weapons bays of X-45



RATHEN

and X-47-size unmanned aircraft as well as the F-35 or F-22.

Explosively generated and pulsed-energy options for the anti-electronic devices exist, but Raytheon is expected to focus on the latter for its initial rapid-development program to meet the demand for non-lethal, non-collateral-damage weapons. ☐



BAE SYSTEMS

Two Canberra-class assault ships now under construction may be based in Western Australia, rather than at the main fleet base at Sydney in the east.

Heading West

Australia, in tandem with the U.S., reviews its defense basing

BRADLEY PERRETT/BEIJING

The great majority of Australia's people and defense industries are on the southeastern fringe of the continent. But valuable and vulnerable natural resources are in the north and west, much closer to Asia. Where should the country put the weight of its defense forces?

Until now, the answer for the air force and navy has been "mostly in the southeast." The government, no longer sure of that stance, launched a review of military basing on June 22.

Australia's national priorities are not the only consideration. As Washington's staunchest ally close to the South China Sea and Indian Ocean, Australia is coordinating its basing reassessment with the concurrent U.S. Global Force Posture Review. That raises the possibility of the U.S. using Australian territory to support its presence in Asia, even if permanent basing of combat forces is not immediately likely, says Peter Leahy, a director of the Kokoda Foundation think tank in Canberra.

Perhaps related to that, the review will consider "the potential strategic and security role" of Australia's far-flung island territories, particularly two in the Indian Ocean south of Indonesia.

The two former secretaries of the defense department who will conduct the review are due to report by the end of March. The government says their work will not be directed at any one country, but it is clear that China is a factor, and not just because its demand is mainly driving the iron ore, oil and gas industries. Defense Minister Stephen

Smith says the review will consider "the growth of military power projection capabilities of countries in the Asia-Pacific." Since India is not regarded as a problem, that can only mean China. The review follows a 2009 white paper that foreshadowed a build-up of Australia's naval and especially submarine forces, citing "the remote but plausible potential of confrontation with a major power adversary"—again, code for China.

Smith has directed the re-evaluation to also consider the increasing global importance of the Indian Ocean rim and "energy security and security issues associated with expanding offshore resource exploitation in our northwest and northern approaches."

Australian air and naval forces are barely deployed to address those issues. The Royal Australian Air Force's main fighter base, RAAF Williamtown, is at Newcastle in the southeast. Though Newcastle is the world's largest coal port, it overlooks the sunny South Pacific, so it hardly needs defending. The strike squadrons are also on the Pacific side, at RAAF Amberley, near Brisbane. Just one fighter squadron is based in the north of the continent, at RAAF Tindal, inland from Darwin; none are in the west.

Australia's solution to this geographic imbalance has been bare bases: empty airfields in the west and north to which aircraft would deploy in a crisis. It is still a good solution, says Andrew Davies of the Australian Strategic Policy Institute in Canberra, who believes the review should keep the combat aircraft where they are. The defense forces have

a big enough problem retaining skilled people in the booming economy, he says. Sending them to isolated locations would hardly help. "They would think: 'I can work out here in the middle of nowhere for the air force, or I could work out here for BHP Billiton and earn twice as much.'" BHP is the world's biggest mining company.

Leahy expects the review to affect the Royal Australian Navy most. Ever since British settlement 223 years ago, naval forces in Australia have had their main base on some of the loveliest urban land in the world, on Sydney's spectacular harbor. Since important infrastructure has accumulated there, too, the navy has never wanted to leave the extraordinarily valuable real estate.

A big chunk of the fleet is now based at Fremantle, in the southwest near Perth, but Leahy points out that even that port is more than 2,000 km (1,242 mi.), at least two days at cruising speed,



Australia has no significant forces deployed on the vast stretch of coast from Perth to Darwin.

from some of the big offshore oil and gas fields to the north. He believes the navy may have to move ships to Darwin, which is closer, or even to a new base next to the resource industries.

The navy's next generation of submarines are expected to be bigger in part to increase time on station, mostly in the South China Sea and northern parts of the Indian Ocean. It makes just as much

sense to base them closer to the operational areas, says Leahy.

Smith mentions most of the navy's ships and submarines as subject to the basing review. Davies expects two big helicopter-carrying assault ships under construction in Spain will be sent to Fremantle, freeing up space in Sydney that could be used for cruise liners. Some of the army could follow the ships west, he adds. Much of Australia's small army is already based in the

north.

It is unclear what the government has in mind for Christmas Island and the Cocos Islands, Indian Ocean territories inherited from the British Empire. Leahy stresses that they need to be secured, because recovering them would be hard. The minister's wording, however, seems to regard them as potential assets as well as liabilities. 

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After the Battle

Planning for growth, digesting cuts: two sides of the Paris air show

ROBERT WALL/LE BOURGET

Airbus scored an unquestionably lopsided win in this year's Paris air show order race, but the week-long flurry may be more of a tactical success than a strategic breakthrough in the competitive airliner wars.

Airbus entered the show with a relatively new product, the A320NEO (new engine offering), and plenty of momentum as airlines emerge from several years of retrenching and address deferred fleet planning, especially in the face of escalating fuel costs. Boeing, by contrast, is still contemplating how to evolve its single-aisle strategy, which in part explains its comparatively anemic order intake for 87 narrowbodies.

But Airbus failed to convince a long-time Boeing customer to abandon the Boeing 737 for the A320NEO. That would have been a knock-down punch, in the view of officials at Airbus and elsewhere in the industry, that might have forced executives in Seattle to expedite their decision. Boeing is expected to choose by year-end whether to launch the New Small Airplane—an all-new 737 replacement—or re-engine the 737. Despite efforts by Airbus's chief operating

officer for customers, John Leahy, to entice SAS Group officials to portray their purchase of 30 A320NEOs as such a deal, executives at the airline demurred and couched it merely as the outcome of one competition without broader implications for their future fleet.

Nonetheless, Airbus received plenty of positive customer feedback that increases pressure on Boeing, including backing for its own message that the A321 is the best candidate in the market to serve as a Boeing 757 replacement.

From a competitive position, perhaps the most important deal for Airbus was Republic Airways' commitment to buy 40 A320NEOs and another 40 A319NEOs, launching the re-engining of that version. But in this case, the pressure is on Bombardier rather than Boeing. The A319NEO is the most direct rival to its CSeries.

Republic has placed orders for 40 of the Canadian narrowbodies and it is insisting they will not be canceled. Airbus officials, though, indicate they believe the CSeries deal will not survive. If nothing else, the A319NEO order adds incentive for Bombardier to ensure the CSeries development does not suffer delays,

which could give Republic an elegant way out of the contractual commitment it made in February 2010.

Despite Airbus's huge order advantage over its rivals, Boeing still managed to secure an edge in the widebody realm. At the air show here last week, Boeing's 777-300ER was the strongest-selling widebody, garnering 27 orders. But perhaps more critically, Airbus has effectively extended the life of the existing 777 with its decision to delay until 2017 the in-service date of the A350-1000.

Although Airbus promises the delayed aircraft will be much improved and a more formidable 777 rival, the extended time frame gives Boeing not just an increased window in which to secure 777 sales, but also further time to determine how to respond. And maybe more importantly, it buys the U.S. aircraft maker time to sequence the series of product upgrades it is working on: the 737 evolution, the Boeing 787-10 and the 777 update, easing strain in Seattle on scarce engineering resources.

Another issue that is clearly in focus for the two big aircraft makers is the dwindling number of production slots available for new orders on some key products. Boeing and Airbus booked orders for only a few 787s and A350s, respectively. Huge order intake in years past means airlines will have to wait for some time for an available production slot, contributing to the recent dearth of new commitments.

Although there were expectations that new market entrants may begin to dent the long-established large aircraft duopoly of Airbus and Boeing, this year's industry gathering here failed to deliver. Neither Comac's C919 nor the Russian MS-21 narrowbody secured a single order. And Bombardier's CSeries order

The Boeing 747-8I was a newcomer to the static display at this year's Paris air show.



total was not enough to worry its rivals.

