January 2014

AEROSPACE AMERICA

UNMANNED UNRESTRICTED

Why opening the airspace to strange, new craft will be harder than it sounds page 28

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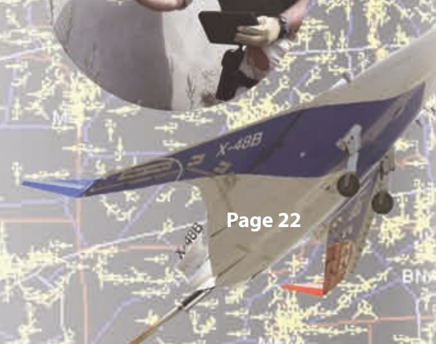
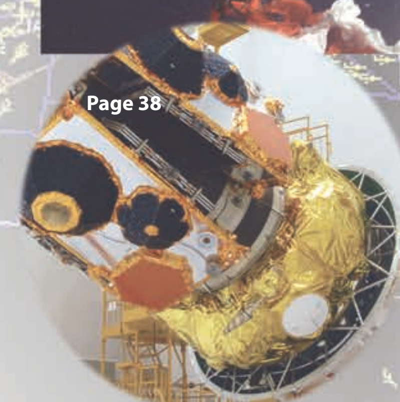
January 2014





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Amazon.com's rotorcraft. Story page 28. Credit: Amazon.com

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AIAA
The World's Forum for Aerospace Leadership

Editor's Notebook

Why government matters

For the aerospace community, this is the era of Bezos, Bigelow, Branson and Musk. A December speech by former FAA chief Marion Blakey was a good reminder that even the most talented entrepreneurs will need civil servants and political appointees to set the conditions for success.

Blakey, CEO of the Aerospace Industries Association, bemoaned the "awful disparagement" of government workers in recent years "by politicians who ironically are trying to win elections by maligning the same government they aspire to lead."

She spoke after receiving the 2013 Wright Brothers Memorial Trophy in downtown Washington, D.C. Blakey delivered her message in her calm, Alabama manner, and with a bit of humor. She noted that she started her government career as a clerk who couldn't type, and that her "old boss," Ronald Reagan, liked to say that Moses "was 80 when God commissioned him to public service."

Blakey's comments about our views of government struck a chord with me and I think the audience too. In fact, in the pages of this issue, there are examples of why we need enthusiastic, skilled civil servants and political appointees. The knowledge and ingenuity of FAA staff will be essential to getting Amazon.com founder Jeffrey Bezos' rotorcraft delivering packages safely through the public airspace. Wise decisions by NASA and the National Oceanic and Atmospheric Administration will be required to plug a potential gap in U.S. weather satellite coverage.

Blakey's words landed just as the U.S. appears to be at an inflection point when it comes to perceptions of government. The bludgeon of government criticism shrank almost daily during last fall's government shutdown. Congressional leaders are now taking steps to ease sequestration, and each side has softened its rhetoric on budget issues.

It's hard to know if this shift in tone and deed will be long lasting. If it is, Blakey's words could figuratively amount to placing a period at the end of a troubled era. Her contention that critics have gone too far carries unusual weight, coming from someone who is fond of quoting Ronald Reagan, and who was nominated to be FAA director by President George W. Bush.

A related issue raised by Blakey could be harder to solve than reining in anti-government rhetoric. Riffing off a 1910 speech by Theodore Roosevelt—given in France after he left the presidency—Blakey described Roosevelt's rough-and-tumble government arena as becoming more like a "gated community with ever-rising walls."

She said today's vetting process for political appointees treats "experience gained in a profit-making enterprise" with automatic "suspicion" and that this is deterring talented people from public service.

If one side's blanket criticism of government goes too far, she seemed to say, so does the other side's tarring of successful business people because of the "misbehavior" of a few.

Blakey's speech reminded me that there's another way our government is like a gated community. In the years since the Sept. 11 terror attacks, a parallel economy has been constructed for workers with security clearances, including those in the defense aerospace sector. It takes so long for a company or agency to clear a worker that many job postings require clearances from the start. This, too, discourages talented people from transitioning to government work.

With luck, Blakey will have sparked a conversation on this issue as well.

Ben Iannotta
Editor-in-Chief

Something old, something (not so) new

I read "Composite tanks promise major savings" (November, p. 12) with great personal interest. When I was at Rockwell, we proposed on the X-33 program. As part of this proposal activity, we fabricated a fiber-wrapped liquid hydrogen composite test tank that was eight feet in diameter. That test article was shipped to Marshall Space Flight Center and tested under flight conditions with liquid hydrogen. It passed those tests without a problem. The tank was wrapped on a removable mandrel, just like the current concept. I'm surprised that the current development program is presented as a "new" technology—and we did it back in 1996!

Refinements: yes, but new: no.

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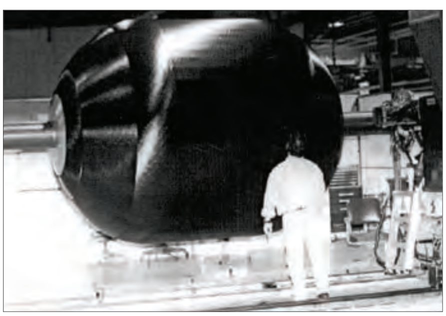
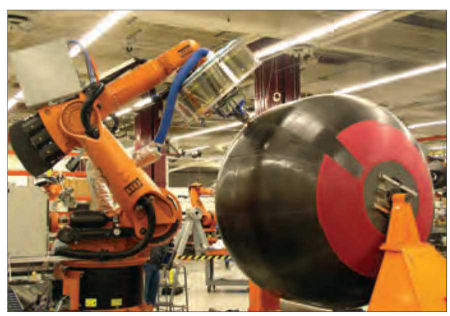


A Rockwell test article, circa 1996.



Boeing's composite pressure vessel, 2012.

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Events Calendar

JAN. 13-17

AIAA Science and Technology Forum and Exposition.
AIAA Guidance, Navigation, and Control Conference.
AIAA Modeling and Simulation Technologies Conference.
Tenth AIAA Multidisciplinary Design Optimization Specialist Conference.
Sixteenth AIAA Non-Deterministic Approaches Conference.
Fifty-fifth AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference.
Twenty-second AIAA/ASME/AHS Adaptive Structures Conference.
Seventh Symposium on Space Resource Utilization.
Thirty-second ASME Wind Energy Symposium.
Fifty-second AIAA Aerospace Sciences Meeting.
AIAA Atmospheric Flight Mechanics Conference.
AIAA Spacecraft Structures Conference (formerly the AIAA Gossamer Systems Conference Forum).
National Harbor, Md.
Contact: 703/264-7500

JAN. 26-30

Twenty-fourth AAS/AIAA Space Flight Mechanics Meeting. Santa Fe, N.M.
Contact: http://www.space-flight.org/docs/2014_winter/2014_winter.html

JAN. 27-30

Annual Reliability and Maintainability Symposium, Colorado Springs, Colo.
Contact: Jan Swider, 818/586-1412; jan.swider@pwr.utc.com

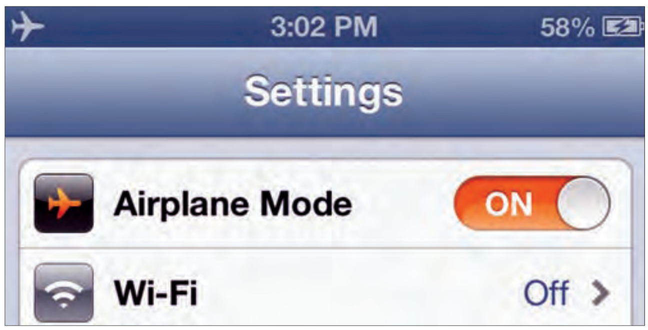
FEB. 2-6

American Meteorological Society Annual Meeting, Atlanta, Ga.
Contact: Claudia Gorski, 617.226.3967; cgorski@ametsoc.org, http://annual.ametsoc.org/2014/

MARCH 1-8

IEEE Aerospace Conference, Big Sky, Mont.
Contact: Erik Nilsen, 818.354.4441; erik.n.nilsen@jpl.nasa.gov; www.aeroconf.org

Next step in electronic freedom on planes



The FAA's October 2013 decision allows personal electronic devices to operate in Airplane Mode during all phases of flight. Credit: Apple.

Regulators might need to address two lingering safety concerns as they weigh whether to permit airlines to allow passengers to talk on their phones as a next step toward passenger electronic freedom. One question is the safety of the electronics in the small handheld devices. Another is the possibility that passengers engaged in voice calls could lead to disruptions aboard planes.

Although interference with onboard electronics hasn't proved to be a major problem, there have been at least 13 recent incidents in which devices have overheated or malfunctioned in some way, many causing smoke, fire or fumes in the cabin, suggests a July 2013 study that looked at incidents recorded in NASA's Aviation Safety Reporting System. Also reported were 10 incidents in which passengers did not comply with requests to turn off their devices, resulting in cases of air rage.

That said, air regulators continue to clear the way for personal devices, and they suggest that new freedoms could be on the way. In November, the European Aviation Safety Agency, EASA, followed the lead of the FAA by permitting airlines to let passengers use smartphones, e-readers, mp3 players or other personal electronic devices in all phases of flight, provided the devices are kept in their flight or airplane modes, which prevents them from attempting to connect to cellular networks.

"This is a major step in the process of expanding the freedom to use personal electronic devices onboard aircraft without compromise in safety," says Patrick Ky, EASA's executive director, in a press release.

In the same press release, EASA says that "in the long term" it is looking at ways to certify mobile phones so that passengers can make calls on flights.

Eleven countries currently allow passengers to make mobile phone calls through onboard cellular base stations during flights. Since 2007, airlines in Africa, Asia, Australia, the Middle East and South America have introduced such services, according to a report compiled at the end of 2013 by the Australian Mobile Telecommunications Association. Such calls are already allowed on more than 30 airlines, "including AirAsia, Air France, British Airways, Egypt Air, Emirates, Air New Zealand, Malaysia Airlines, Ryanair, Qatar Airways and Virgin Atlantic," the report notes.

Studies conducted by safety regulators around the world suggest that airlines equipped with base stations have not experienced any major safety issues.

"The civil aviation authorities who have approved the installation of onboard cellular telephone base stations on aircraft reported that the aircraft with these installations undergo extensive analysis, functional tests, ground tests and flight tests to demonstrate that the cell phones and base stations do not interfere with aircraft systems," according to an FAA report from July 2012, "Study on the Use of Cell Phones on Passenger Aircraft."

These authorities "reported no confirmed occurrences of cell phones affecting flight safety on aircraft with on-board cellular telephone base stations...None of the civil aviation authorities reported any cases of air rage or flight attendant interference related to passengers using cell phones on aircraft," said the study.

Much of the research has concentrated on whether personal electronic devices on airlines pose safety threats, especially from the possibility of low-powered mobiles interfering with aircraft systems such as antenna receivers. The RTCA (formerly the Radio Technical Commission for Aeronautics) lists eight areas where a plane's antenna receiver system could experience interference from such a device but concluded that the probability this would occur "is very low."

Transforming Typhoon

The Royal Air Force is preparing to improve the ground attack performance of its Eurofighter Typhoons by the end of 2014. The plan would enable the plane's pilots to drop precision-guided weapons, including the Raytheon GBU-16 Paveway 4 laser-guided bomb. The upgrades also will be integrated with the Litening 3 targeting pod and the AIM-132 advanced short range air-to-air missile, allowing pilots to engage ground and air targets simultaneously.

The project, called Phase One Enhancement, or P1E, would also improve the aircraft's MIDS—multifunctional information distribution system—data-link, radios and direct voice input functions.

P1E will be standard in all Typhoons starting with Tranche 3 — the third batch of those on order—whose delivery is due to begin later this year. The four Eurofighter partner nations—the U.K., Germany, Italy and Spain—plus Oman and Saudi Arabia have together ordered 172 Tranche 3 aircraft.

The upgrade package includes an

active electronic scanned array radar that would provide higher levels of multi-target tracking and better weapons integration than the current mechanically operated system.

"Conformal fuel tanks will also increase the fuel load of Typhoon, which means extra range," said a spokesman for BAE Systems, the company undertaking much of the test and validation work. "The tanks also free up positions under the aircraft for larger or additional stores, where under-wing fuel tanks would previously have been carried. In case an emergency return to base is needed, or the pilot has a mission requirement, the Tranche 3 Typhoon will have a fuel dump [that] allows the aircraft to make rapid fuel reductions, as opposed to needing to jettison stores."

Major upgrades aim to enhance Typhoon's ground attack performance. Credit: BAE Systems.

Other improvements include new avionics to allow for increases in computing power; a high-speed data network system to offer high-bandwidth data transfer—enabling the plane to carry weapons and stores that need high data bandwidth for video; and provision for fiber optic cabling, which may be needed for future weapons.

P1E is just one of several programs aimed at enhancing the plane's export potential. In October the Evolution Package 2 contract was signed by Eurofighter and NETMA, the NATO Eurofighter and Tornado Management Agency. The agreement calls for enhancing the major avionics sensor, including the radar, as well as the defensive aids subsystems and MIDS.

The Evolution Package 2 also includes upgrading the flight control and utility control systems. This would allow the plane to operate in a commercial airspace environment supported by the Single European Sky and FAA Next-Generation air traffic management systems. The upgrade is due to be delivered by the end of 2015 and will be retrofitted to Tranche 2 and 3 Typhoons.

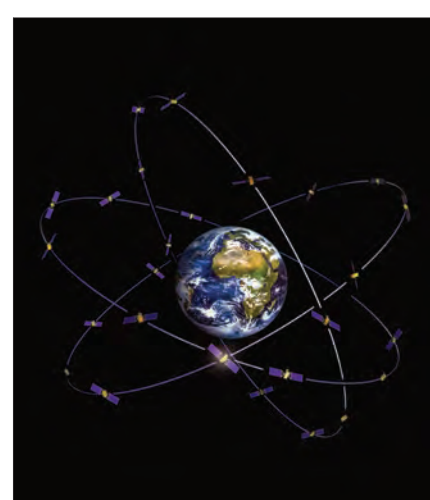
Adding to the plane's strike effectiveness will the Storm Shadow cruise missile, offering a range of more than 250 kilometers. The missile, built by MBDA, will become available in 2015.

Meanwhile, a June 2013 agreement between Eurofighter and MBDA seeks to increase the aircraft's air-to-air combat performance as well. The contract calls for integrating MBDA's Meteor advanced BVRAAM—beyond visual range air-to-air missile—on the Typhoon. The Meteor program is a significant step forward in European defense cooperation, as it combines in a single program the requirements of six countries—the U.K., Germany, France, Italy, Sweden and-Spain.

Galileo's tight schedule

The first few months of 2014 will be a critical time for Europe's Galileo constellation. In November the European Parliament approved €7 billion ($9.45 billion) to complete development of Galileo and the European Geostationary Navigation Overlay Service. Under the current schedule, both systems should be fully operational worldwide by 2020. But the launch of the next two Galileo satellites has been delayed from December 2013 to the middle of the year, complicating the service's rollout schedule.

When the Galileo project was launched in 2002 by the European Commission, the implementation was scheduled for 2019, with costs estimated at €3



Four prototype Galileo satellites in orbit for a validation phase. Credit: European Space Agency.

billion. As late as summer 2013, the commission program managers hoped that at least 14 Galileo satellites out of a constellation of 30 would be in position by the end of 2014. This would allow for a first-stage introduction of positioning, navigation and timing services throughout the world by 2020. But that schedule assumed a launch of the first two FOC, or full operational capability, satellites before the end of 2013. This has now been delayed until the middle of 2014, according to Sara Tironi of the European Commission's Industry and Entrepreneurship office.

The European Space Agency is currently carrying out final testing and validation work on the two FOC units, including vacuum testing at the European Space Research and Technology Centre in Noordwijk, Netherlands. The performance of these two satellites will determine when and whether the full constellation can meet its original operating targets. "Once this has happened, the other FOC satellites will enter production and will be launched every few months," says Giorgia Muirhead of the European Centre for Space Applications and Telecommunications.

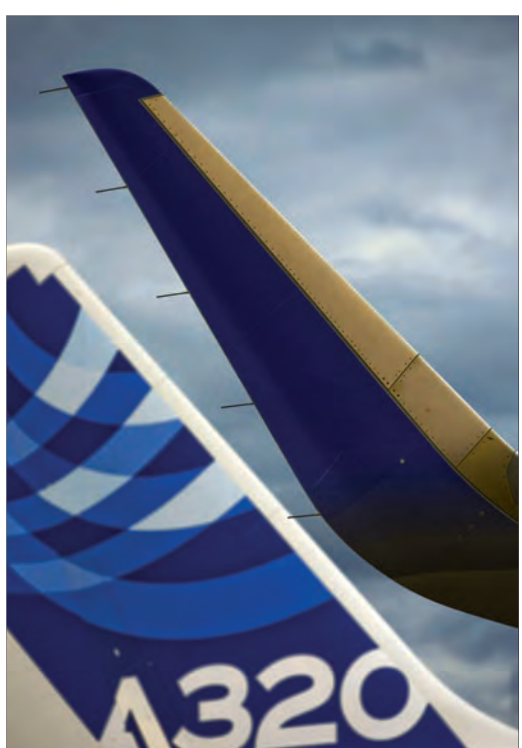
Galileo is a European Commission program, but the European GNSS (formerly Global Navigation Satellite Service) Agency will gradually assume responsibility for the operational management while ESA directs the deployment, design and development of new generations.

The original launch program scheduled the deployment of 14 to 18 FOC satellites over 12 months. Further complicating that plan, however, is a growing log-jam at the Arianespace Kourou Space Center in French Guiana. The Galileo satellites are launched from the center on a medium-lift "Europeanized" version of the Soyuz rocket, which must now compete for launch positions with the heavy-lift Ariane 5 and the new light-payload Vega.

Four prototype Galileo satellites, comprising the in-orbit validation phase of the program, are already in place. The first determination of a ground location using these satellites took place in March 2013 with an accuracy between 10 and 15 meters. But until at least four FOC satellites have been deployed, it will be impossible to determine whether the constellation can meet its full design goals. In September 2013, European governments began to independently evaluate how Galileo's encrypted Public Regulated Service might be implemented for homeland security, emergency management and other government agency roles. A month earlier, QinetiQ and Rockwell Collins demonstrated the first joint satellite navigation positioning using live encrypted signals from the U.S. Department of Defense GPS Precise Positioning Service and Galileo's Public Regulated Service.

Europe to test its wings

A consortium of 61 European aerospace companies and research institutions is on track to start wind tunnel tests in 2015 on a new type of airliner wing, the group reports. The tests would take place at TsAGI, the Central Aerohydrodynamic Institute, near Moscow under the Smart Intelligent Aircraft Structures program, SARISTU.



Airbus began retrofitting its A320 aircraft family with sharklet wingtip devices in late October. Credit: Airbus.

The new wing design will incorporate morphing components on the leading edge, trailing edge and winglet trailing edge. The 51-million-euro SARISTU research program, funded in part by the European Commission and led by Airbus, aims to develop technologies and concepts for reducing the fuel consumption of future airliners by up to 6% over current models.

A major component of the program is the development of a wingtip active trailing-edge design that would reduce the load that large winglets impose on the main wing structure. This load jeopardizes the performance benefit that winglets offer, namely reduced drag.

The design and deployment of fuel-saving winglets is an area where Europe has lagged behind its competitors in the U.S. The first airliner to fly with winglets was a Boeing 747-400, in 1988; the first winglet-equipped 737-300 flew in 2002. It was not until November 2011 that an Airbus A320 test aircraft, fitted with a very similar version, took to the skies.

At the end of October 2013, Airbus launched its "sharklet" retrofit program, giving operators of the Airbus A320 family of aircraft a fuel cost reduction of up to 4 percent by fitting the planes with 2.5-meter-tall winglets. But this was several months after Boeing had announced its split scimitar design enhancement to the conventional winglet, a change estimated to improve fuel performance by a further 1.5%. A Boeing 737 retrofitted with the new design made its first flight in July 2013.

According to Airbus sources, there are no current plans to introduce any refinement to the sharklet. Instead, long-term research efforts are under way within the SARISTU program to improve fuel performance by integrating morphing structures throughout the span of the wing, including the winglets. Following a research agreement announced at the Paris Air Show in July 2013, the German Aerospace Center and Dassault Aviation are also working together on researching the laminar-to-turbulent flow transition around winglets.

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President, National Academy of Engineering
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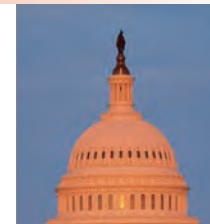

FAA stall rule sparks questions

A new FAA mandate requiring airline pilots to experience stall scenarios in flight simulators is raising questions about whether today's simulators are ready for the task or whether more training should be done in small jets and aerobatic planes.