But the tally of orders does provide clues about the market forces shaping the airline business (see p. 51). What is striking about this year's orders is how dominant carriers in the Asia-Pacific region have been compared with other markets. Even though those airlines have been an engine of growth for commercial aircraft makers for some time, they typically have shared the limelight with carriers in the Middle East, but the level of activity among that region's airlines this year was meek by comparison, perhaps reflecting turmoil in the area that has created uncertainty among smaller Middle East carriers. Moreover, in November, the region will host its own air show in Dubai, where airlines could place further deals.

With commercial aircraft makers largely looking to digest their raft of orders, the military side remains focused on how to deal with budget austerity. Few in industry underscore the wide gulf between military and commercial fortunes as clearly as EADS, which has made balancing the company between



MIKE WINES/AVIATION PHOTO

log to extend bilateral cooperation, too, although there is concern in Europe that the Anglo-French tie-up may leave others on the outside (see p. 55).

Given flat or contracting defense budgets in Europe and the U.S., much energy was spent here on making inroads into new markets. India remains a hot prospect across a breadth of market

Air Tractor is hoping to build on its success with the United Arab Emirates to expand the customer base for the AT-802U.

orders for its AT-802U light attack aircraft for which the United Arab Emirates is the launch customer, with 10 units.

Similarly, the interest in providing lower-cost systems, with an eye on homeland security needs, is what has driven Airbus Military to team with Israel Aerospace Industries' Elta division on the C-295 airborne early warning (AEW) system. The goal is to field a system less costly and complex than it rivals, including IAI's own Gulfstream G550-based AEW offering.

But these needs do not mask concern about the longer-term viability of the defense industry if cutting-edge development programs are no longer affordable in the European and U.S. home markets that fund them.

"What we're seeing right now, with no new starts in the [U.S. Defense Department], is that we are losing our ability to do detailed design and we are losing our capability to transition engineering into production," notes Boeing Commercial Airplanes President and CEO Jim Albaugh, who previously ran the company's defense operation. "I am very concerned about the defense and space industrial base."

With that in mind, the U.S. is launching an extensive industrial base assessment to determine where cuts can be made. U.S. Deputy Defense Secretary William Lynn says recommendations should be ready in the fall. Similarly, the U.K. is finalizing a defense industrial strategy to help set priorities at a time when tough decisions are needed. ☛

Boeing secured two orders for its 747-8 freighter during the Paris air show.



the two sectors a key priority. With Airbus securing deals at a rapid clip, it is very difficult for the defense side to catch up. "We need to add \$2.5 billion in revenue per year to keep up with Airbus," let alone working to draw even with the commercial aircraft maker, says EADS's chief strategy and marketing officer, Marwan Lahoud.

Efforts at cooperation are pivotal to making do with less. For instance, A400M buyers have decided to work together on in-service support, hoping to generate savings. French and British defense officials are continuing their dia-

logues. Sikorsky officials, for instance, are hoping their CH-148 Cyclone, now due to enter service after a series of development programs, will build the company's reputation in that country.

But some promising export markets present concern as well. Brazil is seeing high inflation, which creates worry that the government will retrench from major defense acquisitions for a few years.

While there are few defense growth areas on the near-term horizon, the air show highlighted increasing industry interest in selling lower-end weapon systems. Air Tractor is looking for more

FROM THE SHOW . . .

"Tom, you're taking this competition too far."

Embraer CEO Frederico Curado, in a note to Airbus CEO Tom Enders, after an Embraer building was clipped by the wing of an Airbus A380, which subsequently could not fly. Korean Air lent one of its A380s for the flight demonstration. Curado says he was joking, but Enders came to Embraer's chalet to apologize in person.

"A bad day is a recession where I lost 25% of my commercial business in two years. What we're seeing in defense—that's not a bad day."

Rockwell Collins CEO Clay Jones explaining why he believes fears of declining U.S. defense budgets are overblown. Jones expects growing defense orders from Brazil, India, Turkey and Saudi Arabia to make up the difference.

"We are pleased that there is a real alternative to Boeing and Airbus."

Ryanair CEO Michael O'Leary. The Ireland-based low-fare carrier signed a memorandum of understanding with China's Comac to look at a 200-seat variant of the C919.

"Fine, let them sign a contract with Antarctica if they want. It's all bravado. We have an aircraft ready to fly today."

Ukrainian Deputy Prime Minister Boris Kolesnikov dismissing criticism of the Antonov An-148/158 regional airliner by the CEO of Russia's United Aircraft Corp., which is developing the Superjet 100 regional jet.

"He says a lot of things—and he's been proven wrong."

International Lease Finance Corp. CEO Henri Courpron reacting to Air Lease Corp. CEO Steven Udvar-Hazy urging Boeing to develop an all-new successor to the 737 instead of re-engining the narrowbody jet. Courpron says Boeing should do what it feels is best.

"When you're a first mover, your competitors know your strategy. Right now, Boeing knows the strategies of Airbus, Bombardier and Comac."

Damien Lasou, the Toulouse-based executive director of Accenture's global A&D practice.

"The program is under control, but the critical years are ahead of us."

EADS CEO Louis Gallois on the Airbus A350 program. Analysts believe the company has little cushion left to prevent a delay in the new jet's entry into service.

"The kind of delays we've experienced have been significantly greater than in the past. It's a bit unprecedented."

Eaton Aerospace Group President Brad Morton after Airbus delayed the service entry of two A350XWB models by 18-24 months. Eaton has also been hurt by delays to the Airbus A380 and Boeing 787.

"Bombardier may have snatched defeat from the jaws of victory this week."

Teal Group analyst Richard Aboulafia, after CSeries customer Republic Airways placed orders for similarly sized Airbus A319NEOs the day after Bombardier signed up Korean Air as a new CSeries customer. Republic says it will retain its 40 CSeries orders, but Aboulafia is skeptical.



BY THE NUMBERS ...

2045

The year to which the four partners of International Aero Engines—Rolls-Royce, MTU Aero Engines, Pratt & Whitney and Japanese Aero Engines—agree to extend their collaboration.



102.5

The value (in billions of dollars) of airliner purchases committed at the Paris air show.

10



Number of executives that Boeing's defense unit sent to Le Bourget.

Airbus A320NEO

1,029

deals since program launch six months ago.



9

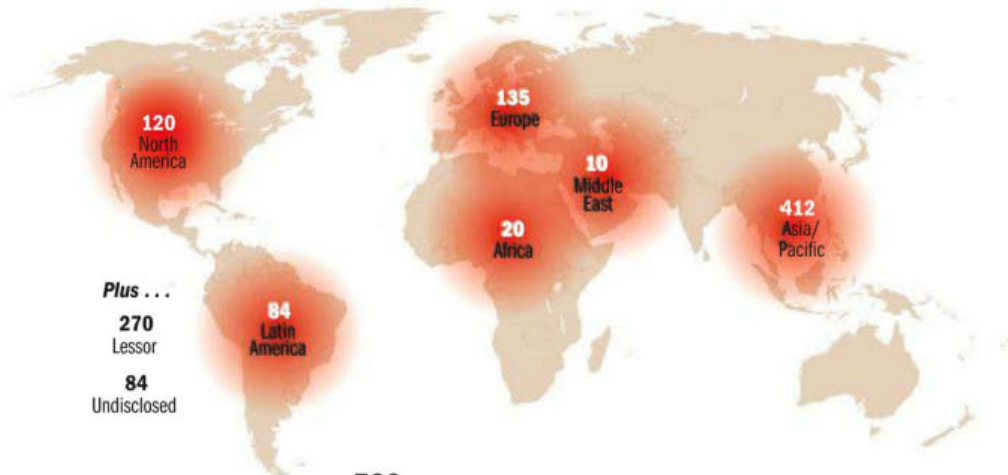
Age of A380 marketing director Richard Carcaillet when the Boeing 747 made its debut at the Paris air show, in 1969. Carcaillet says it is "time for a generational change."

1

Number of days a strike by workers on France's RER railway lasted, snarling travel between Paris and the air show.