The new simulator mandate is among the new regulations implemented in November to help pilots more effectively prevent or recover from stalls or other loss of control situations, called upsets. The rules were required by the Airline Safety and FAA Extension Act of 2010, pushed by Rep. James Oberstar, D-Minn., following the 2009 Colgan Air turbprop crash outside Buffalo. The crash killed all 49 people on the plane and one person on the ground. Investigators concluded that the pilot pulled back hard on the plane's control column and against the plane's stick pusher, a mechanical device that automatically moves the column to adjust the angle of the wings and avoid aerodynamic stall.

Aviation safety experts say there is a lively debate in the airline industry over whether the simulator training specified in the rules will be enough to improve pilot performance in stalls or other upsets. "As far as pilots are concerned, and as far as some airlines are concerned, they don't necessarily agree, so they will find ways to provide flight training in an actual airplane," says aviation safety expert Hans Weber, president of Tecop International, an aviation consulting firm based in San Diego. Aerobatic planes including the Extra 300L or retired fighter jets are sometimes used as surrogates for airliners.

There are some scenarios, including stalls, that even today's advanced Level D simulators cannot mimic realistically enough, says Paul Ransbury, an instructor pilot and president of Aviation Performance Solutions, a Mesa, Ariz., company that specializes in upset prevention and recovery training. He says the fidelity and flight envelopes of the simulators need to be enhanced.

Recover or die: *The cockpit display of an A-4 training jet shows its wings nearly perpendicular to the ground after a severe stall. Credit: Aviation Performance Solutions.*

One commercial pilot tells Aerospace America that his airline has ordered increased emphasis on stall training in simulators in accordance with the new mandate. "We're actually required—either during our six-month or annual training—to put the simulator into a stall and feel the stick shaker"—a vibration in the control column that warns of impending stall—"and feel the stick pusher," the pilot says. "Now it's like, 'All right, I want you to stall the airplane.'"

There are limits to what can be done in simulator training, this pilot adds. Instructors avoid having pilots continue to fly a simulator once it has entered a stall, because an actual plane reacts differently, and pilots could pick up bad habits. "It's very difficult to model," the pilot says.

On top of that, there are the psychological dimensions of loss of control. Ransbury and other experts want to get at that problem through more training in actual aircraft. While simulators can ingrain the correct processes into a pilot, a simulator will never fully replicate fear. Regulators "are going to miss that crucial element until the industry requires additional upset training in a real aircraft," Ransbury says.

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NASA builds case for low-sonic-boom demonstrator

Government-industry studies over the past few years have convinced NASA of the feasibility of transporting people in supersonic planes without the explosive-sounding sonic booms that kept Concorde from flying supersonically over land. Now, some in the agency want to build a demonstration aircraft to prove the boom-dampening technology.

Boeing says its supersonic transport concept met or exceeded low sonic boom goals in wind tunnel tests. Credit: Boeing.

Lockheed Martin's concept is designed to reduce boom noise so it can fly over land. Credit: NASA/Lockheed Martin.

NASA aeronautics experts are looking at what a Low Boom Flight Demonstrator would cost. They said they expect to have an answer by May and then present a proposal to NASA leaders and the White House Office of Management and Budget in hopes of getting a go-ahead. If funded, preliminary design work for the piloted jet could begin in fiscal year 2016, and flight testing could start in FY 2021. If all goes as advocates hope, a supersonic airliner carrying 75 to 100 passengers could be ready to enter service in 2025.

NASA has concluded that contractors could develop a supersonic aircraft that produces a sonic boom noise level of 70 to 75 decibels, which is comparable to a car door down the street being closed and "doesn't bother people," says NASA's Peter Coen, who oversees supersonic research for the agency at Langley Research Center in Virginia. But NASA first needs to collect data with an actual plane to have a chance of winning over the FAA, which since 1973 has prohibited supersonic civil aircraft from flying over land. That regulation greatly limited the potential market of the now-retired Concorde supersonic airliner.

Advocates say the demonstrator could help get the overland prohibition taken off the books. "If we can get the [regulation] changed, I think it will have a significant impact on the airline transportation system," says Tom Jones, deputy manager for high-speed projects at NASA Dryden Flight Research Center in California.

The demonstrator would have roughly the same wingspan as an F-16 or F/A-18 fighter but would be considerably longer. Boeing and Lockheed Martin have already conducted concept studies for NASA to help lay groundwork for a potential demonstrator. Both companies came up with sleeker-looking versions of the Concorde. Lockheed Martin's design has two engines below the wing and one engine atop the fuselage, while Boeing's two engines are atop the wing. Small models of both concepts underwent wind tunnel tests and met or exceeded goals for boom performance, as well as takeoff and landing noise and fuel efficiency.

"It's pretty exciting," Coen says," to see all those pieces come together and to have something new-looking in terms of supersonic aircraft design out there."

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Contractors: Let us plug weather gap

Key U.S. contractors say they are ready to produce a scaled-down polar-orbiting weather satellite, one carrying just enough sensors to sustain the accuracy of long-range weather forecasts, as recommended by a team of non-government experts to prevent a gap in American weather satellite coverage. NOAA would need to approve the plan, and Congress and the Obama administration would need to figure out how to pay for it.

Time is running short. The National Oceanic and Atmospheric Administration's existing polar orbiters will be beyond their design lives when the first Joint Polar Satellite System spacecraft, called JPSS-1, reaches orbit in 2017. In November, a review team chartered by NOAA warned of an "unacceptably high probability" of a gap between the old and new satellites and that it would have "catastrophic national consequences" by degrading forecasts for hurricanes, tornadoes and snowstorms. The panel, led by former NASA Goddard Director A. Thomas Young, said NOAA should act fast to get critical atmospheric sensors into polar orbit aboard a new gap-filler spacecraft.

Scott Asbury, Ball Aerospace's senior JPSS program manager, tells Aerospace America that his company should be able to deliver the gap-filler satellite frame, called a bus, "in approximately two years'" time. "The delivery of the sensors is the key factor" in determining the launch timetable, he says.

continued on page 13

For unmanned craft specialists, budget cuts spell creativity

Aerospace companies are increasingly seeking new areas to fuel revenue growth for unmanned aircraft systems, as the Pentagon makes sweeping cutbacks to new production programs.

After exploding from a total of roughly $750 million in fiscal 2004 to a peak of $3.3 billion in fiscal 2011, U.S. defense procurement of unmanned systems has been on the decline. The figure fell to $1.3 billion in the Defense Department's fiscal 2014 budget request, reflecting reduced overseas deployments and funding cutbacks.

To survive the downturn, some companies have identified specific unmanned aircraft niches, such as low-cost high-altitude, long-endurance aircraft and cargo craft, where they believe there could be emerging markets. International sales are of increasing interest for keeping production lines open, and even for selling products not yet purchased by the Pentagon. Services including maintenance and training are sparking hard-fought battles between prime contractors and smaller companies. Interest is growing in civil markets such as law enforcement and agriculture as the time approaches for the FAA to begin opening U.S. airspace to unmanned systems.

Squeeze on big companies

The major companies are under pressure. Versions of the Global Hawk, Northrop Grumman's premier unmanned program, remain a target. The Air Force repeated its proposed cancellation of the Block 30 version of the RQ-4 Global Hawk in the fiscal 2014 budget proposal. The MQ-4 Triton, the Navy variant of the Global Hawk, had its first production delayed from 2014 to 2015 because of design issues and problems with the software for maritime sensors. That move cut $425 million in production funding, while adding $200 million to research and development.

The proposed 2014 defense budget trimmed procurement of Northrop's MQ-8 Fire Scout from six systems to one, while the Navy makes the transition from the B to the C model.

For General Atomics Aeronautical Systems, procurement of the MQ-9 Reaper has fallen dramatically, from 48 in 2012 to just 12 in the Pentagon's 2014 request.

For AeroVironment, the latest blow came when the Army's 2014 budget request eliminated all funding for new RQ-7 Raven procurement.

The cutbacks are already showing in company results. Although few of the firms break out unmanned system revenues, those that do are showing deep declines. Textron's AAI company reports that its unmanned systems sales were down 10 percent in 2011, with a further 1 percent drop in 2012. AeroVironment's unmanned systems revenue fell from $274 million in fiscal 2012 to $194 million in 2013, a decline of almost 30 percent; the company's gross margin fell from $116 million in 2012 to $79 million in 2013, a 32 percent drop.

Growth niches

U.S. contractors are investing in specific growth niches such as HALE, or high-altitude, long-endurance, systems. With the high costs of existing HALE aircraft, contractors see the potential to penetrate what has been one of the largest segments of the unmanned aircraft market. Teal Group estimates that HALE systems will represent 20 percent of the overall unmanned market for the decade from 2013 to 2022.

Boeing has been particularly interested in penetrating the market with its hydrogen-powered Phantom Eye. The concept for this aircraft is that longer endurance means fewer vehicles would be needed. They would be able to spend less time going to and from the target area, and they would carry less fuel.

Boeing has invested heavily in this potentially lucrative market. In June, the company won a $6.8-million contract from the Missile Defense Agency, the first payload customer for the aircraft. Boeing will incorporate an unspecified payload in the Phantom Eye for testing.

AeroVironment is also interested in hydrogen-powered systems, but the crash of its Global Observer demonstrator in April 2011 has slowed this development effort.

Similarly, Lockheed is very active in cargo unmanned systems, both with the K-Max and advanced systems.

The lure of foreign markets

With U.S. procurement dwindling, contractors increasingly are looking overseas for potential markets. Typically U.S. contractors make less than 10 percent of their unmanned systems sales overseas, but the figure promises to rise drastically in coming years. This increased interest by U.S. companies comes at a time when foreign militaries are planning to catch up with the U.S. in integrating these craft into their forces. They have seen the impact of unmanned systems in Iraq and Afghanistan.

Despite Germany's cancellation of its Euro Hawk program, Northrop Grumman is forging ahead with other possible sales of its Global Hawk. The company has sold five Block 40 versions of the plane to NATO. Japan, which is interested in buying four aircraft, has included money for them in its five-year plan. South Korea, which has requested information about a possible Global Hawk purchase from the U.S. government, is awaiting a detailed response. Australia and Norway have expressed interest in the Navy version of Global Hawk, the Triton.

General Atomics Aeronautical Systems has scored several major sales in its drive to boost exports. The French Ministry of Defense announced plans in June to buy 12 Reaper versions of the Predator from the U.S. at a cost of $874 million. Based on interoperability with U.S. and other European forces, the French purchase strengthens the Predator in a number of upcoming competitions in Germany, the Netherlands,

The MQ-4 Triton is the Navy's version of the Global Hawk. Credit: Northrop Grumman.

Poland and other European nations.

Another important step for General Atomics was the United Arab Emirates' $197-million purchase of the Predator XP, an export version of the Predator A, in February 2013. Because the plane has been modified so that no hard points can be installed, it cannot be weaponized. The UAE's acceptance of this modified version may ease concerns about other Mideast allies such as Saudi Arabia, whose efforts to purchase the weapon-capable Reaper version have gotten a cool reception from the U.S. government.

AAI, manufacturer of the RQ-7 Shadow, is seeking to sell a new version of the Shadow overseas. The Shadow M2, developed using company research and development money, has longer wings and a redesigned fuselage that can carry two separate payloads instead of a single electro-optical-infrared turret. AAI has demonstrated the system for Saudi Arabia, which the company sees as a possible first customer.

Services for stability

Services have emerged as a major focus area because of the market's potential size and its relative stability compared to that of building new systems. The growth of the installed base of unmanned systems means more must be spent to support the systems. Because the revenues from providing support are several times greater than those for manufacturing, companies see strong prospects in offering everything from maintenance to training for unmanned systems.

Battlespace Flight Services won a November 2012 competition valued at up to $950 million for worldwide MQ-9 Reaper and MQ-1 Predator maintenance support through March 2014. In winning the contract, Battlespace competed against AAI, which is seeking to broaden its own footprint in the unmanned aircraft support market.

Training is another important services area. Officials at Montreal-based CAE, the world's largest aerospace simulation and training company, have cited figures showing this area is worth approximately $475 million and is growing at more than 4 percent annually, to convey the importance of the unmanned systems training market. The U.S. military will rely more on simulation as a cost-saving measure, and also because of airspace constraints that will increase as unmanned systems are brought back to the U.S.

Training attracts interest from traditional aerospace prime contractors like Northrop Grumman and IAI—Israel Aerospace Industries—which provide support for their own systems and want to penetrate the aftermarket of competitors. Training also interests companies that dominate other types of flight training and are seeking to broaden their footprint. CAE has been working to penetrate the unmanned systems training and simulation market. The company has been offering its own unmanned aircraft mission trainer with an open architecture.

The Air Force awarded CAE a contract in August to provide comprehensive MQ-1 Predator and MQ-9 Reaper aircrew training services. The $20-million contract could be worth $100 million over five years if all options are exercised. CAE will provide classroom, simulation and live flying instruction as well as courseware development.

Northrop Grumman is offering the low-cost Sandshark system to duplicate multiple unmanned systems such as Predators, Reapers and Hunters. Sandshark allows pilots to practice takeoffs and landings at a small fraction of the price of other systems.

The Air Force awarded CAE a contract to train crews for unmanned planes such as the MQ-1 Predator. Credit: U.S. Air Force.

IAI developed its unmanned systems Mission Trainer, an advanced simulator that can be configured for different aircraft and payloads. The company sold the system to the Israeli Air Force as well as unnamed foreign customers and is working to set up academies overseas to provide training on its own systems and ultimately others.

France plans to buy 12 MQ-9 Reaper unmanned aircraft. Credit: U.S. Air Force.

Other prospects

Fee-for-service contracts are a booming business as companies seek to expand markets for their systems. This concept began over a decade ago with Israeli contractors, including IAI, Elbit Systems and Aeronautics, offering their aircraft for border patrol services for the Israel Defense Forces. In the U.S., Boeing's Insitu pioneered the concept, winning contracts with U.S. Special Operations. Now, at least 15 major prime contractors worldwide offer to work on a fee-for-service basis, and another handful of small companies focus specifically on these services.

Today, most of the world's unmanned systems manufacturers, particularly of mini, small and tactical systems, are willing to provide their systems on a fee-for-service basis. The concept spread as British, Dutch, German and Polish forces used it for reconnaissance needs during deployment in Afghanistan.

In a landmark agreement, the United Nations in July 2013 contracted with Finmeccanica's Selex ES to provide unmanned aircraft support for the U.N.'s peacekeeping mission in the Democratic Republic of the Congo. This was the first time the U.N. has contracted with a civilian operator for such support. The three-year contract allows for a possible two-year extension.

Fee-for-service has another appeal for companies, beyond bolstering demand for their current products. Experience in such work will be critical as the worldwide commercial market develops. Many potential users, such as farmers and natural resources companies, will not want to own their own unmanned aircraft, but rather to contract for services. In such cases, a contractor will provide the required imagery rather than selling an unmanned system.

Companies with smaller systems are interested in preparing for the growth of a nonmilitary market. In the past two years, four companies—IAI, Boeing Insitu, AeroVironment and Lockheed Martin Procerus Technologies—unveiled small aircraft that target the law enforcement market. The companies had expected this to be the first area where there would be widespread adoption of unmanned systems. Heated debate about privacy in the U.S. has chilled immediate prospects for such expansion. There is legislation under consideration at local, state and national levels that would either ban or drastically limit the use of unmanned aircraft. Some local law enforcement agencies have abandoned plans to use these aircraft, while others are waiting to see how the debate develops.

Although precision agriculture represents a significantly larger market than law enforcement, companies have been relatively quiet about their strategy in the market. They appear to be biding their time until the FAA appears closer to announcing the timeline and rules for opening U.S. airspace.

While companies working in this market may have radically different approaches, they are alike in their determination to pursue new areas for growth.

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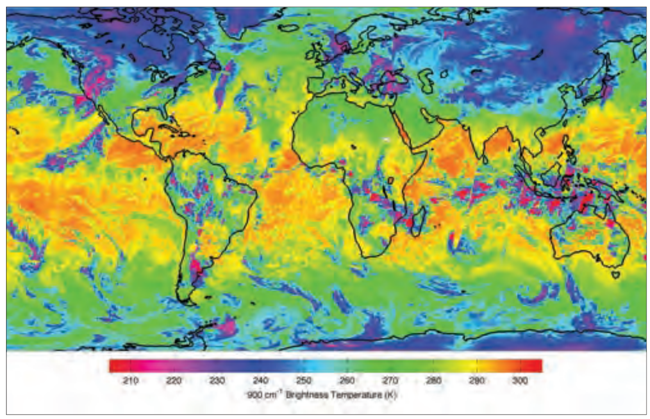
Fully equipped JPSS satellites will carry five sensors each. The review panel recommended equipping the stopgap satellite with only two of them—those built by Exelis and Northrop Grumman Electronic Systems—that provide atmospheric data for weather forecasting three to seven days in advance.

Eric Webster, who heads Exelis' weather system programs, says his company is "very confident" that it can deliver a Cross-track Infrared Sounder by late 2014 to provide temperature, moisture and pressure readings. A CrIS instrument in development for JPSS-1 could be installed on the gap-filler satellite frame instead. Exelis would deliver a second CrIS for JPSS-1.

Northrop Grumman, maker of the moisture-sensing Advanced Technology Microwave Sounder, preferred not to comment in advance of a NOAA decision on whether or how to follow through on the review team's recommendation. NASA, which acquires weather satellites, and NOAA, which oversees their operations in space, may have to ask Congress for additional funds to cover gap-filler satellite production. Such a business-as-usual budgeting process would be slow and could be avoided by adjusting the JPSS program funding profile to accommodate gap-filler satellite production, one expert said.



Orange represents warm sea surface temperatures in this image from Cross Track Infrared Sounder; magenta depicts cold temperatures as well as high-altitude cloud tops. Credit: NASA/NOAA.

The U.S. could turn to European or Chinese weather satellites as an interim solution, but neither course seems politically desirable or possible. "Foreign contributions aren't a solution. A U.S. gap…needs to be avoided by getting new instruments on orbit soon," says Scott Pace, director of George Washington University's Space Policy Institute.

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Taming the cockpit

Meet Mica Endsley, the Air Force chief scientist who wants to make pilots more situationally aware

***The Air Force** needs to plan the right mix of manned and unmanned aircraft in its fleet, and it needs to empower human and automated pilots to know what's happening around them in chaotic combat conditions. Meeting that challenge is where Mica Endsley comes in.*

Endsley became the 34th chief scientist of the Air Force last year, in part for her expertise in human-systems engineering and in the technologies of situation awareness: collecting, fusing and displaying data to human or robotic operators.

As a past member of the service's Scientific Advisory Board, Endsley is well acquainted with the institutional and technical challenges facing the Air Force as it grapples with incorporating unmanned planes and automation into the force. Endsley is the first chief scientist with a background in human-systems engineering. She is also the service's first woman chief scientist.

Endsley has a long track record of work in this area. She started her career as an engineer at the Northrop Corporation in the 1980s, including a stint managing the company's cockpit automation and situational awareness programs. She earned a Ph.D. in industrial and systems engineering along the way from the University of Southern California. In 1997 she founded SA Technologies, which specializes in improving situational awareness through better design, research and training. Headquartered in Marietta, Ga., the company employs about 20 people and has offices in Arizona, Maryland, Mississippi and Texas.

Endsley spoke to Aerospace America's Jim Canan in her Pentagon office about her views on automation, the role of humans and future engineering challenges.

What is your main focus as chief scientist of the Air Force?

I am focused on systems integration and on the interface of humans with systems.

Why?

Our airplanes aren't crashing because there's a problem with their airframes or engines, for example. Eighty percent of our aircraft accidents are attributed to human error, and 88 percent of those are really a function of poor situation awareness. Pilots are doing the right thing in the face of what they think is happening, but they have the wrong picture of what is going on. And in the majority of those cases it's because of faulty design of the human-system interface.

How can the Air Force apply technology in addressing that problem?

It's a problem that's very addressable from an engineering design perspective—bringing the information together and making it more readily accessible and understandable under the conditions of flight, which can be very harsh.

What can you do?

We have to understand what the air crews need in order to reach a high level of situational awareness and meet their operational goals. Over time, the Air Force has greatly increased the amount of data flowing into the cockpits—a deluge of data. We have to integrate all of it better for the pilots, analysts and users of that information. It's not just a matter of throwing new technology in there. We have to improve how we do systems engineering from the beginning.

Where do you start?

Where we have gone wrong with a lot of systems development—and not just in the cockpit, but across a lot of different systems—is that we have added technology piecemeal. And the people who operate the systems have to go through five or six or seven systems or displays and integrate it themselves to find out what's going on around them. That's a big overload for airmen. Given the speed and the conditions they must operate under, they are just not always able to do that. So what we have to do is integrate it for them and make their complex situations immediately obvious to them. We need high-level fusion and effective visualization of all that information.