Airliner Purchases By Region

Includes firm orders, memoranda of understanding, options and other commitments



Aircraft Deals By Value

In Billions of Dollars

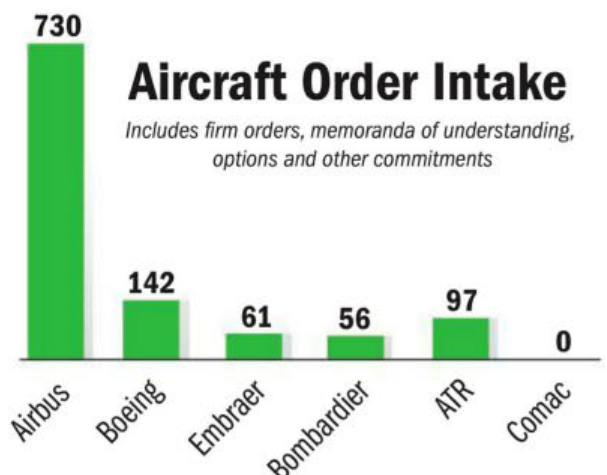
- Airbus
- Boeing
- Bombardier
- Embraer
- ATR

Includes firm orders, memoranda of understanding, options and other commitments



Aircraft Order Intake

Includes firm orders, memoranda of understanding, options and other commitments



Sources: AW&ST and company data

Trading Places

U.S. contractors court European trainer builders as USAF assesses T-X buy strategy

AMY BUTLER and ROBERT WALL/LE BOURGET

A transatlantic mating dance is under way as aerospace companies consider how to pair up to enter the upcoming competition for at least 350 advanced trainers for the U.S. Air Force.

This T-X contract is likely the largest buy to come from the Air Force and, in an unusual twist, it is the U.S. companies courting foreign platform providers rather than overseas contractors chasing after stateside contractors.

however, may have given a peek during a talk hosted by Accenture at the Paris air show here. "There will be increasing budget pressure for the U.S. Air Force to modify its fleet in the best way it can," he said. "It is hard for me to think, looking down the road, there will be a sustained, new development activity with regard to T-X." But he stopped short of committing to an existing design. Service officials continue to stick

Grumman, Boeing, L-3 Communications, Raytheon and the lower-high-profile Spirit AeroSystems are under consideration as partners, according to industry officials.

Any team participating will need to at least assemble the aircraft in the U.S. and expand the team to include more U.S. suppliers. But a factory footprint is not necessarily what the Europeans are after. Likely more important to them is a partner with a strong relationship and solid past performance with the Air Force, Bob Wood, who heads up business development for BAE's T-X bid, told Aviation Week at the air show.

BAE intends to prime its bid and bring in a U.S. partner as a top subcontractor. By contrast, Alenia aims to find a U.S. prime contractor, though plans are not firm, says CEO Giuseppe Giordo. "After seven years of operation in the U.S. now, we know the rules, we know the way to work, and we know how to promote the program," he says.

This is the most strategic marketing campaign for Alenia at present, with talks under way in South America, Africa and the Middle East. Giordo says he hopes to establish regional training centers in South America and Italy, and potentially in Israel as well, depending on progress in negotiations there.

While BAE has opted to forego bidding on a Polish tender for trainers, Alenia is hoping for a win, though it is pitted against the T-50.

Boeing is using a two-pronged strategy for the T-X competition. Chris Chadwick, president of Boeing military aircraft, says that the T-X is "one of those programs that may get moved to the right" in a host of expected budget cuts. This could be wishful thinking, as modernization is urgently needed, with the T-38's recent celebration of its 50th birthday. The company says it could develop a new design to Air Force specifications, bypassing what Chadwick says could be "major mods" to meet requirements, possibly at a similar cost.

But this strategy is not stopping Boeing from courting the platform makers in Europe, although the approach is clearly a nuisance to the Europeans. When asked about the possibility of competing against a new design, Giordo quips: "Boeing has enough development programs now."

Wood says he "struggles with the comment on major modifications." He notes that based on current talks with the Air Force, mods will not be pro-

The M-346 is the newest of the existing designs that could be entered in the U.S. Air Force T-X competition.



The big question that will shape how companies form teams for this purchase of up to 500 trainers is whether the Air Force's request for proposals (RFP) will limit offerings to existing models and production aircraft or if a clean-sheet design option can compete.

An analysis of alternatives led by the Air Force is feeding into the service's procurement strategy, according to industry officials. Pentagon acquisition chief Ashton Carter was slated to review this in mid-summer, but that has slipped to late in the season. Once he codifies a plan, the Air Force expects to release a draft RFP.

The Air Force is keeping quiet about its recommendations to Carter. Service procurement chief David Van Buren,

to a plan of initial operational capability in 2017, another factor leading many in industry to expect that this will be a competition to quickly provide an off-the-shelf model.

The Pentagon's fiscal 2012 budget request included \$307 million over five years, all of it for development. The outcome of Carter's Defense Acquisition Board review will direct how much and when procurement funding will be scheduled.

Meanwhile, none of the potential players are revealing their top choices for partners. The existing designs likely to enter the competition are the Lockheed Martin/Korea Aerospace Industries (KAI) T-50, BAE Systems Hawk and Alenia Aermacchi M-346. Northrop

hibitive for an existing design. They include the installation of an aerial refueling receptacle (for dry contacts, not full plumbing for passing fuel). Other developmental items for some of the companies could include air intercept training, use of an advanced data link and night training, says Mike Griswold, T-50 business development director for Lockheed Martin.

Gary Ervin, president of Northrop Grumman Aerospace Systems, says he is in talks with the European aircraft makers, but he will only team if there is a substantial role for his company. "If we are just building parts, that is something we are not interested in."

Among the leading existing platform programs, the M-346 is nearing the end of flight-testing. T2 Hawk is in a production lull and T-50s continue to be produced in South Korea. Four M346 aircraft are conducting flight tests and the first will be delivered to Italy in the first quarter of 2012. The M-346 has also been selected by Singapore and the United Arab Emirates. Poland is looking for 16 trainers.

While 28 BAE T2 Hawk 128s have been built for the U.K., none are being produced right now. Fifty Lockheed Martin/KAI T-50s have been produced from the factory in South Korea and the system is fully operational, Griswold says. Two other versions have also been sold—

with six of 20 attack models delivered and 50 fighter variants on order.

Griswold says he is confident a U.S. final assembly line could be established, following the F-16 production line model, quickly enough to roll the first production T-50 off of a U.S. line for the Air Force.

The Air Force is seeking an end-to-end training system, including the aircraft and ground-based training and simulators as well as some level of contractor support. The forthcoming RFP release is expected to indicate how much training the service plans to do in the cockpit versus on the ground in simulators. ☼

Next-Gen Strike

MBDA unveils Perseus concept, potential Exocet replacement

ROBERT WALL/LE BOURGET

The world has changed since a French-designed Exocet cruise missile fired by an Argentine navy Dassault-Breguet Super Etendard sunk the Royal Navy's HMS Sheffield during the war over the Falkland Islands in 1982.

France and the U.K. have merged their missile businesses and now MBDA—jointly owned by BAE Systems, EADS and Finmeccanica—has turned to both navies for help in defining a future naval strike weapon concept that could serve as an Exocet replacement. MBDA has devised a new stealthy naval warfare missile concept, the Perseus, which aims to greatly increase the survivability of the weapon and includes novel features to make certain a ship is sunk.

Perseus is part of MBDA's Concept Visions project, which is aimed at shaping the missile systems market in 2030 and beyond, rather than targeting a specific requirement, says Steve Wadey, executive group director technical at MBDA. The goal is to address key defense challenges; last year, it focused on a weapons family for dismounted soldiers.

The CVS401 Perseus derives from 150 concept and technology ideas, Wadey says. The concept has already been shown to the French navy and Royal Navy, both of which provided early input on operational scenarios.

The weapon is a long-range, supersonic precision missile, with both anti-ship and land-attack capability. It is about five meters (16 ft.) long, and weighs 800 kg (1,800 lb.). Although primarily intended as a ship-launched system, it could be fired from any platform that uses Exocet or Harpoon missiles.

Lionel Mazenq, MBDA's project leader, notes that the missile is designed to be capable of engaging time-sensitive targets deep behind enemy lines. One scenario calls for the ability to strike a target at a range of 300 km (190 mi.) within 7 min.