I would have thought that all such technology had just about reached its apex by now.

There's a whole science of human performance, of how people perform under stressful conditions, what their strengths and weaknesses are, and how we develop and apply technology to support their performance. We have to get all that better integrated into our systems design process.

In the early '90s, systems integration was downgraded or dropped as part of the requirements process, and this has caused a lot of problems for us. We had problems with the oxygen generation system in the F-22, for example, because human-systems engineering was neglected in the systems development process. We've seen problems in many other systems resulting from lack of human-systems integration. We can't afford that. It causes high operational costs and high accident rates. We see it in space systems and cyber, too, all across Air Force operations. We have to design technologies that work with the limitations and the capabilities of people.

Which brings us to the topic of automation in aircraft and other systems.

Interview by James W. Canan

Many people think we'll just automate humans away. It doesn't work that way. There are particular functions that are conducive to automation, but we can't automate everything. We will add automation to our operations in bits and pieces. Our big challenge in autonomy is making sure that we are designing it in a way that enables humans to interact with it effectively.

One of the problems with automation is that it works well in the conditions that it is programmed for, but once the operations get outside that envelope, humans have to be able to jump in, and often they can't do it reliably or quickly enough. Humans tend to lose situational awareness in working with automated systems, because the automation puts them out of the loop. We must design automation so that the human operator is firmly in the loop and can take over when he or she needs to. That's a fundamental challenge.

Air Force Chief Scientist Mica Endsley inspects a medical dummy at the 375th Aeromedical Evacuation Squadron at Scott Air Force Base, Ill. Credit: U.S. Air Force.

How can you meet that challenge?

We know now that how we implement the automation makes a big difference. We have to make it far more transparent, so that pilots or anyone else working with it understands what it is doing, what it is going to do next, why it is doing what it does, and can team with it effectively through informed trust—meaning that humans know they can trust the automation. Pilots have to be able to interject their expertise and knowledge and do the thing that humans are really good at, which is making novel decisions. The transition between the autonomy and the human needs to be smooth, simple and seamless.

Are humans becoming less important in Air Force cockpits?

Not at all. Over the last decade, the environments where we've operated have not been contested, or were barely contested, and unmanned systems had their way. That will not be so true in the future. So we have to figure out how to effectively combine manned and unmanned air operations in contested environments.

Also, we need to be able to compensate for the possible loss of GPS capabilities—being able to do navigation if GPS is jammed. So we are researching cold-atom INS [inertial navigation systems] for future use in case we lose GPS. Cold-atom INS has high promise. Basically, it takes advantage of how supercold atoms move at speeds that allow for precision timing and navigation. That research is going on at the Air Force Research Laboratory at Kirtland.

What else is the Air Force doing to become better at operating in contested environments?

We're looking at how to get into and through those environments more quickly, and that's where our research on hypersonic flight comes into play. We just had a very successful flight of the X-51 Waverider hypersonics test vehicle. It's coming along great, and we're excited about the future development of this technology. Also, we're doing a lot of research on directed energy for weapons and for space and terrestrial communications. We have some very exciting programs in the directed energy lab of the AFRL at Kirtland.

What's in store for unmanned aerial vehicles in terms of automation?

We lose a lot of Predators and Reapers because not enough attention was paid to the technology of the remote cockpit. The requirements for situational awareness and decision-making are the same for the pilots on the ground as they are for the pilots in the air, but it is often harder to get the needed situation awareness when they are remote.

How so?

The challenges for the pilots on the ground are actually much greater, because they're getting a much more reduced set of information about what's going on, with only limited visual cues. They can have a much lower level of situational awareness, due to time lags in data that impede real-time control and to interruptions of communications that disrupt their knowledge of the state of the aircraft. Making the UAVs more autonomous on top of all that creates additional problems—out-of-loop loss of situation, and complexity in the human-autonomy interactions. So there are many technological challenges to creating effective remote cockpits to support the pilots of our UAVs and all the people involved in their operations, including those who analyze the information they gather.

It seems pretty complicated.

What we're really focusing on is involving humans as a better integrated component of both manned and unmanned operations. Right now, we're just using remotely piloted aircraft to do a limited set of missions in isolation. But in the future, they may be called upon to work as part of a team with other kinds of manned aircraft. We may have swarms of UAVs working in concert with manned ground-attack aircraft. We want to be able to determine what parts of our missions UAVs are good at doing, as opposed to manned aircraft, and how technology will be of help in supporting these new concepts of operation.

A report from the chief scientist's office a few years ago noted that humans may have to be intellectually enhanced to be able to work with—keep up with—the much-improved autonomous systems of the future. How do you view that?

I think it's going to be a lot easier to design the autonomy to work well with human capabilities, and not the other way around. That's our first goal: Design more effective systems to work with people, because people have many good capabilities. That said, there is some very interesting research on what we can do to augment human capabilities, such as applications of neurophysiology in humans. For example, something as simple as an oxygen monitor to tell us when a pilot is deficient in oxygen and may black out. In general, we have to learn how to deal effectively with all the information coming into the cockpit so that we're doing things for the human and not to the human.

Where is the research centered?

In the human effectiveness directorate of the AFRL at Wright-Patterson [Air Force Base]. It is doing research on how to create informed trust in the autonomy. To develop such trust, the humans first must be properly informed about the capabilities and reliability of the autonomy in the present circumstances. The research also is aimed at improving the capabilities of humans through pharmaceuticals and neurophysiology, which involve studying human capabilities by means of different physiological measurements, such as EKGs [electrocardiograms] and oxygen saturation. The Air Force has quite a few joint programs with NASA on aeronautics research, and we are also collaborating with the Army and the Navy on various research programs. We all have to pool our resources in this time of decreased funds.

Speaking of space, what about disaggregation of satellites—using smaller ones and teaming them in space to do some of the things that the very big, very expensive satellites have always done?

There's considerable research related to that. We have a lot of work to do in figuring out how to do disaggregation well and effectively. There are some things we can do to make space more affordable and also more defensible. One of the operational challenges is that space is congested and contested, and there are many other players out there. Continuing to launch nothing but large satellites that can be easily taken out is not necessarily a good idea in the long run. So disaggregated space is a way of not only lowering our costs through less expensive launches, but also creating a much more defensible system—a more robust and agile system that is more resilient against attack.

What's going on in the realm of space situational awareness?

We can't make good decisions and take effective actions if we don't know what's happening out there. We're trying to move beyond simply tracking space objects. We want to apply technology to become more capable of using the tracking information effectively, understanding the capabilities of the systems we're tracking and how they can impact our space operations—and any number of Air Force missions.

So you're saying that more effective use and networking of information technology is required on all fronts?

That's right. We need to move more toward what I call fifth-generation network information for our fifth-generation aircraft. But we have an overarching issue here that goes across aircraft systems, across space, across cyber. Different networks can't always talk to each other. We need to integrate those networks, both within the Air Force and across the land and sea components of the other armed forces, so that all can operate much more effectively as joint forces.

Overall, is the Air Force doing a good job of applying science and technology in all these areas?

We have to do what I call smart modernization to make sure we have an effective flow of research—basic research through applied research—into acquisition programs. Other countries have been doubling and tripling their investments in military R&D. We haven't done that, and we must. The problem we have is that our development processes are very slow, very costly, and that causes us to lose technological agility. We can't afford such a long process of getting a new piece of research into a major acquisition program.

How are you trying to improve the process?

I took a hard look at it and came up with three leverage points that we can use. The first is investing in what I call innovation testing centers, at the 6.3 level of R&D—advanced development—so we will be able to do rapid prototyping and testing of new technologies at that stage. This will save us a lot of time and money in the out years. One of our major current problems is that our development programs take too long because we're interjecting technologies into them that aren't mature enough. And that's causing long delays, elongated development cycles and a lot of risk in the programs. It's taking 20 years to acquire a major aircraft system.

We also need to involve the operational community in the development process so the technologists and testers understand how the technology will be used in the operational environment, so that we can write better requirements for the systems we procure.

Are the Air Staff and the acquisition community buying into this?

It is getting a very good reception in a lot of places, and I have found many people who are interested in building more opportunities for this type of technology maturation.

And your other leverage points?

The second one is better requirements. We need to make sure the requirements take into consideration life cycle costs, operability and maintainability. Those have to be as important as SWAP [size, weight and power] in developing a system, so that we don't acquire very expensive systems that we can't afford to operate and maintain. We're reaching out to the [Air Force] operational commands and procurement community right now to work on improving how we turn operational requirements into detailed technology requirements.

The third leverage point is agile development, which basically means modular development that allows for rapid technology insertion as a program goes along. The approach of putting all the requirements in at once and creating big, massive programs that take a long time to execute is not going to work for us in the long run. We need simpler, modular systems that can make technology changes very rapidly.

The power of mentors

John Varljen once steered GPS satellites as an Air Force officer. He now flies passengers around the Northeast on Bombardier CRJ200s for Express Jet. Becoming a commercial pilot was a bold career transition for an Air Force aerospace engineer turned executive at Lockheed Martin. Varljen had two career mentors with reputations as iconoclasts, a fact that might have helped him turn his flying hobby into a profession, which he wasn't able to do for the Air Force because of his vision.

Finding a mentor (or two) is something a young aerospace professional "absolutely can and absolutely should do," counsels Varljen. His mentors were Lockheed Martin's Mark Valerio, now general manager of the company's military space line of business, and the late Pete Rustan, who as a 19-year-old snuck out of Cuba by evading military checkpoints and swimming across Guantanamo Bay to the U.S. military base. Rustan was drafted into the Air Force and became a renowned satellite and information technology innovator. Varljen was Rustan's executive officer from 2004 through 2006 at NRO, the National Reconnaissance Office, where Rustan returned after the Sept. 11 terror attacks as a civilian with a rank equivalent to that of a three-star general.

I spoke to Varljen in the weeks after the first Dr. Pete Rustan Courage to Innovate Awards banquet for professionals and students, held in November. We talked about Varljen's decision to become a professional pilot, Rustan's role as a change agent, and advice for working with mentors.

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Find the right mentor >> If your mentor's not a good fit, it's just not going to work. They're going to be giving you advice and you're going to be looking at them like, "You're smoking crack."

Set ground rules >> [Rustan] used to say, "John, most people cannot get in to see me, but I'm giving you my time….If you choose even one time not to follow my advice, then we're always going to be friends, you can call me any time. But never ask for my advice again…" Behind closed doors, it was first name basis. In fact, that was one of the requirements for me to take the job. When we talked about it the first day, I said, "Behind closed doors, it's gotta be John and Pete, it's gotta be, or I won't take the job." And he said, "I promise you now it will always be that way." And it always was.

John Varljen, center, at the 2006 ceremony for his promotion to lieutenant colonel, with Pete Rustan, left, of NRO and Mark Valerio of Lockheed Martin.

> *"I want you to go into industry. I need you to see how the sausage is made. I need you to see capitalism. I need you to see how ugly it is, but the beauty that comes out of it."*
>
> —Pete Rustan, quoted by John Varljen

Don't be a yes man >> [Rustan] would put out an idea, and my job was to debate him. Imagine that—I would spend two or three hours debating him on the merits and de-merits of doing something.

Expect it to be more than a job >> You become a very close friend with somebody to do a job like that. The best work [Rustan and I did] was on Saturdays. They were amazing days, because we weren't doing the administravia of running AS&T [NRO's Advanced Systems and Technology Directorate] at that point. We were putting together future plans. We were putting together his hopes and dreams for where we wanted intelligence to go.

Tame the bureaucracy >> The rules never really say no. They're going to give you a bunch of conditions you have to meet before the answer's yes. Almost anything you want to do, there is a way to do it.

Know a little psychology >> It was my job to act as [Rustan's] translator, because some of the folks that worked for him were pure ISTJ [short for introversion, sensing, thinking, judgment—a personality type in the Myers-Briggs code]. They're thinkers—extreme thinkers. If you arrive at a solution, it has nothing to do with people's feelings. It's because these are the facts presented. Most people in engineering are ISTJs. Then you have somebody like Pete, who's a massive *E*STJ—extravert, bigger than life. When you have an extravert working with a bunch of introverts, that can be very difficult sometimes. A big part of my job was to sort through that and say, "No, the boss is not torqued at you. He's just asking for the next level now."

Nourish related interests >> My first love was always flying airplanes. I decided at six I was going to be a Marine Corps pilot. I got my pilot's license before my driver's license, so I used to ride my bike to the airport [in Glendale, Ariz.]. I didn't fly in the Air Force, because I had poor vision, but all of the requirements in both the military and the civilian world changed since then. As long as your eyes are correctable to 20-20 you can fly jets now….My eyes went sour between my ninth and 12th year. I knew at that point I was not going to fly fighters. Believe it or not, I sat back, and at 12 years old, realized the Air Force had money and the Marines didn't. If I wanted to work on stuff, the other thing I loved was space. So I started studying space—learned everything I could about it.

Advice from Rustan >> The first time [Rustan and I] talked about [a transition to professional flying] was before he got sick. He very bombastically said, "John, the Air Force and I have put years of training into you. You owe it to your country to go be a director, to go run programs. You're better at it than most people. This is what your calling is. This is what you need to do." He said, "I want you to go into industry. I need you to see how the sausage is made. I need you to see capitalism. I need you to see how ugly it is, but the beauty that comes out of it." What he was talking about was the full process of creating a spacecraft.

Life at Lockheed >> For two years, I was in absolute heaven. I was the chief engineer for assembly, test and launch operations. Also the director of test engineering. I was dual hatted—470 employees at my peak, down to 427, and that was the thing that really ate me alive. The last six months I was there, I spent most of my time on the road laying people off or planning to lay people off. The industry was contracting. That's not Lockheed's fault. You know, the military industrial complex goes through a 20-year cycle, right? And it has since 1775.

Turning point with Rustan >> I met him in Waikiki and walked on the beach for three, four hours. [Varljen was on vacation from Lockheed; Rustan was in Hawaii on business.] We talked about his legacy, and what he was going to do next. We talked about the things that he wanted to accomplish and didn't. I reassured him about all the things that he did accomplish. I said, "Pete, what do you think? You know how much I love flying." He looked at me and said "John, I'm dying." He had been fighting for a year and a half at that point. I was well aware. Pete said, "John I know what I told you before, but now I realize that life is too short not to follow your passion. You've always wanted to fly jets. Go follow your passion, John." I had to ask permission, because [Rustan] had specifically told me, "This is what I expect of you," and I was not going to let that man down.

Looking back >> The hardest job I ever had, besides working for Pete, was in the Pentagon. The colonel I worked for there, he also had a great phrase, which was "John, for the rest of your career you're going to meet two types of leaders in the Air Force: Those who have been through the Pentagon and have seen the corporate process, and those who haven't. Those who haven't are just going to make unreasonable demands and explain to you why you're a failure. Those who have been through it, on the other hand, are going to understand and maybe help guide you how to get things funded, how to get things through—how to change a regulation.

Contributing to history >> When you're working jobs like that, your ultimate focus is to provide the machinery that's going to change world history. And that happened several times in my career, where I realized that something I worked on directly really did change the course of human history. GPS of course being the most glaring—certainly the one I can talk about.

Demand grows for miniature unmanned craft, combat planes

Much as swords were once beaten into rifles, not ploughshares, rifles today are increasingly being beaten into unmanned "killer drones." In what used to be a purely U.S. mission, the U.K. carried out its first armed Reaper strike in Afghanistan in April 2013, from a ground control station at Royal Air Force Waddington in England. Previously Britain had flown all Reaper operations from Creech Air Force Base in Nevada.

Also in 2013, French and U.S. officials confirmed that France considered buying armed Reapers from the U.S., reportedly recognizing a greater urgency for acquiring longer range endurance unmanned aircraft following its operations in Mali. However, there have been suggestions of political repercussions in France from acquisition of an armed unmanned plane capable of targeted assassinations.

Broadening capabilities

The writing has been on the wall for years. The Air Force has so far disregarded Isaac Asimov's "Three Laws of Robotics" (preventing robots from harming humans). This may in part be due to the short-sighted belief that today, in contrast to the 1930s-1950s, the U.S. and its allies are dominant enough to do all the unmanned killing themselves. But some of the newest unmanned aircraft sensors and technologies present broadening capabilities that will be ideal for non-state actors—moving intelligence, surveillance, and reconnaissance capabilities down to smaller and smaller mini- and nanosizes, and, at the high end, moving full manned fighter capabilities to unmanned combat aircraft, UCAVs.

Single-target (assassination) missiles are already in development, and small-bird-size nano-aircraft have proven their ISR value in Afghanistan (surprisingly, with the British Army, not the U.S.). Weaponized "trouser pocket" nano-aircraft—with a new U.S. Army ISR program beginning—may one day endanger more than just "enemy" government officials.

At the other end of the spectrum, delays have beset the F-35 Joint Strike Fighter program (although they have receded somewhat to levels expected during testing). These led Saab in 2013 to propose an unmanned Gripen as its next international fighter offering. Several U.S. UCAV programs, classified and unclassified, will provide alternatives to the F-35 by the end of the decade, and even conservative market growth will lead UCAVs to be a major sensor market.

Electrooptic/infrared sensors are still the default type for the vast majority of unmanned aircraft. Teal Group forecasts steady growth in U.S. funding for these systems, from $694 million in FY13 to $859 million in FY19, with a 3.6% compound annual growth rate. But production of the Army Gray Eagle has already ramped up, hundreds of Air Force Predators and Reapers are already in service, and Block 30 Global Hawk production is now done. Thus spending on electrooptics for endurance unmanned aircraft—the dominant and fastest-growing market for the past decade—will be lucky to hold its own.

New technologies such as wide field-of-view and hyperspectral imaging systems have a strong future, and we have forecast substantial continued funding. All our UAV forecasts assume postwar funding drawdowns with or without sequestration, but also a continuing shift of funds from new platforms to new sensors. In addition, we forecast a slow upturn in HALE, high-altitude long-endurance, sensor suites bought for the 'pivot to Asia.

The major trends

But the forecast from the end of this decade is all about UCAV manned-equivalent sensors (or more accurately, man-replacement) and mini/nano-aircraft, from shoulder-launched to insect-sized. One market will focus on extreme high-end capability; the other will focus on extreme miniaturization and a fair amount of basic scientific/materials research.

Teal Group forecasts that numbers of mini/nano-aircraft sensors procured by FY22 will be in the thousands annually—similar to recent annual mini-aircraft totals—with lower unit costs but similar total funding value compared

RDT&E+PROCUREMENT ($MILLIONS)

	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Global Hawk/Triton/HALE	56	64	64	44	66	59	76	88	113	113
Predator/Reaper/Gray Eagle/MQ-X	251	223	247	267	255	234	236	222	226	218
Wide FOV	156	112	108	94	100	86	90	96	86	92
Hyperspectral	107	106	116	122	128	140	140	154	154	156
UCAV	26	70	42	46	44	84	66	254	365	375
Tactical UAV	43	57	59	81	80	71	75	102	99	72
Mini/Nano UAV	55	76	93	91	122	144	176	222	280	339
Total	**694**	**708**	**729**	**745**	**795**	**818**	**859**	**1,138**	**1,323**	**1,365**

to a dozen or so stealthy UCAV sensor suites. Several years ago the Air Force Research Laboratory expected that unmanned aircraft the size of a sparrow could fly by about 2015, but they were already in military service by 2012. The Air Force has declared it wants to have swarms of aircraft no larger than dragonflies by 2030; we suspect this date will also move forward.

Earlier this year, the British Army in Afghanistan stirred international interest by operating dozens of Norwegian-developed $200,000 Prox Dynamics PD-100 Black Hornet personal nano-unmanned aircraft, with a $31-million purchase for 160 more in February. The vehicle and all subsystems weigh 16 grams, including a payload of three daylight cameras with tilt and zoom. The U.S. Army was caught flat-footed by this, and in April was reportedly soliciting technology concepts for cargo pocket unmanned aircraft capable of providing around-the-corner tactical intelligence.

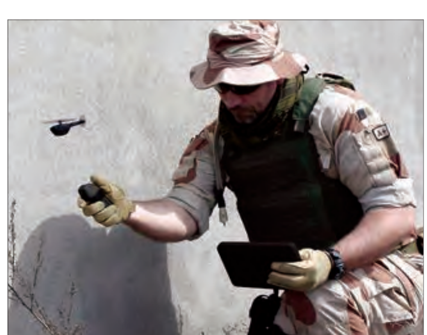
Hobbyists' remote control unmanned aircraft and helicopters typically carry only a very simple, very inexpensive sensor, equivalent to a mobile phone camera. But these aircraft also cost in the hundreds of dollars. Though exact prices have not been released, we assume the PD-100 sensor cost is commensurate with a $200,000 unmanned aircraft. Teal Group estimates the PD-100 sensor for military service costs between $15,000 and $45,000.