Various attack modes are planned. One is a high-altitude



MBDA CONCEPT

The Perseus missile concept includes the ability to deploy two 40-kg guided effectors with small warheads.

strike profile in which the missile would fly at greater than Mach 3 and engage the ship target in a high vertical dive, maneuvering to defeat ship defenses. Another is a sea-skimming mode in which it would fly faster than Mach 2.

The missile can deploy and target two 40-kg effectors with a small warhead. "Spreading the damage is the best solution to mission kill" when attacking ships, Mazenq notes.

In addition to the inertial guided, unpowered effectors—which can be ejected seconds before impact—the weapon also carries a larger warhead that remains within the missile. The overall lethal package weighs 200 kg. The effectors can be retained within the missile in certain attack modes, as well.

Wadey adds that other lethal packages may be possible, depending on customer requirements. The Perseus is designed for modularity, so that it could also serve as a Storm Shadow/Scalp cruise missile replacement.

The weapon has a multi-mode, radio-frequency seeker with an active, phased-array seeker and synthetic aperture radar capability. Its radar sensor is augmented by a laser radar for high-resolution scanning, mainly for land-attack, as well as a semi-active laser seeker.

Wadey calls Perseus "a step-change in maritime strike weapons," noting that it is "super agile" to defeat future air defenses. Different ramjet-powered motor technologies are still being considered, including a scaled-up version of the motor used on the Meteor air-to-air missile. Continuous-detonation engine designs are also being looked at.

The technology should produce a weapon in 15-20 years, but funding could accelerate the time frame, Wadey says. ☼

Double Trouble

Europe at odds over plans for unmanned aircraft

ROBERT WALL/LE BOURGET

For France and the U.K., it is a straightforward calculus: At a time of fiscal pressures, it makes sense to pursue unmanned aircraft programs cooperatively. But for other players, the implications of this move are troublesome and raise concerns about broader European defense industrial considerations.

Europe's approach to meeting long-unmet unmanned aerial system (UAS)

to competing fighter projects—the Eurofighter Typhoon and Dassault Rafale.

But EADS is not singing the praises of European cooperation for selfless reasons. The company has been trying to entice Germany, France and Spain to back the corporation's self-funded Talarion MALE UAS program—aimed at sustaining air vehicle design capacities in Germany—although so far there has been no commitment from Berlin

negotiations linked to the A400M military airlifter, management of the NH90 helicopter project and laborious Typhoon decision-making processes.

Nevertheless, Gallois warns that if the Franco-British effort goes forward in its likely guise of a BAE Systems-Dassault partnership surrounding the Telemos UAS project, EADS may have to find its own partnership, for instance with Italy's Finmeccanica, to assure its industrial capacities in unmanned aircraft.

EADS has been self-funding its Talarion work for several years, but now is looking for the governments of Germany, France and Spain to back a \$300 million prototype phase that would last three years and lead to a first flight in 2014. Zoller says he is in talks with the British government to offer Talarion there as well.

One of the issues for Talarion is that it is largely an EADS program, with little other industrial participation. Dassault Aviation CEO Charles Edelstenne quips, “Talarion is not a cooperation between France and the U.K., [. . . it is] a cooperation between EADS Germany, EADS France and EADS Spain.”

But Zoller says he is open to change. Thales, for instance, could provide the sensor. Other companies could also eventually be brought on-board, although he wants to wait until the program enters a new phase to avoid slowing it further.

Even as those discussions are unfolding, Dassault Aviation is once again approaching the French government about the possibility of acquiring the Israel Aerospace Industries Heron TP UAS. Dassault has

revived its offer to provide an interim MALE system to the French government built around the Heron TP, but has tweaked the proposal to an off-the-shelf system without French sensor modifications that were previously part of the plan to expedite fielding. The deal could take the shape of a sale or a fee-for-service arrangement.

While Telemos is the company's top priority, Eric Trappier, executive vice president international at Dassault Aviation, sees potential to secure an interim program until Telemos is to be fielded around 2016-17. ☐



BAE Systems and Dassault Aviation are building their Telemos unmanned aircraft project around the original Mantis design.

needs has become the battleground for these divergent views.

With France and the U.K. having decided to work together on a medium-extended long-endurance (MALE) UAS, Germany and Spain, for example, are scrambling to figure out where they fit in. If the French and British work alone, “the risk is that all the countries develop their own program,” says EADS CEO Louis Gallois. “We need a European program,” he asserts. If not, “we’ll have two.” That prospect scares some European officials who remember the fissures of the early 1980s that led

to proceed with the project. Turkey has indicated it would join such an effort if it receives the green light.

“We are not pleased by the development that we have potentially two competing programs in Europe,” says Stefan Zoller, CEO of EADS's Cassidian defense business. “We need to have one single European program where even more nations participate.”

But the single-program structure is what scares some officials in London and Paris, who are tired of the headaches associated with broad, multicountry European efforts such as contract ne-

Working In Space

Experienced NASA managers see shuttle's legacy in lessons it passes on for future spaceflight

FRANK MORRING, JR./WASHINGTON

Even after the three surviving space shuttle orbiters have gathered a few decades of dust in their respective museums, mid-century spacefarers from around the Earth will be using tools and techniques for operating in space that were incubated on the historic U.S. spaceplanes.

The 30-year shuttle era—which draws to a close with the upcoming flight of Atlantis (see p. 59)—saw indelible advances in human spacefaring skills, most of them enabled by the shuttle. On April 12, 1981, two Soviet cosmonauts were in orbit as the shuttle Columbia lifted off for the first time. They had traveled to the 90-cubic-meter Salyut-6 space station in a Soyuz capsule that was a relatively modest evolution of the Vostok 3KA capsule Yuri Gagarin flew on the first human spaceflight 20 years earlier, to the day.

Columbia was something entirely new. At the final “wheels-stop” of the shuttle era as early as July 20, the crew of Atlantis will have visited the crew of six—three Russian cosmonauts and two U.S. and one Japanese astronauts—on the International Space Station (ISS), which has grown to 1,200 cubic meters of pressurized volume since assembly started with the first launch on Nov. 20, 1998. The space station, boasting a full set of scientific gear designed to study the effects of microgravity on humans and hardware, could not have been built

without the shuttle fleet's capacious payload bay, advanced robotics and robust extra-vehicular activity (EVA) capability.

Just as the ISS is a direct, tangible result of the shuttle's legacy, senior NASA managers who have built and operated the shuttle fleet over its lifetime expect that legacy to continue to shape human spaceflight indefinitely, both in orbit around Earth and on missions to distant destinations, regardless of the outcome of the ongoing space-policy debate over filling the void that will be left by shuttle retirement.

“There isn't anything we're going to build that does not in some sense derive from shuttle,” says Michael Griffin, who helped implement the decision to retire the fleet as NASA administrator under President George W. Bush. “You can argue about whether it looks or doesn't look like a shuttle or whether it does or doesn't use the same external tank as the shuttle, but whatever we build is going to have enormous amounts of technical legacy from the shuttle and operational legacy from the shuttle.”

At the macro level, “the shuttle enabled us to really learn how to live and work in space,” says Griffin, offering a view widely shared by his former NASA colleagues. Technically, the shuttle has advanced on-orbit construction, in-space communications and navigation, spacecraft control techniques, environmental control and life-support systems



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and a host of other capabilities.

Operationally, the shuttle also has taught very expensive lessons about how to fly safely through the atmosphere to and from orbit, some of them perhaps still poorly understood. Fourteen brave astronauts died in two horrific accidents, one on ascent and one on entry. The disasters underscore the fact that all of the energy that goes into reaching orbit has to come out of the system on re-entry, which makes both ends of the orbital flight profile particularly unforgiving.

Challenger's last launch was cut short when a rubber o-ring embrittled by cold ground temperatures failed, allowing the roaring heat of one of the burning solid-fuel boosters to escape. Columbia's crew died after a piece of insulating foam from the external tank hit a fragile thermal protection panel on the leading edge of the left wing, rendering it useless for re-entry.

In both cases the bureaucracy set up to launch and fly shuttles ignored warning signals, some of them quite explicit,



Columbia, left, the first space shuttle to fly, rolled past Atlantis, the last to fly, on Aug. 9, 1990, when the shuttle program had learned some hard lessons and had more to learn.

and flew when it was not safe to do so. "The normalization of deviance," said the sociologists by way of explanation after both accidents. If something dangerous does not hurt you a few times, the theory goes, groups tend to think it never will.

Doug Cooke joined the shuttle program in 1975, helping astronauts Joe Engle and Richard Truly map the profiles they would fly in the Enterprise atmospheric test vehicle to prove the orbiter could glide to a safe landing. Soon to retire as associate administrator for exploration systems, one of his last tasks at NASA has been to shepherd the selection of reference designs for the heavy-lift Space Launch System (SLS) and Multi-Purpose Crew Vehicle (MPCV) now planned as the agency's next human spacecraft. Along the way he also served as NASA liaison to the Columbia Accident Investigation Board. His career path has given him a broad view of the practicalities and pitfalls of the human spaceflight endeavor.

"This is still a hard business," Cooke says. "Even as we understand some aspects of it better than we did years ago, and it's become more routine, we still run into engineering issues and anomalies and things that we have to understand when they happen . . . It's important in our culture that we always make sure that when we see something that doesn't look right, we really investigate it. Sometimes in the past when we've had some of our biggest problems, that didn't always happen."

Now, after the two accidents and 134 total flights, the agency has more confidence that it knows how to operate high-performance human spacecraft safely, and to "stay hungry" for the situations that need a closer look, says Shuttle Program Manager John Shannon. That knowledge already is being passed on to the U.S. companies and international partners that will have the job of getting cargo and crew to the ISS after the shuttle retires, he says. But the new guys still have a long way to go, and the hard-won

lessons will apply to the new systems too.

"Whereas the airframe itself will not be as complex, certainly the subsystems will be, and those things are required absolutely to have to work," Shannon says. "I think that's what the commercial guys are going to run into. They've really got propulsion down. They do great testing; they've got good designs, but now they're running into the complexity of power systems and eventually the life-support systems, precision attitude and control and docking systems, and things like that that they will get right, but it will take time to do it."

Knowing just where to apply resources to build in safety and reliability will be a key factor as the commercial operators learn to fly safely. "Balance" is a word used often by NASA managers as they explain what it will take to fly into space with some degree of routine, drawing on the lessons of the shuttle era.

"There's a balance in life," says William Gerstenmaier, associate administrator for space operations. "You've got to be selective about which areas you do. The areas where you think your analysis is the weakest or your tools aren't as good or your testing wasn't as good, or you had lots of trouble getting through a particular component to get it to work exactly right, those are clues of areas you need to go look at."

The shuttle taught that lesson not just in the dramatic failures that caused the accidents, but also in the operational decisions that prevented it from flying as often and cheaply as originally hoped. Griffin calls the shuttle a "magnificent vehicle . . . just right at the edge of human capability," and has high praise for the men and women who operated and flew it. But he says he has believed since the 1970s that it was oversold as a vehicle that could go into space 50-60 times a year, and for costs he says were quoted as low as \$14 million (\$58 million in today's dollars) a flight.

When he stepped down as administrator in 2009, he says, NASA was paying about \$3 billion a year in fixed costs "to own a shuttle fleet." The marginal cost of a mission was \$300 million a year. Part of the problem between the promise and reality was that "the folks who were responsible for launching it were not the same as the folks who were re-

sponsible for designing it, and the two groups just did not have a meeting of the minds.”

“Now, it wasn’t ever going to be operated like an airplane, but we didn’t have to operate it the way we did, either,” Griffin says. “There was a middle ground. The people who designed it designed it to be launched with two-out-of-three or three-out-of-four systems working, but the people who launched it would never agree to launch it unless everything was working. So we did not take operational advantage” of the built-in redundancy.

After improving the shuttle for 30 years, managers see many areas where modern technology can aid in the development and operation of the next-generation of vehicles. For Gerstenmaier, whose first shuttle job was taking wind tunnel data for aerodynamicists during vehicle development, advances in computational fluid dynamics enable “phenomenal computations” to aid in design. So will miniaturization of video cameras that allow much better engineering imagery to determine how closely an aerodynamic system’s performance matches predictions.

Cooke’s directorate, which will be merged into Gerstenmaier’s in a pending reorganization, is pushing a shift to hydrocarbon-fueled booster engines for the heavy-lift SLS. Administrator Charles Bolden has accepted and forwarded to the White House for final approval a recommendation that there be an eventual competition for liquid-fueled strap-on boosters after initial use of solid fuel to help get the all-cryogenic SLS main stage off the ground, as it evolves toward the targeted 130-metric-ton lift capacity Congress desires (AW&ST June 20, p. 38).

Engines fueled by kerosene or other hydrocarbons provide a lot of thrust, and burn quickly to lighten their load as they climb toward orbit, Cooke notes. Early in development the shuttle program considered hydrocarbon-fueled flyback boosters, but rejected the idea in favor of large, segmented solid-fuel boosters to save on development costs.

“We haven’t invested a lot in LOX/RP [liquid oxygen/hydrocarbon], and we probably should,” Cooke says.

Shannon sees a clear way



AP/WIDEWORLD OR SCOTT LIEBERMAN FILE PHOTO

Debris from the space shuttle Columbia, which broke up on re-entry Feb. 1, 2003, streaks across the sky over Tyler, Texas.

ahead in developing the reliability in avionics that will be needed for the deep-space missions Congress wants NASA to pursue. “The orbiter probably has too much redundancy in the avionics area, and that drives a lot of complexity,” he says.

But for Shannon, the shuttle has also flagged technical areas that will require close attention from the commercial spacecraft developers, and from the government as it works on the SLS and MPCV. And in some areas, NASA will have to relearn lessons that the shuttle’s capabilities left unexercised for the past three decades.

The Challenger exploded during ascent from Cape Canaveral Jan. 28, 1986. Such accidents tragically illustrate the risks shuttle follow-on human vehicles will face.



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“We haven’t done parachute recovery for a long time, water recovery or any kind of a capsule recovery,” Shannon says. “There are specific engineering lessons that you have to apply.”

One legacy of the shuttle, highlighted by Engle during an astronaut panel at the National Space Symposium in Colorado this year, has been the internationalization of space exploration. While the ISS epitomizes the fruits of partnership among spacefaring nations, and serves as a model for the future as deep-space exploration demands skills and resources beyond those that any one nation can supply, the shuttle itself has

taught valuable lessons for international development and operations that predate the space station.

Before work started on the ISS, for example, shuttle orbiters docked nine times with the Soviet-era Mir space station in what Cooke terms a “stroke of genius” in helping the former Cold War adversaries begin to understand each other’s “engineering cultures” well enough to build a space station together. For Gerstenmaier, an important lesson NASA learned from the Russians involves how far to push reusability.

“They use their spacesuits for about five missions, five spacewalks, and then they throw them away,” he says. “That allows them to keep a production line up that’s continuing to put out spacesuits, so then when they wanted to put more articulation in the elbow joint they were able to add a joint to the suit, and it was not a big impact to them. . . . We would have to do a whole new production run [or] a big design cycle.”

For now, at least, humans will get to and from orbit with capsules and parachutes. But NASA is putting some seed money in Sierra Nevada’s Dream Chaser lifting-body design as a potential commercial human spacecraft (AW&ST April 25, p. 24), and the day may come when space travelers again glide to runway landings.

“I would like to think we’ll go back to a shuttle for low Earth orbit someday,” Gerstenmaier says. “There’s a tremendous advantage to being able to land on a runway, as opposed to doing the parachute landing.” ☼

Buying Time

NASA's final space shuttle mission will stock ISS until commercial cargo deliveries arrive

MARK CARREAU/HOUSTON

If ever there was a time to pack carefully for a journey, it is now. NASA's shuttle era draws to a close with a final mission to the International Space Station (ISS) carrying enough supplies to keep the orbiting science laboratory fully staffed while U.S. cargo deliveries shift to emerging commercial providers.