Mini/micro-aircraft sensors have so far been quite simple—and procured in the tens of thousands over the past decade. The current generation of small unmanned aircraft sensors has grown hugely in capability, sophistication—and expense. But the numbers are likely to remain high, resulting in an order of magnitude difference in market value. A good example is AeroVironment's gimbaled Mantis i23 electro-optic/infrared sensor for the Army's Raven mini-unmanned plane.

Typical until recently on most mini/micro-aircraft has been a small, simple, fixed camera. Most of these craft present a harsh landing environment, crashing in some form. AeroVironment's Raven and Puma mini-unmanned aircraft land with a vertical stall technique, which could easily damage a protruding sensor ball, common on tactical and larger unmanned planes. Many thousands of Ravens have therefore been purchased with two small fixed cameras, forward- and sideways-facing, in swappable day and night sensor packages.

The Mantis i23 digital camera fitted on the AeroVironment RQ-11B Raven. Credit: AeroVironment.

But with improved miniaturization, many mini/micro-aircraft today are being offered with miniature gimbaled payloads, more closely mirroring their larger unmanned brethren. In April 2012, AeroVironment unveiled its new Mantis i23 gimbaled payload for Raven, part of a larger Army effort to ease the user's burden in operating small unmanned planes. The gimbaled payload allows the operator to view an area continuously without changing the flight path.



The British Army operated dozens of PD-100 Black Hornets in Afghanistan. Credit: Prox Dynamics.

The Mantis i23 fits under the Raven's nose, measuring 3.1 inches in diameter and weighing only 16 ounces. It includes a 5-megapixel daylight camera with enhanced stabilization and improved optics, and a 640x480 pixel bolometric (uncooled) infrared thermal camera with four zoom levels (replacing the earlier 320x240 camera). The payload uses two levels of stabilization—electromechanical (gyro) and electronic (image stabilization). Mantis also adds a laser illuminator (pointer), all integrated into a multiaxis ball capable of continuous pan. The i23 will be the standard sensor for future Raven production and can be fitted to older Ravens as an upgrade, requiring a software update for each plane and a new ground control station.

But the new Mantis i23 is a lot more expensive than earlier fixed payloads. AeroVironment reports a price range of $30,000-$48,000, depending on quantity—almost as much as the entire Raven. The company also says orders have already been received for both new Ravens and upgrades to fielded air vehicles.

(Continued on page 26)

A sweet spot for saving fuel

Aerospace engineers at NASA Dryden Flight Research Center are conducting flight experiments that could lead to improved fuel efficiency for military and civilian aircraft, manned or unmanned. The project, called Intelligent Control for Performance, or ICP, is part of ERA, NASA's Environmentally Responsible Aviation program.

The team's work has sparked interest from the military. Beginning in late 2012, the engineers conducted five ICP test flights from Edwards Air Force Base, Calif., using NASA's F/A-18A Full-scale Advanced Systems Testbed, or FAST, aircraft.

The purpose was to see if an experimental software algorithm could produce real-time optimization of pitch trim. This peak-seeking, closed-loop algorithm was developed by John "Jack" Ryan, deputy branch chief of Dryden's Controls and Dynamics Branch, in conjunction with Jason Speyer of the University of California, Los Angeles. The algorithm was programmed into the FAST aircraft's airborne research test system.

NASA researchers reckoned that deflections of wing control surfaces not normally used for trim control might create the desired optimization. The flight experiments followed promising simulation work by the NASA engineers, as well as measurements of the wing control surfaces' effects on fuel flow and feedback-signal noise. The work suggested that trim optimization might well be achievable and might produce measurable fuel-burn reduction.

Previous work

The algorithm was originally developed for NASA experiments with Boeing's X-48B Hybrid Wing Body test aircraft. The planned trim optimization work also builds on drag reduction experiments NASA performed on symmetric downward aileron deflection in 1999 using a Lockheed L-1011 TriStar airliner.

Similar thinking also went into the Performance Improvement Package that Boeing developed in 2009 for United Airlines' 777-200ERs. The company found that one of those improvements, a software-controlled, 2-degree symmetric aileron droop during cruise flight, reduced fuel burn and emissions.

Boeing now has a patent pending for a trailing-edge variable camber system for the 787. The system symmetrically deflects flaps and ailerons downward to reduce aerodynamic drag in cruise. This camber's control software does not, however, feature a closed-loop system: the software allows real-time estimation of optimum control-surface deflection, but does not measure fuel flow rates in real time.

NASA's FAST jet

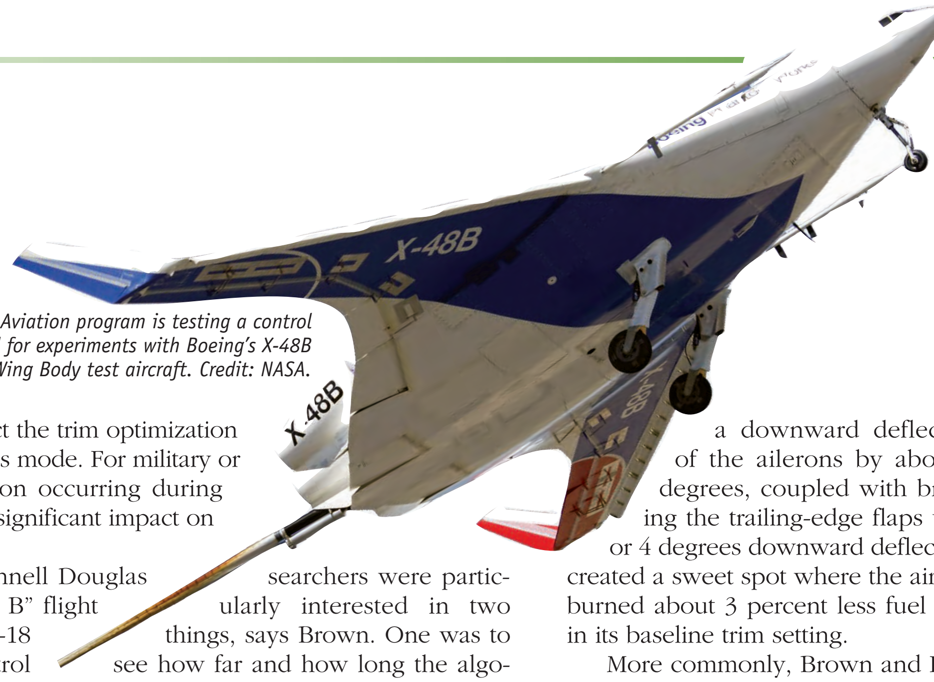
Jack Ryan and Nelson Brown, a NASA Dryden aerospace engineer who was the ICP project's principal investigator, note that pitch in the F/A-18 is normally controlled by the rear fuselage-mounted stabilators (combined horizontal stabilizers and elevators). These trim the aircraft for all conditions of flight in accordance with the trim table developed by the manufacturer.

But Ryan and Brown reason that fuel-burn reductions of 1 percent to 5 percent might be possible if the aircraft's trim can be fine-tuned in real time, and its aerodynamic drag thus reduced. The closed-loop algorithm, they believe, would enable this fine-tuning by producing deflections in the plane's ailerons and its leading-edge and trailing-edge flaps and then measuring the resulting fuel flow rates.

The FAST aircraft has racks of data-gathering computers, pressure sensors, strain gauges and high-resolution, low-noise fuel flow meters. It also has two separate flight control system processors. One is programmed with the standard control laws for the F/A-18A; the other can be programmed for any experimental control laws that researchers wish to introduce. At any time during flight, the pilot can press a button to re-establish the plane's normal flight control laws. If an issue with the experimental control laws ever arises, the flight control computers automatically revert to the standard control laws.

In designing their ICP experiments with the F/A-18A, Brown and Ryan reasoned that since large commercial and military planes spend most of their time

Control processors aboard the Full-scale Advanced Systems Testbed aircraft allow testing of experimental control laws. Credit: NASA.



NASA's Environmentally Responsible Aviation program is testing a control algorithm originally developed for experiments with Boeing's X-48B Hybrid Wing Body test aircraft. Credit: NASA.

in cruise, it would be best to conduct the trim optimization tests with the aircraft operating in this mode. For military or civil aircraft, any fuel-burn reduction occurring during cruise flight would probably have a significant impact on overall block fuel burn.

In the 1990s, NASA and McDonnell Douglas defined and analyzed a safe "Class B" flight envelope in which the modified F/A-18 could recover from any flight-control software bug before undergoing an upset and without any aircraft "bend or break," according to Brown. The Dryden researchers chose flight test conditions and designed their ICP flight experiments so that while the F/A-18A was attempting the real-time trim optimization exercises, it would remain in the middle of that safe flight envelope.

The flight tests

Ryan and Brown had the F/A-18A cruise at an altitude of 25,000 feet for all five ICP test flights. In four of the flights, the plane flew at a cruise airspeed of 250 knots (not the F/A-18A's optimum cruise speed), and for the other flight it flew at 200 knots—"very slow, on the back side of the power curve," says Brown.

To help establish whether the peak-seeking algorithm actually was responsible for any real-time trim optimization that occurred during the test flights, the team used a wide variety of starting trim settings. One was the standard baseline trim for the F-18A, but the other five settings selected were all near "corners" of the plane's trim envelope and entailed large, high-drag deflections of various wing control surfaces.

Since the FAST aircraft has high-resolution fuel-flow meters as well as the stock meters found on production F/A-18s, NASA also ran several tests using different feedback signals. These included throttle setting and use of stock fuel-flow meters.

Throughout the flights, the researchers were particularly interested in two things, says Brown. One was to see how far and how long the algorithm went "wandering"—selecting various combinations of large control-surface deflections—before finding its way to a hoped-for "sweet spot" combination of deflections where aerodynamic drag and fuel burn would be at a minimum. The other was to find out if the algorithm could even receive "a noisy signal like fuel flow and, through all that noise, find real-time optimization."

During each flight, the pilot stabilized the aircraft at the pre-determined initial trim setting for at least 30 seconds, with the autopilot ensuring the plane remained at a constant speed, altitude and wings-level attitude. Then, by pressing a button, the pilot engaged the peak-seeking algorithm—the one working to deflect the wing control surfaces to reach a new trim setting. The pilot repeated this procedure for each interim trim setting, pressing the button again and again until the fuel flow reached a settled state. Every press of the button advanced the algorithm one iteration.

Each time the fuel flow settled, the pilot turned off the algorithm and repeated the initial trim setting, then started the test again. This helped isolate the measurement of any trim-setting optimization from the underlying trend, which saw fuel burn gradually decrease as the aircraft got lighter during the flight and thus required less energy to retain speed and altitude.

The findings

Brown and Ryan found that, with the plane flying at 250 knots at 25,000 feet, a downward deflection of the ailerons by about 4 degrees, coupled with bringing the trailing-edge flaps up 3 or 4 degrees downward deflection, created a sweet spot where the aircraft burned about 3 percent less fuel than in its baseline trim setting.

More commonly, Brown and Ryan observed lower fuel-flow reductions, of 1 percent to 2 percent, in other test runs after the algorithm ran for 15 to 20 minutes. They also found that with the plane flying slowly, at 200 knots indicated airspeed, the algorithm achieved fuel-burn benefits, but the sweet spot combination of the surface positions was much less obvious than with the aircraft flying at 250 knots. There may be multiple "right answers" that result in similar drag counts.

The engineers also found that the algorithm didn't wander off into any "long walks," according to Brown. For each initial trim setting, the algorithm would take only three to five iterations to reach the optimal setting. Interestingly, they also noticed that different flap configurations required different lateral-direction inputs from the pilot. The symmetry of the plane wasn't measured before the flight tests began, but it can't have been absolutely symmetrical.

Ryan and Brown stress that the peak-seeking algorithm they used is a "real-time optimization" with current measurements. This means the algorithm would produce a different result for every individual aircraft in a fleet, rather than one result for the fleet as a whole. This is because no two aircraft are absolutely identical, even when they are the same model and newly rolled out.

Over time, every individual plane encounters a unique set of operating

(Continued on page 27)

Fundamentals of Aircraft and Airship Design

Volume 2—Airship Design and Case Studies

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To show the effect of these new costs on our forecast, over 40,000 FLIR Systems Photon 320 uncooled infrared cameras reportedly have been produced, mostly for mini-aircraft. The Army has procured more than 15,000 RQ-11 Raven mini-aircraft. Our conservative postwar production forecast is for only 1,500 mini-aircraft sensors and 2,400 nano-aircraft sensors in FY21—but this will still dwarf tactical unmanned aircraft sensor production rates and likely be worth nearly $200 million for production alone.


In July 2013, the X-47B landed on the aircraft carrier George H.W. Bush. Credit: Northrop Grumman.

UCAV: Man-replacement sensors

On the high side of the sensor mix are UCAV sensors. While some may not be as long-range as Global Hawk or other high-altitude sensors, they will need to provide full targeting and attack functions, added stealth, and multiband sensing. In addition, some degree of autonomy will unquestionably be designed in, to allow immediate reaction both for self-defense and for rapidly changing targets or situations. Relayed sensor information that requires decisions back at the base station are already less than ideal for some Reaper attack missions, but for a UCAV in antiaccess/area-denial airspace, waiting for a remote decision will not be acceptable.

What this means is a full, stealthy combat sensor suite on the order of the F-35, but adding yet-to-be-developed sense-and-avoid sensors and semiautonomous/semiintelligent C4I. All in all, it will be a very expensive undertaking.

Currently, development is still focused on the stealthy UCAV airframes, most recently Navy aircraft carrier trials. In July of this year, the first Northrop Grumman X-47B unmanned combat air system demonstrator landed on the aircraft carrier George H.W. Bush. One other attempt succeeded, followed by two waved-off attempts. With the demonstrator's test program now essentially complete and the Navy's follow-on unmanned carrier-launched surveillance and strike production program planned, Teal Group expects sensor development to get under way full-steam, adding to classified development programs likely in progress for years for the Air Force.

Our research, development, test and evaluation funding forecast is extremely conservative, and it assumes that many sensors will come almost directly from manned fighters, probably the F-35. In terms of production, our UCAV forecast is for a mere 15 sensor suites produced annually in FY21 and FY22, at an estimated cost of about $20 million each (including installation, initial spares, and so on), worth about $300 million.

While this will be the world's number-one unmanned aircraft electro-optic/infrared sensor program in value, compared to F-35 funding for these sensors, it may be only a minor program. With a real near-peer threat and a genuine need for stealthy unmanned strike, if production doubled to only 30 systems annually (likely cutting into F-35 procurement), UCAV will be the dominant place to be in unmanned aircraft electro-optics/infrared. Terminators will be expensive and profitable.

A dark future?

So far, "unmanned aircraft don't kill people; people kill people." But whether or not today's autonomous operation developments succeed, which they likely will, if only to permit self-awareness and avoidance operations in civil airspace, the varieties of remote surveillance and strike will continue to grow. Mini/nano-aircraft will provide everything from Big-Brother-like civil surveillance to commercial industrial espionage to targeted assassinations. Individual killings will be possible worldwide with tiny, undetectable unmanned aircraft (and possibly undetectable poisons—bugs do it, so will unmanned planes), with near-zero collateral damage.

Think autonomous, semiintelligent Terminator-like UCAVs at the top of the unmanned market. At the bottom, expect silent nano-aircraft killers and 24-hr military/civil/commercial surveillance. The development programs are already in place, with first-generation production systems already in service.

The military, political groups, and anyone with an iPhone 9 should be able to watch *everything* their adversaries are doing by the end of the decade, unless strict new laws are written and enforced. And that is unlikely to apply to our military, just as it disregarded international legal challenges to the weaponizing of the first Predators.

Privacy will evaporate even further, with opposing military leaders, candidates for public office, and civilians monitored constantly by tiny, long-endurance perching/staring nano-aircraft ('Is that a dragonfly at the window or…?'). This may sound like science fiction, but a high-low mix of new sensors may determine the future of much of the unmanned aircraft market. We forecast funding commensurate with that importance.

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conditions and experiences, and the treatment each receives on the ground is different. One aircraft, for instance, might be a victim of hailstone strikes, while another may have winglets and an external blister installed.

"An aircraft does not get cleaner over its life," says Ryan. But since the peak-seeking trim-optimization algorithm works in real time with actual performance measurements, this means any single aircraft's performance can potentially be optimized.

The way forward?

NASA is not planning any further ERA-related trim-optimization research. However, the Dryden engineers say there are potential avenues of research they could pursue to further their understanding of how non-traditional control methods might help optimize aircraft performance.

"We've just put our toe in the water so far," says Brown. For one thing, Ryan and Brown note the ICP experiments involved only the pitch axis; additional optimization might be possible if the yaw and roll axes were studied as well. They believe the biggest benefits of all might be found in optimizing performance in the lateral, yaw axis. Fortunately, their research has attracted interest from key potential customers.

"There is strong interest from our leadership and from the outside," Ryan confirms.

This includes interest from the U.S. military, which the researchers see as the most likely avenue for ensuring sufficient funding is provided for further development of their ideas. "The U.S. military has a mandate to reduce energy consumption—it is very sensitive to fuel-cost efficiency," says Ryan.

This is entirely understandable considering that in Afghanistan, where there are no fuel pipelines, the effective cost of a gallon of jet fuel can be as high as $55 when the cost of flying it to where it's needed is factored in. Reducing fuel burn not only helps cut fuel costs but also increases the military's tactical capabilities.

Brown and Ryan see peak-seeking algorithms reducing fuel burn in two particular areas of military operations: planes flying with asymmetric loads of external stores; and groups of aircraft flying in loose formation.

By flying in the right position relative to the vortices shed from the wingtips of other aircraft in formation, a plane can use the rising currents of air in the vortices to help generate lift, so its engines don't have to work as hard and the plane uses less fuel. In the future, peak-seeking algorithms could prove extremely useful for such flights.

"They would need an algorithm with a gradient to follow," says Ryan. "A peak-seeking algorithm would probably be a very good solution."

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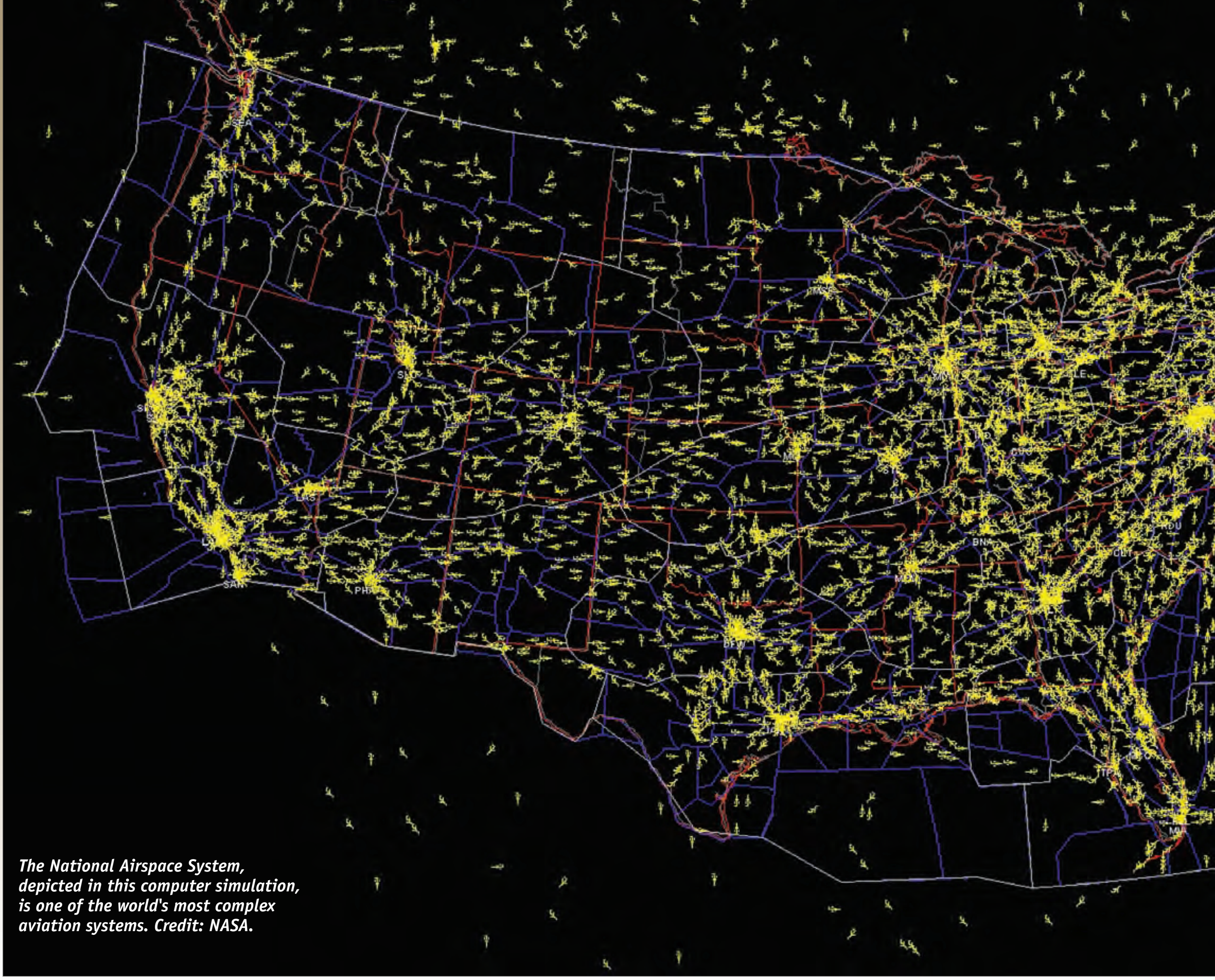


The National Airspace System, depicted in this computer simulation, is one of the world's most complex aviation systems. Credit: NASA.