Attention to detail will mean the difference between a successful transition tolerant of typical start-up issues for NASA's Commercial Orbital Transportation Services (COTS) partners, Space Exploration Technologies Inc. (SpaceX) and Orbital Sciences Corp., and an unplanned retreat from six-person staffing and disruption of the growing ISS research agenda.

The 12-day STS-135 mission falls to Atlantis, which is tentatively scheduled to lift off from NASA's Kennedy Space Center on July 8 at 11:26 a.m. EDT.

"After that, we begin a more utilization-focused operation of the ISS—away from the assembly flights—where time for research is allocated and the systems guys go figure out how to operate the ISS with what is left," says Mike Sufredini, NASA's ISS program manager. "That's exactly the opposite of what we have done all the way through the assembly phase."

The first of 37 shuttle construction and outfitting missions launched in late 1998.

The 26-year-old Atlantis will deliver nearly 12 tons of equipment. Most of the cargo will be sandwiched in the Raffaello multipurpose logistics module (MPLM)—enough food, clothing, spare parts for critical life support systems and research gear to provide a year-long cushion for the COTS partners. With the STS-135 cargo and the anticipated arrival of Russian Progress flights, the station should be adequately provisioned through 2012, according to Chris Edelen, NASA's lead space station flight director.

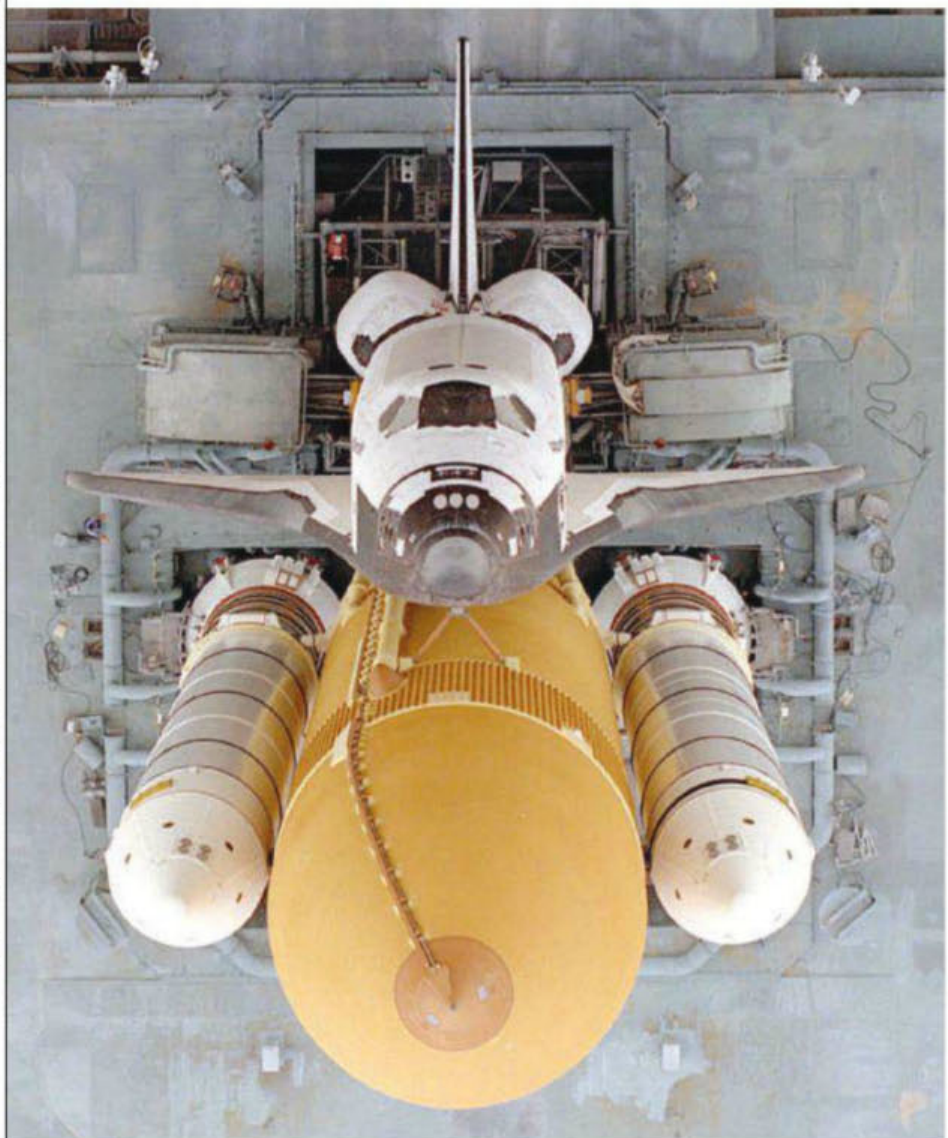
The initial SpaceX Dragon and Orbital Sciences Cygnus vehicles are targeted to make their first cargo deliveries before the end of this year. Depending on the final strategy NASA selects, three remaining Dragon test flights could be compressed, allowing the second to attempt the first U.S. commercial supply delivery to the station as early as September, says William Gerstenmaier, associate administrator for space operations, speaking on June 1 after the shuttle Endeavour made its final landing.

Atlantis will return with more than

nine tons of science samples and unneeded equipment that have no other means of retrieval. The high-priority downmass includes a failed station thermal control system ammonia coolant pump that engineers will examine to determine what led to a disruptive breakdown on July 31, 2010.

Chris Ferguson, a 49-year-old retired U.S. Navy captain and veteran of two previous shuttle flights, will command what his colleagues are calling the shuttle program's "Final Four." Doug Hurley, a 44-year-old U.S. Marine Corps colonel, will pilot his second mission. Sandra Magnus, a 46-year-old former space station crew member, and Rex Walheim, a 48-year-old two-time shuttle veteran and retired U.S. Air Force colonel, will serve as the mission specialists.

The Atlantis crew is the smallest since the STS-6 mission of 1983, a decision driven by the need for an improvised rescue strategy. Should



Orbiter Atlantis departs the Vehicle Assembly Building at Kennedy Space Center in 1996, headed for Launch Pad 39A for STS-79.

Atlantis encounter a problem that prevents a safe re-entry, NASA's rescue plan would rely on a series of Soyuz flights to retrieve the astronauts from their "safe haven" on the station. The four astronauts would return to Earth in a staggered fashion rather than as passengers aboard a single "launch-on-need" shuttle mission—the cornerstone of contingency planning since the Columbia loss.

NASA's station program pushed hard for STS-135 after Atlantis completed what was then its final scheduled mission in May 2010, delivering Russia's Rassvet research and docking module to the station. At STS-132's conclusion, Atlantis was reassigned to the "STS-335 Launch-On-Need" rescue role for Endeavour's final flight in May.

But with an external fuel tank and solid rocket boosters already procured, the agency persuaded lawmakers that an additional supply mission would help to ensure the success of the NASA-nurtured COTS and more recent Commercial Crew Development initiatives. Both strategies are intended to extend station operations through at least 2020, while facilitating the transition of NASA's human spaceflight focus to missions of deep-space exploration.

The supply-laden Raffaello module will be temporarily transferred from the shuttle's cargo bay to the station's Harmony module using robot arm operations on the day after Atlantis docks. Unlike previous shuttle supply missions, Raffaello will be hauling supplies packed in dozens of small bags rather than in large racks designed for wholesale transfer from the MPLM to the station.

Cargo moving in and out of Raffaello will occur simultaneously, under Magnus's supervision. Ferguson estimates the transfers will consume at least 140 crew hours and likely require help from the station's Russian crew members.

Unlike the already-retired Endeavour and Discovery, Atlantis is not equipped with the station-to-shuttle power transfer system that allows solar power generated by the orbital outpost to augment the shuttle fuel cells to easily extend the mission beyond 12 days.

"With a crew of four, that is probably the one thing that concerns me the most," says Ferguson of the success-oriented schedule.

Because of the small crew size, the mission's only scheduled spacewalk will be carried out by the station's two U.S. crew members, Mike Fossum and Ron



STS-135 SPACE SHUTTLE MISSION

MISSION: STS-135 International Space Station Utilization/Logistics Flight 7 (ULF 7), the 135th and final launch of the space shuttle program and the 37th to the ISS.