The FAA's effort to bring unmanned planes into the nation's airspace faces tough obstacles, political as well as technical. Work is under way to resolve questions about privacy and to find affordable detect-and-avoid technologies.

When Richard Christiansen was working at NASA headquarters in the mid-1990s, he suggested to FAA officials that they establish regulations for unmanned aircraft flights. Christiansen and others at NASA were excited about unmanned planes, because flight crews and equipment could be replaced with instruments for studying hurricanes, air pollution and other phenomena, perhaps for days at a time.

The reaction was surprising. "A couple of people said, 'Why are you bothering us about something that is only going to happen a couple of times a year? We don't need to go through the long, arduous process of developing certification, rules and regulatory documents,'" recalls Christiansen, now vice president of the engineering company Sierra Lobo in Fremont, Ohio, and chairman of AIAA's unmanned systems program committee.

Making way for unmanned aircraft

Two decades later, the Teal Group forecasts that governments and businesses will spend $89 billion on unmanned systems through 2023. The FAA now has a roadmap and comprehensive plan describing the actions that will be required to integrate these aircraft into the national airspace without compromising safety. President Obama signed the FAA Modernization and Reform Act in 2012 to prod his FAA to work faster but carefully on this initiative—to "accelerate safely," as the law puts it.

Problem solved, right? Not so, say those who want to use unmanned craft for everything from spotting poachers and crime suspects to delivering consumer packages, as proposed on "60 Minutes" in December by Amazon.com founder Jeffrey Bezos. The modernization law tells FAA to integrate unmanned aircraft in the national airspace by Sept. 30, 2015, but doesn't set a deadline for regular flights.

On a recent episode of "60 Minutes," Jeff Bezos, left, says his company, Amazon.com, is testing drones for use in delivering packages. Credit: CBS News.

On top of that, the integration process assumes human pilots or operators will fly the planes from ground sites. According to the roadmap: a "pilot-in-command" would have "full control or override authority" of the craft. Many in the private sector, including Bezos, ultimately want autonomous craft—planes or helicopters that could be com-

by Debra Werner

manded to navigate to a point on map. Then there are the U.S. states to consider. Thirteen of them have passed laws or resolutions restricting unmanned aircraft operations because of safety or privacy concerns, and skeptics in many other states are trying to do the same.

The reality is that it will take time—possibly lots of time—to turn desire into specific rules and standards for everything from pilot certification to detect-and-avoid technologies to secure command and control links. "In about 2025 and maybe beyond that, we would like to be at the stage where you could actually file your flight plan and conduct routine operations without restriction," says Ali Bahrami, vice president of civil aviation for AIA, the Aerospace Industries Association.

Starting point

For safety's sake, the first rules are expected to apply to craft weighing less than 55 pounds and operating within visual range of their ground-based pilots. FAA anticipates 7,500 of these aircraft will be flying in the national airspace in the next five years.

Right now, hobbyists and enthusiasts are allowed to fly those by remote control so long as the craft stay within visual range, away from air traffic and below an altitude of 400 feet. They can't legally be flown for commercial services like those proposed by Bezos. Paving the way for freer flight in U.S.-controlled airspace are two unmanned aircraft certified by the FAA to conduct commercial operations over the Chukchi Sea west of Alaska. ConocoPhillips used four ScanEagle planes in September to track whales and map sea ice. The 18-kilogram ScanEagle X200s were launched by catapult from a commercial research ship. They are similar to the model that flew over the Maersk Alabama merchant ship in 2009 to watch the scene where Capt. Richard Phillips was being held hostage on a lifeboat by Somali pirates. The FAA has also approved another veteran of military action for flights in the Arctic—AeroVironment's 6-kilogram Puma, used by troops in Afghanistan.

ConocoPhillips flew a remotely piloted InSitu ScanEagle off Alaska in September. The FAA says this was the first U.S. commercial unmanned flight. Credit: Insitu.

Used by U.S. military troops in Afghanistan, the 6-kilogram Puma has been approved by the FAA for flights in the Arctic. Credit: AeroVironment

Amazon had to leave the U.S. to legally fly its eight-rotor, electric craft, according to the FAA. U.S. law only allows hobbyists to fly such craft for recreational purposes. Amazon did not respond to requests for comment.

For advocates, FAA's approval of the Arctic flights was heartening, but not the entire answer they seek. A rule allowing operations of these small unmanned craft in any U.S. airspace, but below the altitude where other commercial planes generally cruise has been stalled in the approval process for more than a year. The FAA says it expects to publish a proposed rule on these small aircraft in 2014, and eventually to address larger aircraft too. "Creating the right regulatory structure is the biggest challenge to integration, especially for larger unmanned aircraft systems," according to spokesman Les Dorr. "That structure has to address and accommodate the technological aspects of an evolving industry, as well as the regulatory standards," he says.

When it comes to the sub-55-kilogram craft, one executive says the delay in approval of the rule is creating a dangerous situation by tempting developers to fly their craft anyway.

"It's the Wild West," says John Langford, chairman and chief executive of Aurora Flight Sciences, the Manassas, Va., company that makes a full range of unmanned craft, including the hand-launched Skate. "People are ignoring the law. That's going to lead to accidents that will create huge setbacks for the industry."

Job number one

The FAA is famously cautious when it comes to rule changes that could impact the safe operation of 60 million flights annually. Whereas military leaders might accept the risk of one catastrophic incident in 100,000 flight hours, provided the incident would not doom the overall mission, the FAA works toward no more than one catastrophic failure in a billion flight hours.

"The challenge is going to be having unmanned aircraft systems that are robust enough to give you that kind of performance and reliability," says Bahrami, who spent 24 years at the FAA before working for AIA.

That insider's view has convinced Bahrami that there is no shortcut on the path to unmanned aircraft integration in the national airspace. Many different government agencies, research institutions and private industry groups will have to work in parallel to tackle a variety of thorny technological and societal issues. Nevertheless, he is encouraged by publication of the FAA roadmap and an accompanying document, "Unmanned Aircraft System Comprehensive Plan: A Report on the Nation's UAS Path Forward."

What will be needed, he says, is to "follow the steps the FAA outlined, execute them and deliver on those commitments."

The U.S. is not alone in barring unmanned planes from its busy air corridors. In fact, no countries allow routine operations of unmanned aircraft in or around major cities, but many do permit them to operate at low altitude or in areas where there is little air traffic. In South Africa, for example, Aurora Flight Sciences recently demonstrated how its 1-kilogram Skate unmanned plane could help national park rangers detect poachers hunting endangered rhinoceroses. The flights helped Kashmir-Robotics of Great Falls, Va., learn about unmanned aircraft operations in advance of its Wildlife Conservation Challenge, a $65,000 competition to find anti-poaching aircraft.

Going abroad has its attractions. To conduct flight tests in South Africa's Kruger National Park, Aurora didn't need to go to the country's equivalent of the FAA. The company needed approval only from park officials, because "whoever owns the land gets to decide what can be flown above it," Aurora's Langford says.

Flying unmanned aircraft in the U.S. for research or other government purposes is hard, but not impossible. NASA has a fleet of unmanned planes that peer into hurricanes, study volcanoes, analyze pollution and map wildfires. U.S. border patrol agents working with law enforcement agencies in Texas and Arizona fly unmanned aircraft to detect and interdict drug smugglers. Academic researchers employ unmanned planes in numerous weather, disaster response and agriculture research projects. North Dakota State University teams used the planes in 2010 to obtain images of the flooded Red River Valley.

Each of those government and academic research flights required an FAA waiver, called a Certificate of Authorization. In response to congressional direction, the FAA has streamlined the waiver application process and extended the period of each authorization's validity from 12 to 24

(Continued on page 37)

Saving wildlife

In November, rangers in South Africa's Kruger National Park got their first glimpse of unmanned aircraft small enough to fit in a backpack. Aurora Flight Sciences employees used 1-kilogram Skate unmanned planes to show rangers a new way to protect endangered rhinoceroses from poachers seeking to kill them for their horns.

Aurora Flight Sciences' Skate unmanned aircraft is small enough to fit in a backpack. Credit: Kashmir-Robotics.

Advocates say it could take hours for rangers on the ground to do what unmanned craft can do in minutes.

That time saving is critical, because Kruger National Park employs approximately 200 rangers to protect wildlife and manage an area that spreads across two million hectares. Relying primarily on jeeps and foot patrols, the rangers have been unable to prevent poachers from killing about 500 rhinos in 2013 alone, according to the Republic of South Africa's Environmental Affairs Department.

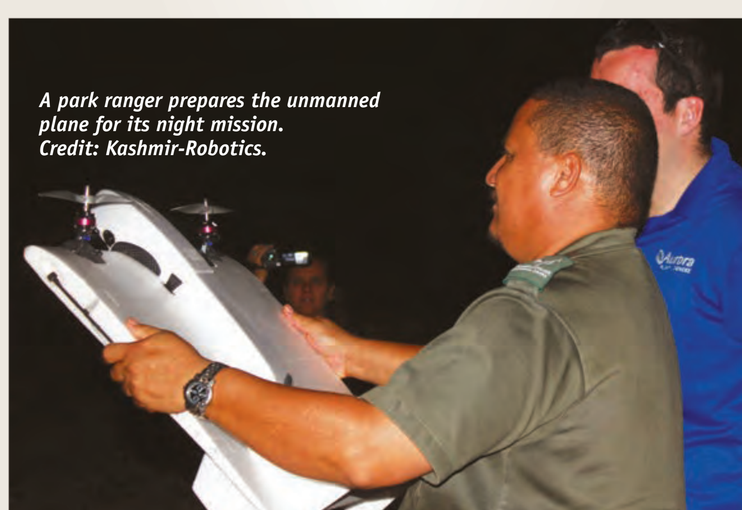
Kashmir-Robotics, a division of the Al-Kareem Foundation, is seeking to halt this rampant killing by providing rangers with unmanned aircraft selected through the Wildlife Conservation UAV Challenge. Through that competition, Kashmir-Robotics is offering $65,000 in prizes to teams that demonstrate the ability to use inexpensive unmanned aircraft weighing less than 25 kilograms to protect wildlife.

Aurora, a partner in the contest, is working with Kashmir-Robotics to help determine technical and operational requirements for unmanned aircraft to counter poaching. Aurora also might seek to include technology used by the contest's winners in its unmanned aircraft, said Aurora's Larry Wirsing.

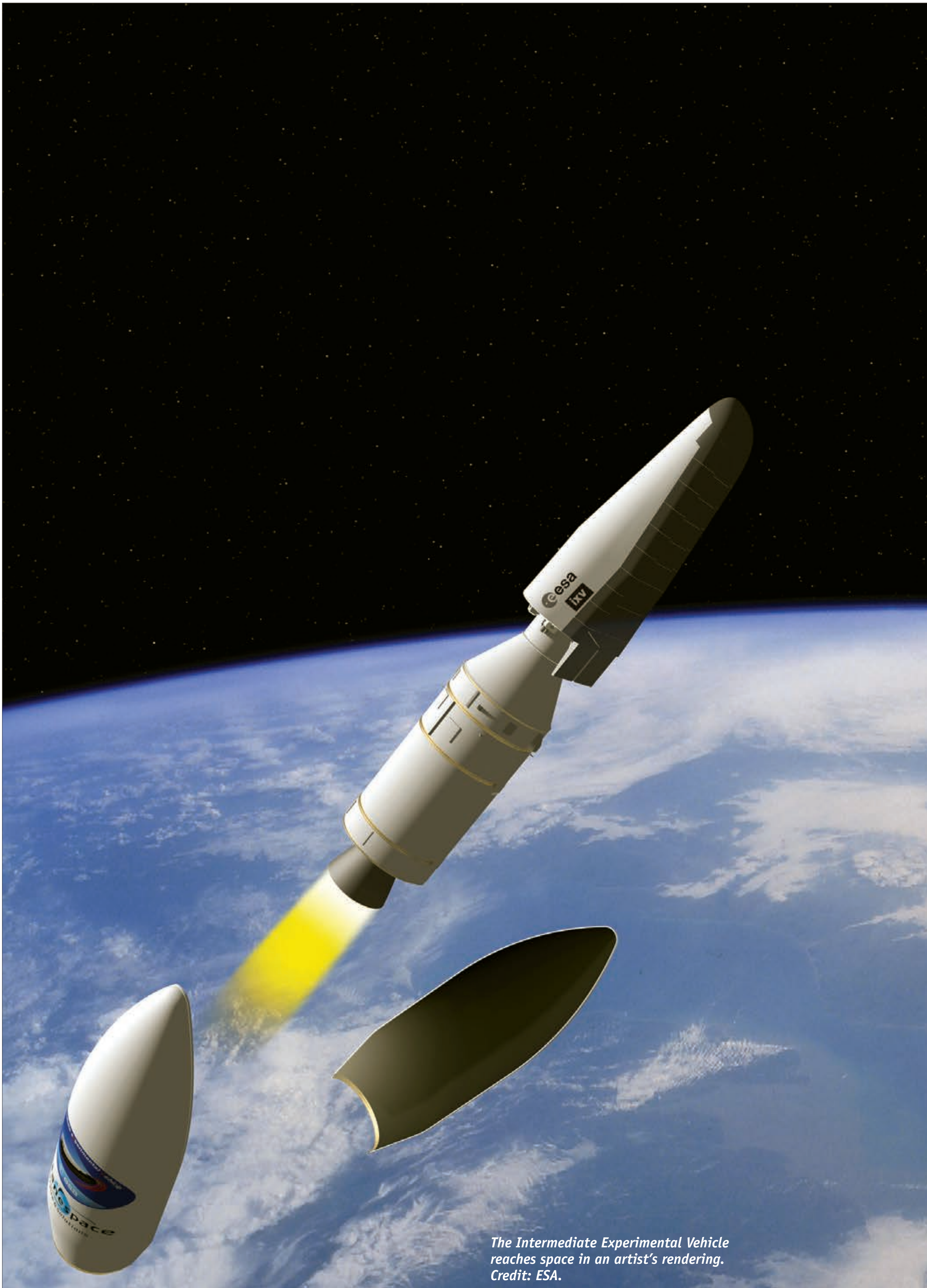
Since the competition opened on Oct. 21, 85 teams have entered, according to Aliyah Pandolfi, chief executive officer of the Al-Kareem Foundation. Participants are required to submit concepts for proposed aircraft, communications, sensors and embedded systems by Jan. 31. Teams will then build aircraft and conduct local flight demonstrations by April 30, with detailed design reports due June 30. Finalists will participate in flight demonstrations in October. Those demonstrations, which initially were expected to take place in San Diego, Calif., may occur in Kruger National Park, pending the outcome of ongoing discussions, Pandolfi said.

The contest's ultimate goal is not limited to protecting rhinos. Unmanned aircraft could be used to monitor and protect elephants, snow leopards and other endangered species. "Anytime someone at point A needs to see what is going on at point B without traveling there, UAVs can help," Wirsing said.

While that capability was apparent at Kruger National Park, the rangers did not catch poachers during the November Skate demonstrations. "We were able to work with the rangers to launch and fly UAVs, receive video and conduct counter-poaching missions," Wirsing said. "We did not see poachers. That would have been a home run."



A park ranger prepares the unmanned plane for its night mission. Credit: Kashmir-Robotics.



The Intermediate Experimental Vehicle reaches space in an artist's rendering. Credit: ESA.

Europe's reentry demo

Getting to orbit and back with a powered, winged craft poses fascinating engineering challenges. Space technology consultant Mark Williamson explains the European Space Agency's effort to solve one of the key problems — getting back into the atmosphere safely.

ANALYSIS
by Mark Williamson

The field of atmospheric re-entry was once dominated by governments that needed the capability to launch and return people from orbit, namely the United States, Russia and China. That's beginning to change. Re-entry technologies such as thermal protection systems and guidance, navigation and control were important to Japan's Hayabusa spacecraft, which returned dust from the asteroid Itokawa in 2010. They're now used by commercial companies to return cargo from the International Space Station. But these craft are ballistic capsules that must be launched on rockets, and they return to Earth with limited steering capabilities. The Holy Grail would be a spaceplane that would take off from a runway, reach orbit on its own power, and land on a runway. An example would be the proposed Skylon craft now in early stages of development by Reaction Engines Ltd. of Abingdon, U.K.

Returning any craft to Earth is challenging because of friction with the atmosphere, but guiding it to a runway is even more of a challenge. This is easier for a winged craft, such as the space shuttle or Skylon, than it is for a capsule, but the wings add complexity and weight. This is where IXV, the Intermediate Experimental Vehicle, comes in. Its wedge-shaped profile represents an intermediate step between a simple ballistic re-entry capsule and a future spaceplane.

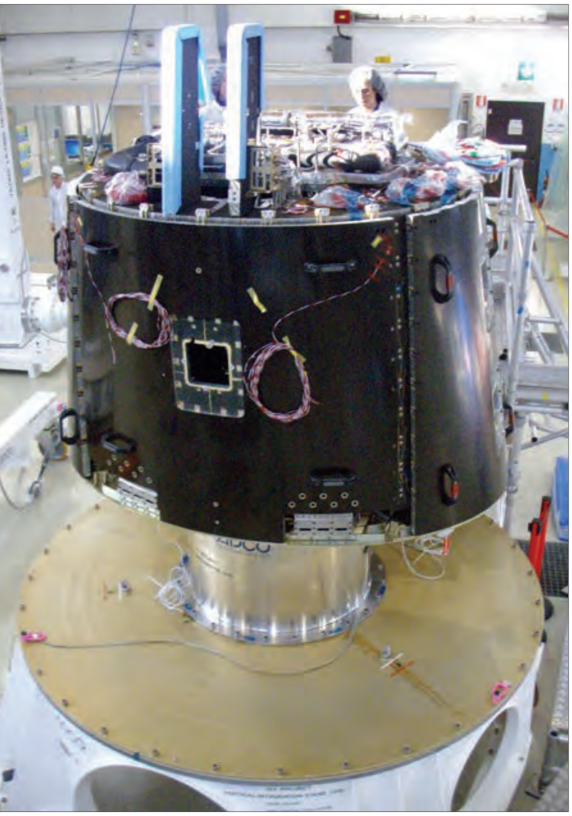
The European Space Agency has long recognized the importance of atmospheric re-entry to both manned and unmanned spaceflight, and the ESA-funded IXV demonstrator is the latest manifestation of this recognition.

ESA expects to launch IXV on a Vega rocket from the Guiana Space Centre in August in a suborbital demonstration of thermal and guidance technologies that a future powered spaceplane like Skylon would need to reenter the atmosphere and land. IXV will splash down in the Pacific.

Arguably most important is that IXV could one day lead to what some in Europe have long wished for: the ability to conduct manned space missions without recourse to other nations.

Flying brick

So, why should it interest those outside of Europe that ESA is playing catch-up on a re-entry technology mastered decades ago by the U.S. in the Space Shuttle program and the erstwhile Soviet Union in the Buran program?



The rear segment of the Intermediate Experimental Vehicle on an integration stand. Credit: ESA/Thales Alenia Space.

The potential advantage for European countries lies in their penchant for applying technology to commercial applications – in the satellite manufacturing and launch industries, for example. That ESA is funding a re-entry demonstrator suggests the potential for future commercial application.

Europe's investment in a craft that looks more like a spaceplane than a capsule comes as NASA and its commercial partners are largely focused on capsules reminiscent of the Apollo era. Specifically, SpaceX and Orbital Sciences have chosen the capsule solution for reasons of cost and relative ease of implementation. The drawback to capsules is that they're unable to carry payloads of large dimensions and mass. Bucking the trend is Sierra Nevada's Dream Chaser, which owes its heritage to NASA's proposed HL-20 Personnel Launch System lifting-body design of the late 1980s.

A lifting body is usually defined as a craft that produces aerodynamic lift using its body or fuselage rather than wings. ESA's project manager for IXV, Giorgio Tumino, explains that lifting bodies "have the advantages of capsules and winged bodies, without their disadvantages." Although capsules are simple and efficient, they have "problems in maneuverability, controllability and comfort if re-entering from orbit through off-nominal scenarios"—for example, if the angle of entry is too steep, he says. Winged bodies are best for maneuverability and controllability, but are "complex and expensive."