ORBITER: Atlantis (OV-104), making its 33rd and final flight. Atlantis last returned from orbit on May 26, 2010, after the STS-132 flight to deliver Russia's Rassvet Mini Research Module 1 to the space station.

LAUNCH: Targeted for 11:26 a.m. EDT July 8 from Kennedy Space Center Pad 39A. Atlantis is scheduled to return to KSC on July 20 after a nominal 12-day mission.

PAYLOAD: The Raffaello multi-purpose logistics module packed with supplies and hardware to help sustain the ISS after shuttle retirement. Also on board is the Robotic Refueling Mission, a simulated spacecraft built to test robotic satellite servicing with the Dextre multi-purpose dexterous manipulator.

CREW: Commander, U.S. Navy Capt. (ret.) Chris Ferguson (third flight); pilot, USMC Col. Doug Hurley (second flight); mission specialists Sandra Magnus (third flight) and USAF Col. (ret.) Rex Walheim (third flight).

Garan, on the day after Raffaello's relocation. The spacewalkers will move the bulky Ammonia Pump Module Assembly from an equipment stowage rack outside the station's Quest airlock to the orbiter's cargo bay.

The pump, responsible for circulating coolant through the station's thermal

control system loop A, failed suddenly. The unexplained breakdown prompted a rapid power down of nonessential equipment, including science experiments, that extended deep into August 2010 until two of the station's crew replaced the pump with an onboard spare during a series of spacewalks. Once back on Earth, the pump will undergo a failure analysis in order to improve future pump reliability.

Fossum and Garan will also haul the Robotic Refueling Mission (RRM) experiment from the payload bay to the Enhanced Orbital Replacement Unit Temporary Platform on Dextre, the station's Canadian-built two-armed robotic handyman.

The RRM was developed by NASA's Goddard Space Flight Center to demonstrate robotic satellite re-fueling techniques (see p. 62). Following the shuttle's departure, the RRM will be transferred by the station's robot arm and Dextre to Express Logistics Carrier 4 on the station's inboard starboard truss. Future refueling demos will be carried out by Dextre and the RRM while under ground control.

NASA's risk assessments place the odds of an issue leading to an Atlantis crew rescue at 1/500. However, if Atlantis is unable to descend, Walheim would make the first Soyuz return after three months. Ferguson would follow after six months, Magnus after nine months and Hurley after a year.

"I drew the long straw . . . or the short straw," says Hurley. With the exception of Magnus, who spent four-and-a-half months on the station in 2008-09, the Atlantis astronauts have much less than the normal three to five years of training in station operations and Soyuz procedures.

"There are a lot of astronauts currently in training that would love to take that deal," says Hurley.

Atlantis, the fourth of the five shuttle orbiters to roll off the Rockwell International production line in Palmdale, Calif., lifted off for the first time on Oct. 3, 1985, deploying a classified Defense Department payload over a four-day mission. The spacecraft was named for the primary research ship that sailed for the Woods Hole Oceanographic Institute between 1930 and 1966.

After its 33rd and final flight, Atlantis will be de-serviced and transferred to the Kennedy Space Center Visitor Complex near Titusville, Fla., for public display. ☐

Shrinking Corps

Astronaut ranks thin as future of human spaceflight is debated

MARK CARREAU/HOUSTON

Though unlikely to go the way of the American cowboy, NASA's astronaut corps—a modern symbol for boldness and noble national achievement—could be corralled in Earth orbit until prosperity returns.

Their path beyond the shuttle era stretches across a rugged political landscape clouded by a stale economy and dotted with warning signs of flat budgets ahead, or worse.

In the near term, the ranks are dwindling as NASA prepares to pay Russia to launch astronauts to the International Space Station (ISS) until a U.S. commercial crew transport is ready.

The long-term prospects for the astronaut corps are a focus of the National Research Council (NRC), which assembled the 14-member Human Spaceflight Crew Operations Panel to provide an independent assessment of NASA's astronaut needs and training requirements, including T-38 training jets and simulators.

The peer-reviewed report, mandated by Congress, is expected this fall—in time to shape the agency's 2013 budget.

"What skill sets do you need?" asked Joe Rothenberg, the NRC panel co-chair and a former NASA associate administrator, quizzing Johnson Space Center (JSC) executives during a site visit in January. "I assume we are not going to talk about going to Mars for at least 15 to 20 years. For the next 10 years, we will be doing low Earth orbit operations."

JSC Director Mike Coats urged the panel, which includes five former astronauts, to proceed cautiously. Deep-space exploration should be part of a national strategy for long-range economic growth, improved international relations and scientific achievement, he suggested.

Currently, NASA lists 61 astronauts as eligible for flight assignment. Trained as test pilots, scientists, engineers and medical doctors, they range in age from 35 to 56—averaging 47—and include 12 women. Attrition will drop the total to 51 within five years, even with some modest future recruiting, according to NASA estimates.

Astronaut staffing peaked at 139 in the early 2000s, when NASA was launching five or six shuttle missions annually and starting to staff the ISS full-time. That translated into flight opportunities for at least 30 astronauts annually and demanded training or technical assignments for most of the others. Senior astronauts often graduated to management posts.

The agency now counts 47 non-flight-eligible management fliers, among them Coats and Administrator Charles Bolden. Chief astronaut Peggy Whitson is a research biochemist whose ties to Russian space span two decades. Her 377 days in space, including a space station command, are the most for a woman. Another, Brent Jett, a four-flight shuttle veteran, was named deputy manager for NASA's commercial crew program earlier this year to help guide that critical transition.

As the launching of the final shuttle flight—STS-135—nears, NASA is in the congressional crosshairs over the agency's own replacement for the shuttle, the Multi-Purpose Crew Vehicle and the Space Launch System. Together, the four-person capsule and its propulsion source could vault explorers beyond



NASA/JOHNSON SPACE CENTER

NASA astronauts wear shuttle ascent and entry suits in a 2007 test of seating configurations for the Orion capsule.

Earth orbit—if policymakers can agree on destinations, timescales and budgets.

"The opportunities are still there," insists Rex Walheim, one of the four STS-135 crew. Walheim gazed into his crystal ball on June 22 while standing at the Kennedy Space Center's Launch Pad 39A, from which Apollo 11 hurtled toward the moon 42 years ago this month.

"It may take a few years," he said. "But to the young kids of today, it should be the blink of an eye. Look to the long term." ☛

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Robot Workout

Refueling demonstration on ISS to prepare for the real thing on a weather satellite

IRENE KLOTZ/KENNEDY SPACE CENTER

By demonstrating a robotic capability to refuel satellites not designed for on-orbit servicing, NASA hopes to use the final flight of the space shuttle to help launch a new industry in the U.S. intended to extend the operational lifetimes of geosynchronous spacecraft.

The Robotic Refueling Mission (RRM), a pilot project developed by the Goddard Space Flight Center team that designed hardware for the Hubble Space Telescope servicing missions, will be delivered to the International Space Station during the STS-135 mission on Atlantis (see p. 59). The payload consists of a box of tools and fittings and a tank of ethanol fuel that the station's Canadian-built Special Purpose Dexterous Manipulator (SPDM), also known as Dextre, can use to perform tasks needed to refuel a satellite. Those include cutting away thermal insulation and wires, removing protective caps, installing fuel valves and transferring fuel from one tank to another.

"I've likened it to a Fisher-Price play toy for a robot, and I don't mean that in a negative sense," says Atlantis Commander Chris Ferguson. "It's an opportunity for the SPDM to get in and use several different tools and prove the capability to do something extremely novel, and that is to refuel satellites on orbit that were never designed to be refueled."

NASA plans to follow the \$22.6 million two-year demonstration aboard the space station with an operational mission, conducted jointly with a competitively selected commercial partner; first to refuel a National Oceanic and Atmospheric Administration (NOAA) weather satellite, and later to service nine more commercial and government spacecraft in geosynchronous orbits.

"We want the commercial world to take over this service," says Benjamin Reed, deputy project manager for God-

dard's Satellite Servicing Capabilities Office. "Our partner will identify the nine other satellites, depending on how that company wants to make its investment back. We do the engineering part—the robotic arms, tools, the sensors to find the right spacecraft."