Research in the 1960s and 1970s produced a range of short, stubby lifting bodies predominantly with upturned tail-fins of various shapes and sizes to provide stability. Likewise, most of the craft proposed in the 1990s, such as the NASA-Defense Department X-30 National Aero-Space Plane and NASA's X-33 Venturestar, had between two and four fins at various angles to the main body.

The debt owed by the space shuttle program to lifting body research has been well documented, but it is worth remembering that, much like its forebears, each shuttle orbiter had a single chance at landing because it lacked engines. Although its wings endowed it with an enhanced cross-range capability, allowing it to glide to the left or right of its initial entry trajectory, the shuttle was—to recall a nickname coined during approach and landing tests of the 1970s—a "flying brick."

A glance at the outline of the IXV shows it to be different from most previous lifting bodies in its relative lack of aerodynamic control surfaces, having just two horizontal flaps at the base of the rear fuselage. Tumino says that "IXV will be the first-ever lifting body without even winglets to be flown on a mission fully representative of a return from low Earth orbit," which implies a body with an entry speed of approximately 7.5 kilometers per second.

The trick in providing stability without wings, winglets or tailfins, Tumino explains, is to design a shape that is "intrinsically stable longitudinally and laterally," effectively absorbing the winglet cross-section within the solid body of the fuselage. This is possible only because of modern-day computer optimization techniques and joined-up thinking in mission design: For example, the 40-degree angle of attack on re-entry means that any rudder would be, as Tumino says, "in the shadow of the vehicle" and therefore ineffective. As the IXV flies in an intrinsically stable configuration—the antithesis of today's fighter aircraft—any perturbations can be corrected by minimal adjustments of its rear body flaps and its roll, pitch and yaw thrusters, which are also programmed to maneuver the craft through re-entry and landing.

Not having winglets or tailfins smooths the upper aerodynamic surfaces, which reduces complexity and therefore manufacturing costs, while increasing the internal volume available for instruments and payloads. Not least, Tumino adds, is that "if we had winglets, we would need a larger fairing"—and a bigger, more expensive launch vehicle.

Given the long history of lifting bodies and atmospheric re-entry systems, it seems fair to ask what, apart from its shape, makes IXV special. Luigi Quaglino, senior vice president for exploration and science at Thales Alenia Space, is direct in his response: "IXV is special for Europe because it is actually going to fly." Apart from that, he sees IXV as "a clear step ahead for Europe" with respect to advanced guidance, navigation and control and active aerodynamic flight control.

For a craft designed to re-enter the Earth's atmosphere and land at a given position on the surface, thermal protection and guidance are among the main engineering challenges. From a systems engineering standpoint, says Quaglino, a key aspect was to ensure "the best compromise" between robustness and simplicity in the design.

To avoid what Quaglino terms "an extensive use of the tiles and blankets approach" of the space shuttle, IXV adopts a ceramic-metal composite, or CMC, approach based on relatively larger elements compared to the tiles that protected the shuttle orbiters. For a future operational craft, he adds, this choice offers more effective, simpler maintenance and "an obvious improvement of the overall vehicle reusability." CMCs are restricted to the nose cone, leading edges and flaps, while other areas are covered in ablative materials that dissipate re-entry heat by erosion.

As far as guidance and control are concerned, IXV will be an entirely autonomous spacecraft that uses more than 300 sensors to assess its attitude and thermal environment and respond accordingly using its reaction control thrusters and body flaps. Lift is produced by the lifting body design itself, but the challenge for the avionics subsystem is to match this with a natural tendency to fall because of gravity, while guiding the craft along a specified re-entry corridor to a predetermined touchdown point. It's what Buzz Lightyear would have called "falling with style."

Resurging interest

Few technology development programs start from scratch, and IXV is no exception: It relies on a wealth of heritage data from both sides of the Atlantic.

Arguably most relevant of the bewildering array of NASA X-vehicles is the X-40 Space Maneuver Vehicle, designed to investigate aerodynamics and guidance for the agency's X-37 Future-X reusable launch vehicle project. With a length of 6.5 meters and all-up weight of some 1.6 tons, it was similar to the IXV, which is 5 m long and weighs about 2 tons. The X-40 made seven test flights between 1998 and 2001, before the X-37 itself was transferred to the Department of Defense, where in 2004 it became the X-37B Orbital Test Vehicle, conducting three orbital missions between 2010 and 2012.

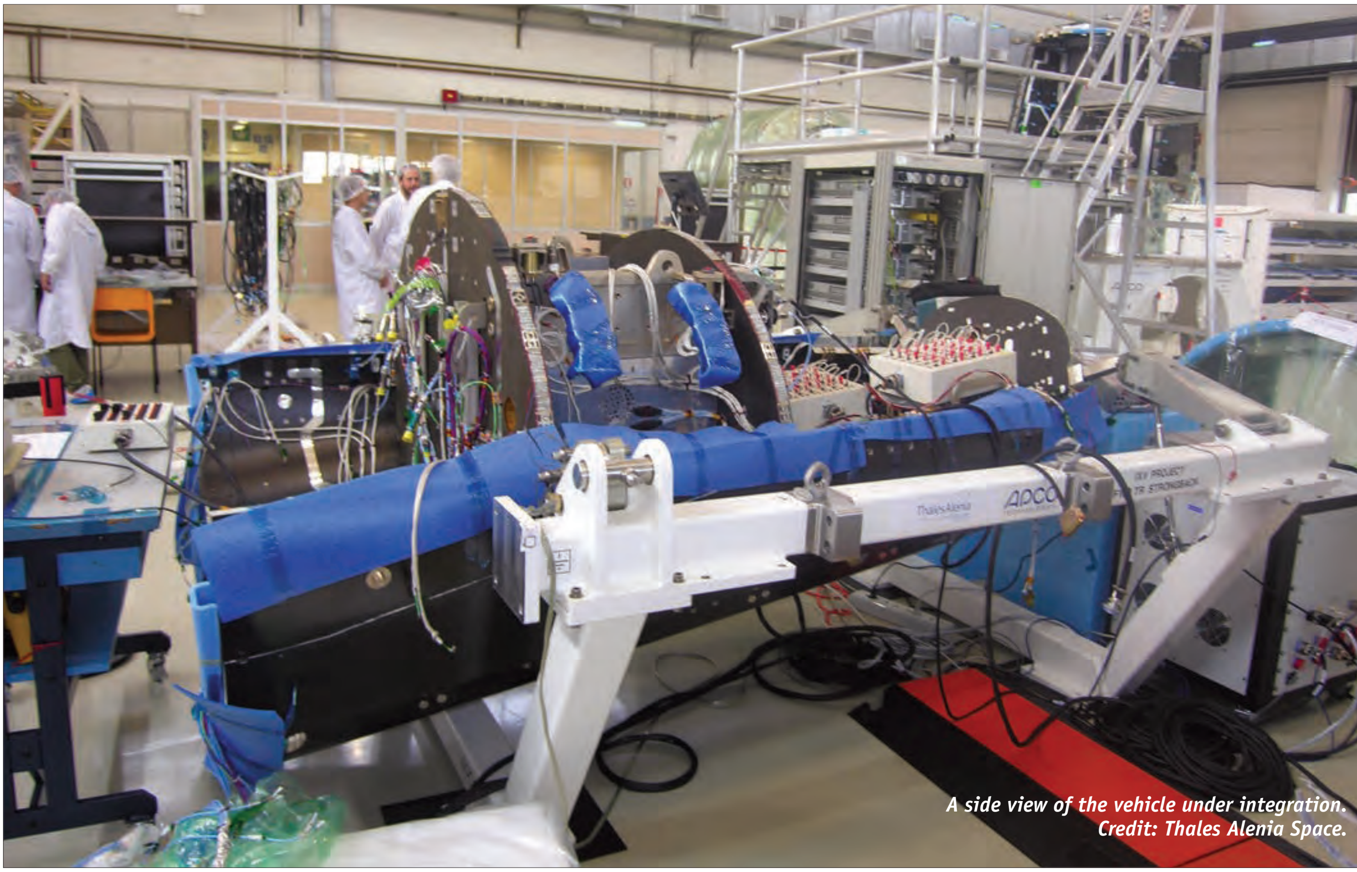
Apart from a number of study-based technology programs, Europe can claim heritage from Hermes, a lifting-body craft proposed by the French space agency CNES as an Ariane 5-launched three-seat shuttle. Although it was approved as an ESA project in 1987, it failed to meet its cost or performance goals and was cancelled in 1992 before any flight hardware had been built.

According to Tumino, a resurgence of interest occurred in the early 2000s when several European concept studies highlighted a desire to perform "the next step in the technology maturation process." In technological terms, this included integrating "critical atmospheric re-entry technologies," including advanced thermal protection, guidance and navigation, aerodynamics and control algorithms, to verify performance in conditions representative of a re-entry from low Earth orbit. With respect to system aspects, adds Tumino, this would mean progressing beyond Europe's Atmospheric Re-entry Demonstrator —a quasi-ballistic capsule flown in 1998—by "defining a lifting vehicle with higher lift-over-drag coefficients than a capsule, and therefore higher maneuverability and controllability, as an intermediate step toward future applications."

A drop test of the full-scale model took place in June 2013. Credit: ESA.

This marked the genesis of the Intermediate Experimental Vehicle, initiated as part of ESA's Future Launcher Preparatory Program in 2004. According to Quaglino, following "a thorough industrial trade-off on shape and system concepts…the concept selected for the IXV was a lifting re-entry body," designed for launch by ESA's Vega rocket on an equatorial trajectory leading to re-entry and parachute-assisted splashdown in the Pacific Ocean about 100 minutes later.

The program reached a key milestone on June 19, 2013, at the Salto di Quirra test range in the Tyrrhenian Sea off the east coast of Sardinia, Italy. A full-scale model was released from a helicopter in a drop test from 3,000 meters, reproducing the final descent and splashdown phase of the proposed mission. According to Quaglino, the objective is to complete the IXV's System Qualification and



A side view of the vehicle under integration. Credit: Thales Alenia Space.

Acceptance Review by mid-year, with a launch "foreseen in August 2014."

Although the IXV's development cost is around 150 million euros, Quaglino expects this to rise to some 170 million euros when ground segment procurement, the launch campaign, recovery and initial postflight analysis are included. Thus, in the context of space systems development, IXV is certainly not an expensive program, especially considering its strategic importance in terms of research and development for Europe.

The front and rear segments mated into a single assembly. Credit: ESA/Thales Alenia Space.

Next steps

According to Tumino, a broad consensus on atmospheric re-entry research has produced a flight demonstration roadmap that will see an evolution of IXV through PRIDE, the Program of In-orbit Demonstration for Europe, for which Tumino is also project manager.

Although Quaglino warns that IXV evolution "may follow different paths," his current expectation is that PRIDE will involve "a small winged vehicle launched to LEO [low Earth orbit] by Vega." The program will add "two important technological bricks to the current IXV mission," he suggests: orbital operations, and autonomous guidance to an automated landing (as opposed to a splashdown as with IXV). "It is an extremely challenging and demanding mission," says Quaglino, that would lead eventually to "a fully reusable transportation system" for satellite servicing and other missions in LEO. In other words, the holy grail of the space community for the majority of the Space Age—and arguably before that.

Tumino is currently focused on the IXV. "The successful accomplishment of the IXV mission," he concludes, "is a fundamental step for Europe to validate the performance of critical atmospheric re-entry technologies in the hypersonic flight regime required for any future operational system."

Indeed, he notes a number of initiatives in Europe that would benefit from a successful IXV mission, including the U.K.'s Skylon, Germany's Spaceliner and the proposed Astrium spaceplane. "All these different European initiatives indicate a wide range of re-entry technology applications," says Tumino.

Perhaps most important, they indicate that Europe is not content, in the longer term, to rely on other nations for guaranteed access to space.

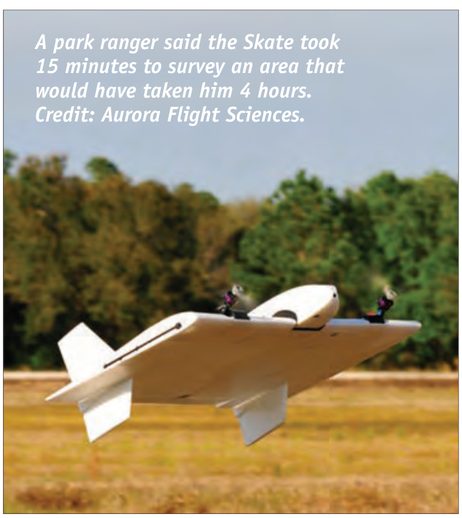
Unnamed aircraft

(Continued from page 31)

months. The roadmap and comprehensive plans are the FAA's attempt to move away from the waiver process and establish permanent rules governing unmanned aircraft operations.

Detect and avoid

The FAA documents describe the major technical challenges that must be solved to integrate the new aircraft into the airspace. For starters, unmanned craft and their operators will need to show that they are as good as traditional systems at detecting the location of other planes and avoiding them. A federal advisory committee is currently developing standards for detect-and-avoid technologies based on recommendations made by the non-profit Radio Technical Commission for Aeronautics, the FAA says.



A park ranger said the Skate took 15 minutes to survey an area that would have taken him 4 hours. Credit: Aurora Flight Sciences.

Draft requirements circulated in 2008 called for unmanned planes to be capable of detecting other aircraft at a range of 3 statute miles with a 30-degree vertical field of view and a 220-degree horizontal field of view. The draft was produced by a subcommittee of the American Society for Testing and Materials, a non-profit organization that develops voluntary consensus standards. Sensors that can meet the above requirement today either weigh too much or would be too costly for many missions. Research scientist Sanjiv Singh of Carnegie Mellon University's Robotics Institute sees a possible answer: He suggests requiring all aircraft to carry the type of transponders commercial jets are adopting for the Next Generation Air Transportation System.

The fear factor

Engineers are wrestling with the challenge of developing sophisticated command and control systems that can withstand hacking. "No matter how you look at it, UAVs have got to have data links with ground control stations," said retired Air Force Maj. Gen. James Poss, former assistant deputy chief of staff for intelligence, surveillance and reconnaissance at Air Force headquarters. "Those data links will be vulnerable to hacking."

The command link also could be lost because of equipment failure, and an aircraft must be programmed to handle this kind of situation. If communication with a ground-based pilot or operator were lost, a plane would need to rely on autonomous systems to guide it home, back to the last point where its data link worked, or to a safe landing on the ground, says Poss, now director of strategic initiatives at Mississippi State University.

Although these technological hurdles are significant, there's an arguably higher political hurdle. While the FAA has been busy figuring out how to let these craft into federal skies, some states have been busy working to strictly limit their use. Legislators in 43 states have proposed 118 bills and resolutions to limit unmanned aircraft operations. Thirteen states have enacted 16 bills; 10 states have adopted resolutions, according to the National Conference of State Legislatures.

Most of those would prohibit police from using unmanned craft for surveillance without a warrant. Some go even farther. In Montana, law enforcement agencies cannot use unmanned aircraft to collect evidence. In Nebraska, the same rule applies unless a terrorist attack is suspected. Virginia law would prevent state agencies from employing unmanned planes until July 1, 2015, except in specific emergencies such as search and rescue operations and National Guard exercises.

Advocates for unmanned aircraft say this patchwork of laws and resolutions is unworkable. "Can you imagine using unmanned aircraft systems to conduct a disaster relief effort, but being unable to cross state lines?" Bahrami says. To resolve the problem, the Aerospace Industries Association is calling for national leadership to address privacy concerns.

That type of initiative is under way. FAA's comprehensive plan notes that integration of unmanned craft in the national airspace raises many issues related to national security and privacy. The FAA is working with the White House national security staff to establish an interagency committee to address these concerns, according to the comprehensive plan.

In one view, the federal bureaucracy is in a race, whether it likes it or not, with the states. Without a firmer national plan, states are likely to persist in their efforts to address the matter. "When the federal government fails to do its job, authority reverts back to the states," Langford says. "In aviation, we need one set of laws that applies to the whole country."

MOBILE SATCOM

A batch of Globalstar second-generation satellites is readied for launch aboard a Russian Soyuz 2 rocket. Credit: Arianespace.

REVIVAL

Constellations vie for new business

by Ben Iannotta

After cellphones decimated the projected market for satellite-based mobile communications, rivals Globalstar and Iridium rose from the flames of bankruptcy promising a mix of voice and data comms. The companies have vastly different strategies for how to do that, and those strategies are now unfolding in orbit and in ground networks. We'll soon learn whether one or both of these phoenixes can stay out of the flames.

One thing satellite operators Globalstar and Iridium have in common is a knack for survival. Each spent time in bankruptcy in the early 2000s after terrestrial cell phone coverage expanded faster than expected, gobbling up potential mobile communications customers for their low-Earth-orbit satellite constellations.

After a decade of ownership changes, financial restructuring, and brainstorming supplements to their phone businesses, Globalstar and Iridium are about to do something that seemed unlikely in the dark days of bankruptcy. The time has come for them to modernize their networks of satellites and ground equipment.

The success of this modernization work could determine whether one or both of these phoenixes manages to stay clear of the flames in an age of smartphones, terrestrial networks, and a fierce competition between the two firms.

Competing strategies

As it stands, Globalstar is the proud owner of 24 new satellites in orbit, and it is now working to win back voice customers it lost because of electronics troubles on its first satellites.

Globalstar's total of 32 satellites—eight survivors from the original constellation, plus the new models—is well short of the 48 it operated 14 years ago, but Globalstar says this reflects its lean-and-mean strategy. "With the growth of cellular and with the growth of other satellite communications companies, we only need 32 satellites to serve our business plan very, very competitively," says Tony Navarra, Globalstar's president of operations.

Globalstar's modernization plan counts less on global coverage than on boosting data speeds, and that will not be complete until the company finishes rolling out its second-generation ground network by 2016.

Unlike Iridium, whose satellites bounce data or calls over intersatellite cross links, Globalstar moves signals around the world via its satellites and 26 ground gateways. The best data rate Globalstar can achieve today is 40-50 kilobits per second, by combining multiple channels of 9.6 kilobits. Once the second-generation ground system is deployed, the rate will jump "upwards of 144 kilobits per second," says Navarra.

Iridium's plan is bolder still. In 2015, the company plans to start launching Iridium NEXT, an entirely new $3-billion constellation of 66 satellites plus spares, whose blueprint passed the critical design review in October. These spacecraft will be launched on SpaceX Falcon 9 rockets and will outweigh the second-generation Globalstars by 100 kilograms. Iridium CEO Matt Desch predicts a big improvement in data rates too. Consider small antennas like those on an aircraft: "If you use that same size of antenna with an Iridium NEXT system, we would be able to take that [rate] from about 2.4 kb up to almost 100 kb," he says. Certain antennas could crack a rate of "about a megabit and a half," he adds.

> **"If you use that same size of antenna with an Iridium NEXT system, we would be able to take that [rate] from about 2.4 kb up to almost 100 kb....[Certain antennas could crack a rate of] about a megabit and a half."**
>
> Matt Desch
> Iridium

Globalstar and Iridium have entirely different technology strategies for modernizing. Globalstar is counting on the ground upgrades to make the biggest impact. Iridium's networking brawn will remain on its satellites. Just as with the original Iridiums, the NEXT spacecraft will have K-band cross links to relay data or voice calls around the world.

Hosted payloads

Iridium's modernization plan now extends beyond Iridium NEXT. In September, the company held a press briefing in Paris to announce plans to create a parallel constellation called Iridium PRIME starting in 2017. These satellites will be built specifically for the hosted payload market, in which customers pay to fly sensors on satellites they don't own. It's unclear how many Iridium PRIME satellites will be built, but Iridium says it could control up to 140.

The Iridium PRIME satellites will be similar to the Iridium NEXT spacecraft, except that designers have removed a set of electronics for the airline industry and a large L-Band antenna that would normally provide ground coverage. The PRIME satellites won't need the airliner tracking equipment because the NEXT satellites have that market covered. The L-Band antenna won't be needed because the PRIME satellites have another strategy for getting data to the ground. Each PRIME satellite will use cross link antennas to feed data into the NEXT constellation, which will route it from satellite to satellite and to the ground via feeder antennas.

Removing the airliner comms and L-band equipment frees up a lot of volume and power for hosted payloads. "With Iridium PRIME, we expand that space, essentially, to the whole nadir deck," Desch told reporters, referring to the side of the spacecraft that faces Earth and has connections for power, data, and command and control. Each Iridium PRIME satellite will have at least 17 times more volume available for hosted payloads, and as much as 30 times more volume for versions launched on the largest rockets.

Harris, one of Iridium's potential hosted payload partners for Iridium PRIME, is billing the satellites as manna for cash-strapped agencies looking to keep gathering weather data, Earth observations, and surveillance information.

"Government obviously cannot continue to do things as they have in the past," said Janet Nickloy, director of aerospace mission solutions at Harris, during the briefing.

Harris designed a payload electronics box, called AppStar, that will fly on the Iridium NEXT satellites. Much of the volume will be reserved for the Harris-built data receivers needed for Iridium's planned airliner tracking service. But under an arrangement with Iridium, Harris has marketed the remaining electronics slots to support other hosted payloads.

Harris reports it has sold all the extra slots on the forthcoming Iridium NEXT satellites. "With minimal marketing, the interest in leveraging just a few card slices and a little bit of deck space has just been amazing," Nickloy said.

Iridium and Harris hope that means a brisk business for Iridium PRIME.

Retired Air Force Col. David Anhalt, the new general manager of Iridium's hosted payload business, sees a new way of thinking: "My whole background on this subject has been perhaps imprisoned by this idea that a hosted payload is a secondary payload, and therefore has limited rights on a primary platform."

He views Iridium PRIME this way: "Iridium will be hosting this payload on its network. It's not hosting it on the spacecraft."

Survival plan

While Iridium was growing and making bold plans, Globalstar climbed out of bankruptcy by innovating in the face of faulty satellite electronics that limited some of its spacecraft to one-way communications. "We never did find the event, the anomaly itself, that caused that failure," says Navarra.

What the company knows for sure is that the S-band amplifiers on its satellites began to fail. The affected spacecraft were limited to one-way, or simplex, communications instead of real-time voice communications. Globalstar suspects that the electronics were not adequately protected from radiation. The company made a dramatic decision in 2006 when it ordered its second-generation satellites. It shifted from Space Systems/Loral as its satellite prime contractor to Thales Alenia Space, a joint venture between Paris-based Thales and Rome-based Finmeccanica. It didn't matter that Loral had been a founding investor in Globalstar.

Engineering changes followed: "We've tucked all of the active components for the S-band frequencies inside the spacecraft, protecting them with additional metal and gold foil," says Navarra.

In the meantime, Globalstar survived in the marketplace with two innovations. It created a website-based Call Times Tool to tell subscribers when the optimal time would be to make a call or share data over the remaining duplex satellites. Chairman James "Jay" Monroe III also sat executives down and asked them to think of valuable things Globalstar might do with simplex services. Monroe had a lot at stake, having arrived at Globalstar in 2004 as the majority owner of Thermo Companies, whose investment arm purchased the Globalstar assets out of bankruptcy in 2004.

"We said, 'Okay, now let's go for the market for children'—parents that want to be backpacking with the girl scouts and boy scouts and want to always know they can send an SOS message where they can ask for help," Navarra recalls.

Globalstar launched the SPOT messenger service for nervous parents, hikers, boaters, and adventurers. Today, subscribers can send GPS coordinates and one-way status messages from SPOT handheld devices.

The Globalstar executives also got busy restructuring financing to launch the 24 second-generation satellites on Russian Soyuz rockets. The last of the 24 was put into full commercial service in August 2013. In an earnings call not long after, Globalstar said its two-way calling business is coming back strong, with a doubling of subscribers in April, May and June 2013 and a 41 percent increase in minutes used.

> **"We've tucked all of the active components for the S-band frequencies inside the spacecraft, protecting them with additional metal and gold foil."**
>
> Tony Navarra
> Globalstar

As pleased as Navarra was with the SPOT location service and the machine-to-machine business, he says there's nothing like voice communications: "People never stop talking."

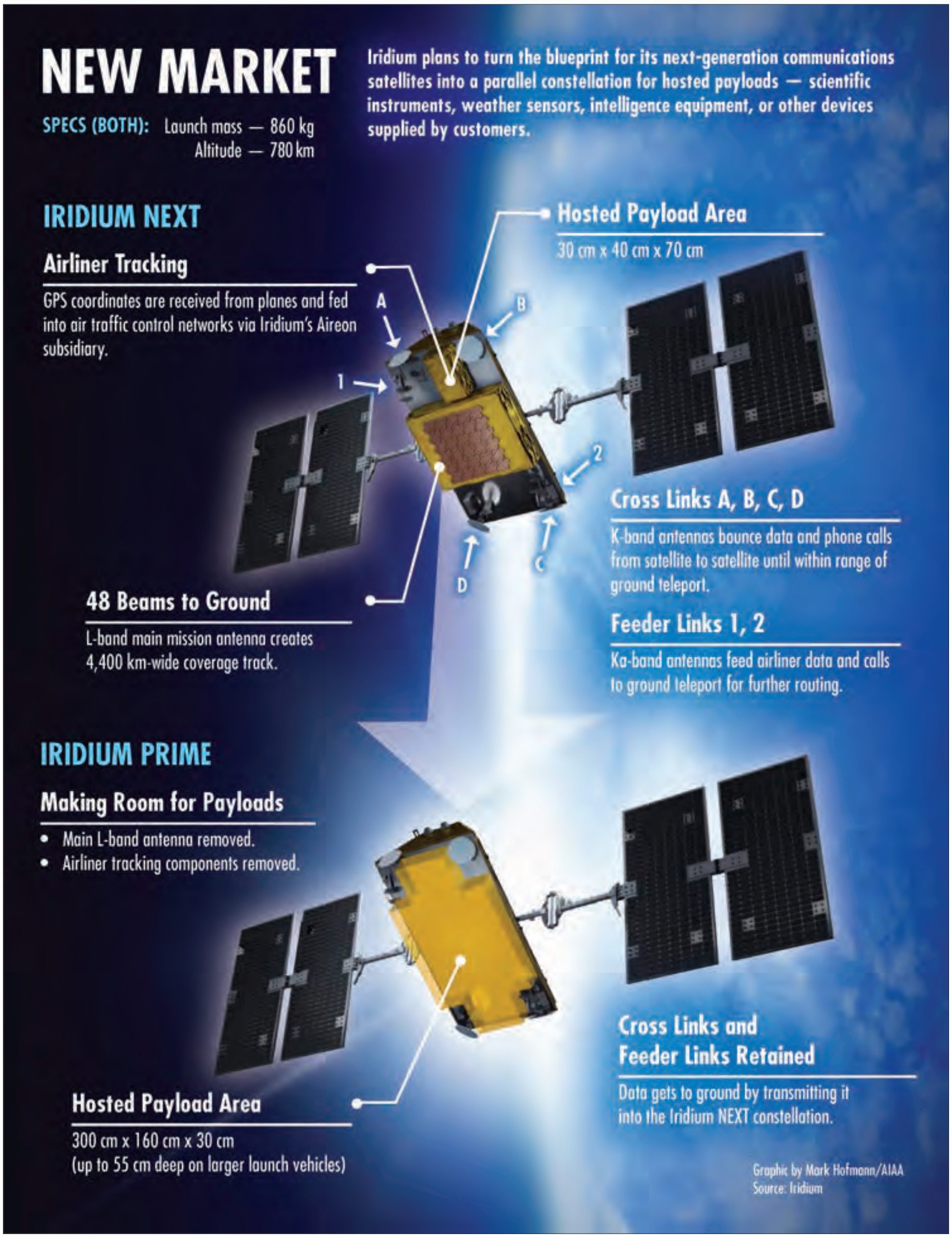
Growth plan

Iridium is arguably in a stronger position than Globalstar, and it owes a lot—some say everything—to the U.S. military, which was interested in Iridium's wireless comms and its ability to automatically track objects equipped with location transmitters. Iridium, in fact, has a gateway in Hawaii specifically for the military. The Pentagon assisted Iridium out of bankruptcy with a $72-million contract award in 2000 to provide communications for 20,000 troops. That was followed by classified business and a wartime innovation called the Distributed Tactical Communications System, or Netted Iridium.

ITT—now ITT Exelis—manufactured push-to-talk Iridium radios for troops in Afghanistan and tweaked the Hawaii gateway to handle the new service. Iridium and Boeing figured out how to program the satellites to accommodate the netted communications mode.

Mark Adams, now general manager of specialty applications for Exelis, was on the team that purchased Iridium LLC's assets and led the reborn company out of bankruptcy with Netted Iridium and new services in the data relay market.

"The world had shifted," says Adams, then Iridium's chief technology officer.



everyone in the network could hear them. Iridium, however, was a dial-up phone service. Could Iridium be made compatible with push to talk?

If so, that had to be done without crimping Iridium's growing consumer and data services.

"I think one of the cool things that we were able to do is make it so you're not utilizing system resources until you actually push the button to communicate," explains Adams. "At that point, the system configures the channel, sets it up within the net, and you're only occupying one channel to provide that communication, which could go to a large number of listeners that are in the net."

Up next, Exelis and Iridium hope to demonstrate that they can reduce Netted Iridium's voice latency—currently 1.5 sec— and expand the service so that troops can use it wherever they need it around the world. The work is being undertaken for the Defense Information Systems Agency.

The current version of Netted Iridium relies on a single satellite passing overhead, which limits the range of a network to 250-500 miles. DISA and its contractors think they can go worldwide by tapping Iridium's K-band intersatellite links.

"I could extend that [voice net] into different areas, and then make it global, and that's exactly what we're doing," Adams says.

"Data became extraordinarily important, and so there was a whole host of data services that we tried to deploy rather rapidly to keep pace with customer demand," he says.

Data helped Iridium grow, but there was also work to do in the voice realm. Netted Iridium was born out of feedback from the military.

"One of the things that became apparent when I started talking to the different military communities about how they support an operation, was [that] for them, push to talk is fundamental," Adams says.

Soldiers doing dangerous jobs were comfortable pushing buttons on radios so

The constellations

Iridium's future hinges on the success of the Iridium NEXT satellites. The company plans to buy 81 of them to maintain a constellation of 66 operational spacecraft in six orbital planes. Thales Alenia Space, which built the new Globalstar satellites, is also Iridium's prime contractor, but with an American twist: Orbital Sciences will assemble and test the 860-kilogram satellites at its facility in Gilbert, Arizona.

"The parts will come in one side and out the other side—every 56 days will come an Iridium NEXT satellite," says Desch.

They will then be sent to Vandenberg Air Force Base, Calif., for launch.

For its part, Globalstar thinks it can get by with 32 spacecraft, and it readily acknowledges that this will mean ceding coverage of the polar regions.

"The reason we did that, to be perfectly honest, is there's not a lot of people, not a lot of surface up there. So why waste the energy?" says Navarra.

New markets

For Iridium, satellite coverage isn't just about people on the ground. It is increasingly about aircraft, especially airliners flying Asian or Atlantic routes over ocean and mountain areas that air traffic radars can't reach.

Iridium and Globalstar are vying to provide space-based versions of what are called automatic dependent surveillance broadcast services. ADS-B messages are sent by transponders on aircraft. They include GPS location, identity, speed and altitude. The idea is to save fuel: For years, controllers had to wait five to six minutes for position reports to come in via high-frequency radio links. With almost instantaneous reporting, controllers in the U.S. and abroad can decrease the separation between planes and put them on more efficient routes. The surveillance information has started flowing over a new network called the Future Air Navigation System, or FANS. After real world trials, FAA approved FANS over Iridium in 2011.

Iridium set up a subsidiary, called Aireon, to prepare for a new version of the surveillance technology on Iridium NEXT. In late 2012, Nav Canada, the company that runs Canada's air traffic control system, agreed to join the Aireon venture as a first user. Each Iridium NEXT satellite will have a Harris-built receiver to listen for location and data reports from airliners and relay the information to air traffic controllers.

Globalstar has been testing its version with a company called ADS-B Technologies. They call their version ALAS, for ADS-B Link Augmentation System. ADS-B says on its website that it's anxious to use Globalstar's second-generation satellites. It anticipates starting essential services in 2015 and critical services in 2017.

An issue for Globalstar is that its bent-pipe approach means transmitting GPS coordinates up to a satellite and down to a ground gateway. As it stands, Globalstar's gateways leave uncovered 40 or 50 regular flights, Navarra says. Also, Globalstar's satellites are in Walker orbits that top out at 70 degrees latitude, which means a new polar orbiter would need to be added to cover airliners at high latitudes. "That's absolutely possible, and it's low cost," Navarra says.

> **"The world had shifted...Data became extraordinarily important, and so there was a whole host of data services that we tried to deploy rather rapidly to keep pace with customer demand."**
>
> Mark Adams
> Exelis

Data volume won't be a problem for the Globalstar network, Navarra predicts. "It's not even a challenge for our ground stations to handle thousands of aircraft that are simultaneously transmitting," he says.

Desch doesn't see how more ground stations will solve the airliner problem for Globalstar: "You can't put a ground station in the middle of the Atlantic, or the middle of the Pacific."

He views the ADS-B aircraft surveillance market as fresh vindication for Iridium's decision long ago to install intersatellite links on the first Iridium satellites and the Iridium NEXT versions too. "I remember everyone talked about what a crazy idea it was putting intersatellite links on satellites. That was only done by militaries for spy satellites," Desch recalls.

Even as they push to modernize, Globalstar and Iridium are being careful not to make the mistake of overreaching, as they did in their early years. Communications services that rely on expensive space launch vehicles and dozens of radiation-protected satellites can never take on lower cost terrestrial communications where those services exist. The companies are focusing their efforts on markets where they can add value.

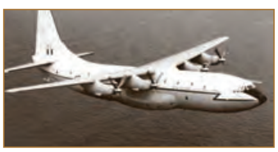
As Desch puts it: "We still view ourselves as complementary long term to many other technologies that are even faster and lower cost than ours."

Out of the

25 Years Ago, January 1989

Jan. 3 NASA's ER-2 high-altitude aircraft, with a team of scientists on board, makes its first joint U.S.-European study of ozone layer depletion around the North Pole. NASA, *Astronautics and Aeronautics, 1986-90*, page 203.

50 Years Ago, January 1964



Jan. 5 Short Brothers' Belfast, the largest-ever British military aircraft, makes its inaugural flight from Queen's Island Airport at Belfast, Northern Ireland. The heavy-lift freighter, which has four turboprop engines and a takeoff weight of 171,000 pounds, will enter Royal Air Force service in 1966. *Aviation Week*, Jan. 13, 1964, page 39; Short Brothers Belfast file, National Air and Space Museum.

Jan. 7 Martin and Black & Decker demonstrate the first power tool designed and built for use in space. Called the electric minimum reaction space tool, the battery-powered drill is similar to home-use drills but has 99.97 percent less reactive torque and thus can be used in zero-gravity. The drill was developed for the Air Force and tested in a simulated 100-mile-altitude space environment. *Flight International*, Feb. 2, 1964, page 300; *Space Business Daily*, Jan. 8, 1964, page 37.

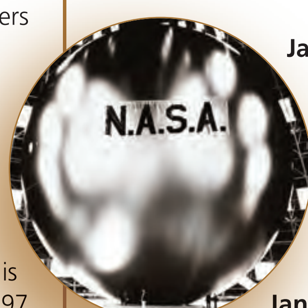
Jan. 18 British aviation pioneer and inventor Air Commodore William Helmore dies at age 69. His inventions include the lighting equipment used during World War II by night fighters to illuminate enemy bombers; the Leigh Light, a submarine detection device; and an aircraft ice detector. He also worked on lubricating additives for aircraft fuels. *Flight International*, Jan. 23, 1964, page 117.

Jan. 20 The new six-to-eight-place turboprop-powered Model 90 King Air business aircraft starts its test program. Built by Beech Aircraft, the plane has two Pratt & Whitney PT-6A-6 engines of 550 horsepower each. *Aviation Week*, Jan. 27, 1964, page 40.

Jan. 21 A Thor-Delta rocket launches the 184-pound Relay 2 experimental communications satellite, the last in the Relay program. The satellite's main goals are to test transoceanic communications and measure the radiation in its orbital path. Relay 2's first public demonstration is the live transmission of a Winter Olympics hockey game on Jan. 20 from Innsbruck, Austria, to the U.S. Other tests include voice and radio signal transmissions between ground stations in Nutley, NJ, and Raisting, West Germany. *New York Times*, Jan. 22, 1964, page 17; Relay 2 file, National Air and Space Museum.

Jan. 21 The two stages of the Gemini Titan 2 rocket are test fired for the first time at Cape Kennedy in Florida. *Flight International*, Jan. 30, 1964, page 179.

Jan. 25 United Aircraft's United Technology Center fires a prototype of its 120-inch-diameter solid-propellant Titan 3C booster motor. *Aviation Week*, Feb. 3, 1964, page 71.



Jan. 25 The Echo 2 passive communications satellite, an inflatable 135-foot-diameter laminated mylar plastic and aluminum balloon, is launched on a Thor-Agena B rocket from Vandenberg Air Force Base, Calif. The satellite's estimated lifetime is about 100 years. Like its predecessor, Echo 1, the craft can be seen with the naked eye. *Flight International*, Feb. 27, 1964, page 338.

Jan. 28 From Edwards Air Force Base, Calif., the North American X-15 rocket research aircraft makes its 100th flight. Piloted by USAF Maj. Robert A. Rushworth, it reaches an altitude of 107,000 feet and a speed of Mach 5.4. *Aviation Week*, Feb. 3, 1964, page 35.

Jan. 28 The U.S. and Spain sign an agreement to build a $1.5-million tracking station near Madrid to become part of NASA's Deep Space Network. *Aviation Week*, Feb. 3, 1964, page 35.

Jan. 29 The Saturn I SA-5 makes its first flight with both stages of the rocket. The first stage, S-1, consists of eight upgraded H-1 engines for a total thrust of 1.5 million pounds, while the second, S-IV, has six liquid hydrogen RL-10 engines, for a total thrust of 90,000 pounds. It is the world's largest known rocket. The mission demonstrates the ability of the liquid-hydrogen, clustered upper stage to place a 20,000-pound payload in orbit. *Aviation Week*, Feb. 3, 1964, page 34; *Missiles & Rockets*, March 2, 1964, pages 17-18.

Jan. 30 An Atlas-Agena-B launches Ranger 6 toward the Moon to photograph the lunar surface. The 804-pound spacecraft carries six television cameras

Past

An Aerospace Chronology

by **Frank H. Winter**
and **Robert van der Linden**

designed to send back more than 3,000 high-resolution photos during the final 10 minutes of its 66-hour flight, before it impacts the Moon. Lunar photography is critical for the final design of the Apollo lunar landing module and for selecting potential landing spots. However, the camera system fails and no images are returned. Not until the mission of Ranger 7, launched July 28, 1964, will the first close images of the lunar surface be transmitted back to Earth. *Aviation Week*, Jan. 27, 1964, page 40, and Feb. 10, 1964, pages 22-25; Ranger 7 file, National Air and Space Museum.

Jan. 30 The Soviet Union orbits two scientific spacecraft, Electron 1 and Electron 2, with a single launch vehicle. The satellites will study layers of the upper atmosphere and radiation belts surrounding Earth. Electron 1 orbits at 4,412 miles apogee and 252 miles perigee, while Electron 2 is at a 42,379-mile apogee and a 286-mile perigee. *Washington Post*, Jan. 31, 1964, page A14.

75 Years Ago, January 1939

Jan. 1 Following the annexation of Austria by Germany, Austrian airline Oesterreichische Luftverkehers Austroflug is taken over by the German Luft Hansa and transformed into Bezirksleitung Sudost, or district section Southeast, with headquarters in Vienna. *Interavia*, Jan. 4, 1939, page 12.

Jan. 3 The Navy submits its program for establishing new bases, including naval air bases at Midway, Guam, Johnston Island, and San Juan, Puerto Rico. *Interavia*, Jan. 17, 1939, page 14.

Jan. 9 Celebrations mark the16th anniversary of the autogiro's first flight, made from Madrid by aviation pioneer Juan de la Cierva, who invented the craft. Festivities include the unveiling of a memorial to him at the Guggenheim School of Aeronautics at New York University. The memorial is an engraving of the inventor's name on the building's stone façade alongside the names of Leonardo da Vinci, the Montgolfier brothers, the Wright brothers, and Samuel Langley. *Aero Digest*, Feb. 1939, page 27.

Jan. 17 Eastern Air Lines wins a bid for a Post Office Department contract for rooftop mail service by autogiro. The experimental route is to operate between the post office building and Philadelphia's airport, which was chosen because its roof was built for autogiro use. *Aero Digest*, Jan. 1939, page 32.

Jan. 21 George W. Lewis of the National Advisory Committee for Aeronautics is elected president of the Institute of the Aeronautical Sciences, succeeding T.P. Wright of Curtiss-Wright. *Aero Digest*, Feb. 1939, page 31.

Jan. 23 A Curtiss-Wright Hawk 75A single-seat fighter aircraft intended for France reaches an unprecedented 575 mph during a diving test. The dive begins at an altitude of 22,000 feet. *Interavia*, Feb. 7, 1939, page 10.