Negotiations are under way for servicing a NOAA satellite currently slated to be deorbited in May 2013. "We're going to ask them to hold off for another



Dextre grasps a white cargo transport container from its perch atop the Destiny laboratory module as Canadarm2 pulls the Alpha Magnetic Spectrometer from Endeavour's cargo bay during the STS-124 mission.

year or so until we can get up there [and] give them more fuel so it can continue its operations," Reed says.

NASA's solicitation for an industry partner is expected this summer, likely before the space station demonstration. The RRM hardware is a box measuring about one cubic meter, carried in the shuttle's payload bay on the Lightweight Multi-Purpose Equipment Support Structure Carrier.

The hardware will be transferred to the station's Enhanced Orbital Replacement Unit Temporary Platform during the mission's sole spacewalk, scheduled for the fifth day of the 12-day flight. After the shuttle's departure, the box will be moved by the station's Canadarm2 to a permanent location on the outboard, nadir side of Express Logistics Carrier 4.

The box holds four tools: the wire cut-

ter and blanket manipulation tool, which can be used to cut tape, thermal insulation blankets and wires to access a fuel cap that is identical to hardware used on existing satellites; two adapter tools to remove and capture safety caps and redundant fuel seal mechanisms; and the nozzle tool, which will connect a quick disconnect fitting to a sample fuel valve and open and close the valve. Boards with satellite components are mounted on one side and the top of the box.

Robotics engineers at the Johnson Space Center will operate Dextre during the experiment, with oversight from Goddard, and commanding of the RRM pumps from the Marshall Space Flight Center.

In addition to refueling, RRM includes other legacy satellite interfaces to demonstrate tasks for minor repair of satellites and to test machine-vision algorithms. The technology draws from the 1997 Darpa (Defense Advanced Research Projects Agency) Orbital Express mission, which demonstrated autonomous satellite servicing in orbit. That target spacecraft, however, was designed for servicing, unlike the non-cooperative operational satellites that could be customers for orbital refueling and servicing under the NASA-developed system.

"We plan to be going up to satellites that have no navigation aids, no transponders, no retroreflectors. No one has ever done this before with non-cooperative satellites," says Reed.

Since the same technology also could be used to disable satellites, Reed says NASA intends to be as open as possible about the project.

"We plan an international workshop next spring where we will lay out in more detail what our plans are to make the world aware of what we are doing so that we can minimize the anti-satellite weapon accusers," he says.

The use of Dextre in the demonstration may also help Canada's MacDonald Detwiler and Associates, which has signed a \$280 million deal with Intelsat to provide refueling and other services to the commercial satellite operator's spacecraft (AW&ST March 21, p. 23). The Canadian company built Dextre, as well as the station's Canadarm2 robotic boom. ☛

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July 21-22—Practical Aeronautics Short Courses: "Introduction to Jet Engines—A Practical Perspective." Ohio Aerospace Institute, Cleveland. Also, **Sept. 12-15**—"Introduction to Aeronautics: A Practical Perspective." National Institute of Aerospace, Hampton, Va. Call +1 (970) 887-3155 or see www.practicalaero.com

July 23-24—Thunder Over Michigan Air Show. Willow Run Airport, Ypsilanti. See www.yankeeairmuseum.org/airshow

July 25-31—Experimental Aviation Association's Airventure Oshkosh (Wis.). Wittman Regional Airport. Call +1 (920) 426-4800 or see www.airventure.org

July 26-27—American Association of Airline Executives' Seventh Annual Aviation Air Quality Conference. Embassy Suites Portland (Ore.) Downtown. Also, **July 31-**

Aug. 2—Northeast Chapter Winter Operations and Deicing Conference and Exhibition. Renaissance Hotel, Seattle. See www.aaae.org

July 31-Aug. 4—American Astronautical Society/American Institute for Aeronautics and Astronautics' Astrodynamics Specialist Conference. Alyeska Resort, Girdwood, Alaska. Call +1 (703) 866-0020, fax +1 (703) 866-3526 or see www.astronautical.org

Aug. 1-5—Military Aviation Museum's Warbirds and Wings Aviation Summer Camp. Virginia Beach, Va. Call +1 (757) 721-7767 or see www.militaryaviationmuseum.org

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How To Measure NATO Efficiency



John Dowdy leads McKinsey & Co.'s global aerospace and defense practice.

In one of his last policy speeches as U.S. defense secretary, Robert Gates railed against NATO members' unwillingness to pay their fair shares of the costs of the transatlantic security alliance. Importantly, his remarks went beyond the usual admonition to Europe to come up with more money, zeroing in for the first time on how NATO actually spends its limited defense resources.

This is a crucial distinction. U.S. taxpayers, facing deep budget cuts at home, are understandably frustrated that their country's contribution to NATO's defense spending now exceeds 75% of the total and that they shoulder so much more of the burden than their rich European counterparts. U.S. taxpayers are entitled to ask why just four of their 28 allies—the U.K., France, Greece and Albania—devote the agreed 2% of their GDP to defense, and why others fail to honor that commitment.

“Many members maintain large, static forces ill-equipped for expeditionary warfare, and obsolete and top-heavy command structures.”

In the current economic and political climate in Europe, however, this situation is unlikely to change quickly, and Gates seems to acknowledge it. By focusing on *how* the allies spend their money as well as *how much*—a refrain echoed by NATO Secretary General Anders Fogh Rasmussen—he is aiming at the right target.

McKinsey's benchmarking of 33 defense forces around the world, the only international comparative analysis of its kind, has shown how NATO has collectively failed to spend its scarce defense dollars optimally (at least not if the goal is to maximize military output). The study highlights an organization whose members largely retain large, static forces ill-equipped for expeditionary warfare, and maintain obsolete and top-heavy command structures and outdated formations.

The Gates speech underlined how both the international mission in Afghanistan and the latest in Libya have exposed these shortcomings. With more than 2 million troops in uniform, NATO has struggled to sustain a deployment of 25,000-40,000 troops on the ground in Afghanistan (while the U.S., with

1.5 million troops, has sustained a deployed force of more than 100,000 since the surge). Worse still, only 11 weeks into an operation against a poorly armed Libyan regime in a sparsely populated country on Europe's doorstep, many allies are running short of munitions, relying yet again on the U.S. for resupply.

How can the non-U.S. members of NATO, who collectively spend more than \$300 billion on defense, allocate their resources so as to buy more military capability than they do today?

As our benchmarking study shows, the ratio between personnel and equipment budgets in these countries is particularly inverted. The U.S. spends three times as much on equipping its forces as NATO and a greater proportion of its budget on equipment than any other NATO member. Given the fact that the U.S. has a smaller force in aggregate than the rest of the alliance, this means each American service member is better equipped than his/her NATO counterpart for the rigors of modern warfare by a ratio of almost 5:1.

Encouragingly, some forces are managing to punch above their weight. Gates points to the Norwegian and Danish air forces, which have provided 12% of allied strike aircraft yet have struck about one-third of the targets. Belgium and Canada also receive honorable mentions for finding ways to make credible military contributions within their constrained resources.

It is time for NATO to move beyond measuring inputs, and start measuring how efficiently and effectively they are translated into outputs. NATO should be studying benchmarks, for example, not just on defense spending as a percent of GDP, but on measures such as the tooth-to-tail ratio (the proportion of uniformed personnel in combat and combat support roles), the proportion of the combat force that is deployable, and the efficiency and effectiveness of spending on equipment procurement and sustainment.

In this regard, the U.S. could also stand to follow Gates's advice. Our benchmarks suggest that the Defense Department could improve its own performance against some of these metrics.

The new multilateralism signaled by the war in Libya means the U.S. will increasingly look to Europeans to lead on issues in and around Europe. The two-tiered alliance is therefore no longer a hypothetical worry, it is an unacceptable reality. Gates's comments come not in the spirit of megaphone diplomacy, of which he has been accused in the past, but as blunt talk among true friends. Without more bang for the buck, Gates tells us, NATO risks the very real prospect of collective military irrelevance. ☪



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