Jan. 27 The Lockheed XP-38 prototype makes its inaugural flight. The twin-boom-configured P-38 Lightning becomes one of the fastest and most famous U.S. fighter aircraft of World War II. R. Francillon, *Lockheed Aircraft Since 1913*, page 160.

And During January 1939

–The firm of Louis Breguet takes over Latecoere, turning the Breguet concern into the largest private aviation business in France. Both Breguet and Latecoere have played important roles in French aviation, Breguet having produced several types of fighter aircraft during and after World War I and Latecoere having built large long-distance transports such as the Latecoere 631. *Interavia*, Jan. 21, 1939, page 3.

100 Years Ago, January 1914

Jan. 1 The world's first scheduled passenger airline begins service, run by the St. Petersburg–Tampa Airboat Line, on a 22-mile route between the two Florida cities. Electrical engineer Paul E. Fansler started the airline with financial backing from St. Petersburg city officials and businessmen. The service transports passengers and freight on a Benoist Type XIV flying boat piloted by Tony Jannus. Former mayor A.C. Pheil is the first passenger, but the business lasts only until April. R. Davies, *Airlines of the United States Since 1914*, pages 1-4.

And During January 1914

–For the first time, an airplane in flight is seen in Tehran, Persia, when Russian aviator Alexander Kouzminsky pilots his Blériot over a parade ground and attracts many spectators. On Jan. 12 he flies before the Shah and other members of the country's Imperial family. *Flight*, Jan. 10, 1914, page 46.

INSTITUTE FOR SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL OF ENGINEERING

FACULTY POSITION IN MODEL-BASED SYSTEMS ENGINEERING

The Institute for Systems Research (ISR) and the A. James Clark School of Engineering at the University of Maryland, College Park, invite applications for a tenure-track assistant professor position in Model-Based Systems Engineering (MBSE). We seek applicants with a doctoral degree who have research expertise in MBSE, formal approaches to engineering design and validation, requirements engineering, and multi-objective optimization and trade-off analysis, with appropriate connections to an engineering and/or biological domain.

This position is tenure track in a Clark School department (Aerospace, Electrical and Computer, Fire Protection, Mechanical, Civil and Environmental, Chemical and Biomolecular, Materials Science and Engineering, or Bioengineering) with a joint appointment to the ISR. The tenure home for this appointment will be in the department, and the ISR and its Director will also review the candidate's dossier.

The position holder will contribute to teaching systems engineering, advise systems engineering students for their theses, and develop new systems engineering courses. With regard to research responsibilities, the position holder will propose and conduct MBSE methodology and tools research that improves the ability to conceive, design and analyze complex multi-domain systems and will collaborate with other ISR faculty researchers to incorporate MBSE methods into ISR multi-disciplinary research.

The Clark School's (**www.eng.umd.edu**) graduate programs collectively rank 19th nationally (11th among public universities) in U.S. News & World Report's "America's Best Graduate Schools 2014." In 2013 the Academic Ranking of World Universities ranked the Clark School programs 16th in the world. ISR (**www.isr.umd.edu**), an original NSF ERC, celebrates 27 years of multi-disciplinary research in cooperation with universities, government, and industry. With annual expenditures exceeding $20M, it conducts interdisciplinary research and provides education in systems engineering and sciences; and devises basic solution methodologies and tools for systems problems in disparate application domains. ISR has 38 joint appointment faculty; 27 affiliate faculty; and eight research scientists from four colleges and 14 units across the University of Maryland.

Prospective candidates should demonstrate the required expertise and apply with:
1) A cover letter; 2) Curriculum vitae; 3) Teaching and research statements; 4) Three relevant scientific papers; 5) List of references

TO APPLY: Please visit (**ejobs.umd.edu**) and find posting #105839. For best consideration, submit applications by January 31, 2014; the position remains open until filled. The University of Maryland is an EEO/AA employer. We strongly encourage women and minorities to apply.

UNIVERSITY OF CALIFORNIA IRVINE

The Mechanical and Aerospace Engineering Department invites applications for a tenure-track, assistant professor position in Flight Systems. We seek candidates with (i) expertise in dynamics, control, and optimization, (ii) research directed at a flight system, combining experiments with theory and modeling, (iii) high potential for world-class research and attracting students and funding, and (iv) commitment and capability to contribute to the educational mission of the Department. A doctoral degree in aerospace engineering or a closely related engineering field is required.

To ensure full consideration for the first round of interviews, applications should be received by February 1, 2014. The search will continue until the position is filled. Completed applications containing a cover letter, curriculum vitae, three to five letters of recommendation, and copies of three principal publications should be uploaded electronically.

Please refer to the following website for instructions:

https://recruit.ap.uci.edu/apply/JPF02170

Information about the department can be found at:

http://mae.eng.uci.edu.

UCI is an equal opportunity employer committed to excellence through diversity and strongly encourages applications from all qualified applicants, including women, minorities and other under-represented groups. UCI is a recipient of an NSF ADVANCE award for gender equity; responsive to the needs of dual career couples; and committed to work-life balance through an array of family-friendly policies.

Eminent Scholar in Propulsion

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE: The College of Engineering at the University of Alabama in Huntsville invites nominations and applications for a prestigious position of Eminent Scholar in Propulsion. The College of Engineering in conjunction with the UAH Propulsion Research Center is building a team of faculty and students engaged in (1) Propellants and Energetics; (2) Aerospace Propulsion Systems; and (3) Fusion and Plasma Propulsion.

The College of Engineering currently has a research focus that has expanded to include aerospace and systems engineering; and energy conversion and storage. UAH has an interdisciplinary Propulsion Research Center that exists to be a major generator of talent and innovative solutions in propulsion and energy related technologies. The PRC connects the academic research community with industry and government to advance basic science and technology development in propulsion and energy.

Applicants should have an earned Ph.D. degree preferably in Aerospace, Mechanical or Systems Engineering, or a closely related discipline, and possess (a) an established record of research scholarship and an ability to develop externally funded research programs within a collaborative environment, (b) a strong commitment to teach and mentor undergraduate and graduate students, and (c) dedication towards university and professional service. It is expected that applicants seeking this appointment as Eminent Scholar at the rank of Full Professor with tenure will have an outstanding track record in all aspects of research, teaching, and service.

Application material including a cover letter, curriculum vitae, short summary of current research interests (2-4 pages), teaching philosophy (1-2 pages), a vision statement for building a robust and dynamic research program at UAH (2-3 pages), and the names of three references, should be sent to propulsionscholarsearch@uah.edu for consideration. The anticipated starting date would be in the fall of 2014.

UAH is an Affirmative Action/Equal Opportunity Employer. Consistent with our core values of integrity, respect, diligence, excellence, inclusiveness and diversity, the university strongly encourages applications from members of all under-represented groups.

University of Colorado **Boulder**

CU BOULDER FACULTY SEARCH ANNOUNCEMENT

The University of Colorado Boulder (CU) invites applicants for a tenure-track faculty position in support of an exciting new initiative called CU AeroSpace Ventures. CU has a well-established reputation as a world leader in space, geosciences, and aerospace engineering. CU AeroSpace Ventures brings together related departments, institutes, and centers along with government labs and industry to create knowledge and develop new technologies to observe, measure and better understand Earth and our space environment. The primary units involved are the Departments of Aerospace Engineering Sciences, Atmospheric and Oceanic Sciences, and Astrophysical and Planetary Sciences along with CU institutes: Laboratory of Atmospheric and Space Physics (LASP) and Cooperative Institute for Research in Environmental Science (CIRES). The Boulder / Denver area is home to the government labs of NCAR, NOAA, NREL, USGS, and National Solar Observatory (NSO), all in close proximity of campus.

Candidates who specialize in developing engineering solutions for Earth and space science research or who perform scientific research in Earth or space science with an emphasis on instrumentation or aerospace vehicles are of particular interest. We seek applicants from any relevant area of focus who complement existing department and institute strengths while bridging geosciences, space, and aerospace engineering. The successful candidate will demonstrate the ability to develop an innovative and robust research program, as well as have the vision and potential for excellence in both classroom teaching and student mentoring.

The position is nominally at the level of Assistant Professor, but more senior ranks may be considered for exceptional candidates with suitable experience. The home department will be determined based on the hired candidate's research and teaching alignment. Applicants will be expected to pursue multidisciplinary research across departments, college and campus, and to establish interactions with the various geoscience and space-related labs and companies in the Boulder/Denver area and across the nation. Women and underrepresented minorities are especially encouraged to apply. This is a 9-month tenure-track position, rostered in any one of the three departments and jointly with either LASP or CIRES.

A PhD in an appropriate engineering or science field is required at the time of appointment, and post-degree experience is preferred. Teaching experience and familiarity with government funding activities is desirable.

The University of Colorado is an Equal Opportunity Employer committed to building a diverse workforce. We encourage applications from women, racial and ethnic minorities, persons with disabilities and veterans. Alternative formats of this ad can be provided upon request for individuals with disabilities by contacting the ADA Coordinator at: hr-ada@colorado.edu or 303-492-6475.

Applications are accepted electronically at https://www.jobsatcu.com, #F00952. Applications must include a cover letter, curriculum vitae, statement of research interest, statement of teaching interest, and the names and email addresses of four professional references. The University of Colorado conducts background checks for all final applicants.

Review of applications will begin on January 15, 2014, and applications will be accepted until the position is filled. See more at the Jobs at CU web site.

AIAA Bulletin

Sandy Magnus and Chinese astronaut Liu Yang engage with grade school and high school students during “A Dialogue between Female Astronauts of China and United States” that was hosted by the Beijing University of Aeronautics and Astronautics and sponsored by AIAA and the Chinese Society of Astronautics in September 2013. Read the special section on “AIAA’s Collaboration with China” on pages **B8–B9**.

JANUARY 2014

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* Also accessible via Internet. Use the formula first name last initial@aiaa.org. Example: megans@aiaa.org.
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Addresses for Technical Committees and Section Chairs can be found on the AIAA Web site at **http://www.aiaa.org**.

We are frequently asked how to submit articles about section events, member awards, and other special interest items in the *AIAA Bulletin*. Please contact the staff liaison listed above with Section, Committee, Honors and Awards, Event, or Education information. They will review and forward the information to the *AIAA Bulletin* Editor.

Event & Course Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
2014			
11 Jan	1st AIAA Sonic Boom Prediction Workshop	National Harbor, MD	
11 Jan	Low Reynolds Number Workshop	National Harbor, MD	
11–12 Jan	Decision Analysis	National Harbor, MD	
12 Jan	Introduction to Integrated Computational Materials Engineering	National Harbor, MD	
13–17 Jan	AIAA SciTech 2014 (AIAA Science and Technology Forum and Exposition 2014) **Featuring:** 22nd AIAA/ASME/AHS Adaptive Structures Conference 52nd AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference AIAA Guidance, Navigation, and Control Conference AIAA Modeling and Simulation Technologies Conference 10th AIAA Multidisciplinary Design Optimization Specialist Conference 16th AIAA Non-Deterministic Approaches Conference AIAA Spacecraft Structures Conference (formerly the AIAA Gossamer Systems Forum) 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 7th Symposium on Space Resource Utilization 32nd ASME Wind Energy Symposium	National Harbor, MD	**5 Jun 13**
26–30 Jan†	24th AAS/AIAA Space Flight Mechanics Meeting	Santa Fe, NM Contact: http://www.space-flight.org/docs/2014_winter/2014_winter.html	**2 Oct 13**
27–30 Jan†	Annual Reliability and Maintainability Symposium (RAMS) 2014	Colorado Springs, CO (Contact: Jan Swider, 818.586.1412, jan.swider@pwr.utc.com)	
Feb–June	Advanced Computational Fluid Dynamics	Home Study	
Feb–June	Computational Fluid Turbulence	Home Study	
Feb–June	Introduction to Computational Fluid Dynamics	Home Study	
Feb–June	Missile Design and System Engineering	Home Study	
Feb–June	Spacecraft Design and Systems Engineering	Home Study	
2–6 Feb†	American Meteorological Society Annual Meeting	Atlanta, GA (Contact: Claudia Gorski, 617.226.3967, cgorski@ametsoc.org, http://annual.ametsoc.org/2014/)	
1–8 Mar†	2014 IEEE Aerospace Conference	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)	
24–26 Mar†	49th International Symposium of Applied Aerodynamics	Lille, France (Contact: Anne Venables, 33 1 56 64 12 30, secr.exec@aaaf.asso.fr, www.3af-aerodynamics2014.com)	
30 Apr	2014 Aerospace Spotlight Awards Gala	Washington, DC	
5–9 May	SpaceOps 2014: 13th International Conference on Space Operations	Pasadena, CA	**5 Aug 13**
26–28 May	21st St. Petersburg International Conference on Integrated Navigation Systems	St. Petersburg, Russia (Contact: Prof. V. Peshekhonov, +7 812 238 8210, icins@eprib.ru, www.elektropribor.spb.ru)	
26–29 May†	6th International Conference on Research in Air Transportation (ICRAT 2014)	Istanbul, Turkey (Contact: Andres Zellweger, 301.330.5514, dres.z@comcast.net, http://www.icrat.org/	
5 Jun	Aerospace Today ... and Tomorrow: An Executive Symposium	Williamsburg, VA	
14–15 Jun	Third AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-III)	Atlanta, GA	
16–20 Jun	AVIATION 2014 (AIAA Aviation and Aeronautics Forum and Exposition) **Featuring:** 20th AIAA/CEAS Aeroacoustics Conference 30th AIAA Aerodynamic Measurement Technology and Ground Testing Conference AIAA/3AF Aircraft Noise and Emissions Reduction Symposium 32nd AIAA Applied Aerodynamics Conference AIAA Atmospheric Flight Mechanics Conference 6th AIAA Atmospheric and Space Environments Conference 14th AIAA Aviation Technology, Integration, and Operations Conference	Atlanta, GA	**14 Nov 13**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
	AIAA Balloon Systems Conference AIAA Flight Testing Conference 7th AIAA Flow Control Conference 44th AIAA Fluid Dynamics Conference 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference 11th AIAA/ASME Joint Thermophysics and Heat Transfer Conference 21st AIAA Lighter-Than-Air Systems Technology Conference 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference AIAA Modeling and Simulation Technologies Conference 45th AIAA Plasmadynamics and Lasers Conference 7th AIAA Theoretical Fluid Mechanics Conference		
22–27 Jun†	12th International Probabilistic Safety Assessment and Management Conference	Honolulu, HI (Contact: Todd Paulos, 949.809.8283, secretariat@psam12.org, www.psam12.org)	
13–17 Jul†	International Conference on Environmental Systems	Tucson, AZ (Contact: Andrew Jackson, 806.742.2801 x230, Andrew.jackson@ttu.edu, http://www.depts.ttu.edu/ceweb/ices/)	
15–18 Jul†	ICNPAA 2014 – Mathematical Problems in Engineering, Aerospace and Sciences	Narvik University, Norway (Contact: Seenith Sivasundaram, 386.761.9829, seenithi@aol.com, www.icnpaa.com)	
28–30 Jul	Propulsion and Energy 2014 (AIAA Propulsion and Energy Forum and Exposition) **Featuring:** 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference 12th International Energy Conversion Engineering Conference	Cleveland, OH	**14 Jan 14**
31 Jul–1 Aug	2nd AIAA Propulsion Aerodynamics Workshop	Cleveland, OH	
2–10 Aug†	40th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events	Moscow, Russia http://www.cospar-assembly.org	
4–7 Aug	SPACE 2014 (AIAA Space and Astronautics Forum and Exposition) **Featuring:** AIAA/AAS Astrodynamics Specialist Conference AIAA Complex Aerospace Systems Exchange 32nd AIAA International Communications Satellite Systems Conference AIAA SPACE Conference	San Diego, CA	**21 Jan 14**
7–12 Sept†	29th Congress of the International Council of the Aeronautical Sciences (ICAS)	St. Petersburg, Russia (Contact: www.icas2014.com)	**15 Jul 13**
29 Sep–3 Oct†	65th International Astronautical Congress	Toronto, Canada (Contact: http://www.iac2014.org/)	
2015			
5–9 Jan	AIAA SciTech 2015 (AIAA Science and Technology Forum and Exposition 2015) **Featuring:** 23rd AIAA/ASME/AHS Adaptive Structures Conference 53rd AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference AIAA Spacecraft Structures Conference (formerly the AIAA Gossamer Systems Forum) AIAA Guidance, Navigation, and Control Conference AIAA Modeling and Simulation Technologies Conference 11th AIAA Multidisciplinary Design Optimization Specialist Conference 17th AIAA Non-Deterministic Approaches Conference 56th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 8th Symposium on Space Resource Utilization 33rd ASME Wind Energy Symposium	Kissimmee, FL	
7–14 Mar†	2015 IEEE Aerospace Conference	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)	

For more information on meetings listed above, visit our website at www.aiaa.org/calendar or call 800.639.AIAA or 703.264.7500 (outside U.S.).

†Meetings cosponsored by AIAA. Cosponsorship forms can be found at https://www.aiaa.org/Co-SponsorshipOpportunities/.

AIAA Continuing Education courses.

From the Corner Office

AIAA AND STEM

Sandy H. Magnus, Executive Director

I want to devote some time to address AIAA's engagement in STEM activities as Steve Gorrell, our VP of Education, and I have received many questions resulting from the 2014 budget cuts in this area. First and foremost I want to state and strongly emphasize that AIAA leadership, both staff and members, are passionate about STEM and committed to continuing to engage AIAA in this area. I also want to highlight that neither the 2014 budget decision nor any changes occurring at the national level impacts the STEM activities that sections are conducting locally. Steve recently sent a letter to the K–12 committee and regional deputy directors outlining the situation. I am providing the text of the letter below to help clear up confusion about the Institute's goals.

(*The first part of the letter recapped the decisions that led to the 2014 budget. That information has been sent to you in a communication from me earlier this year so I won't repeat it here.*)

The STEM K–12 Outreach Committee operates with funding from the operations budget, the AIAA Foundation and the Institute Development Committee. The allocation from the operations budget generally has paid for AIAA staff support and partnerships and thus the cuts affected these two areas. Programs not affected by this decision include the Educator Academy (funded by the IDC for one additional year) and the Educator Grants which are founded by the Foundation. It is important to note that some STEM activities have been deferred not eliminated.

The situation we are going through is forcing the organization to take a hard look at all of our programs and operations across the Institute and make appropriate adjustments. I wish to be clear that AIAA senior staff and volunteer leadership are passionate about STEM and committed to engaging in and encouraging meaningful activities in this area. Our section activities, unaffected by the budget situation and controlled locally, will continue their programs and be the most effective means for promoting AIAA STEM K–12 activities. We need to strengthen and increase our interaction with sections to leverage lessons learned and positive experiences to identify what types of activities work well and are popular. Our Educator Associates are valuable resources in this area and we must tap them more effectively.

At the national level we are working toward moving all of the AIAA STEM programs under the auspices of the AIAA Foundation. With all of the STEM activities located in one place, under one budget, a more coherent national program can be devised. In addition, with the right program (or programs) it would be possible to attract sponsorship and collaborative partners by using the Foundation as a vehicle for funding. Ideally, with the right strategic plan and programs, a staff person with a full-time commitment to not only managing STEM programming but also fundraising, working in the Foundation, can be acquired.

In addition we will be taking a look at how we can collaborate better with our sister engineering societies in the area of STEM K–12. As a member of the America Association of Engineering Societies we share a common interest in encouraging young people to think of engineering, in general, as a career choice. Collaboration with other engineering societies, at both the national and the local level, will leverage all of our efforts in the STEM areas.

Transitions are very difficult and AIAA is in the midst of an institute-wide effort to examine what we are doing and what is important for our future. STEM is one of the many areas being examined. The number of programs the STEM K–12 Committee is responsible for has grown substantially in the last few years. Some of the programs are doing well, others are not. I would like to repeat that the Institute commitment remains strong. With some of the strategies outlined above I believe as we move through the transition we will emerge in a much more stable and strategic position.

Sincerely
Steven E. Gorrell,
Vice President, Education

I am very excited about the potential for AIAA to become even stronger and more engaged in STEM activities as we consolidate our activities into the Foundation and develop a strategy going forward. For those of you active in the sections at the local level, I encourage you to keep up the great work! In addition please keep sending us your reports and highlights of the events and STEM activities that you are doing so we can keep an accurate track. I encourage you to reach out to the other engineering societies in your area and develop collaborative programs. One thing that is clear to me having talked to a lot of you, is that our AIAA community is very engaged in the STEM area—as we continue to develop a national approach I encourage you to send Steve and I suggestions and comments and in turn we will continue our communication about how things are unfolding.

SUSTAINED SERVICE AWARD RECIPIENTS ANNOUNCED!

AIAA is pleased to announce that Sustained Service Awards will be presented to the following members during 2014. We sincerely thank them for their dedication and service.

Region 2

Thomas M. Hancock, AIAA Greater Huntsville Section, "For making significant contributions to AIAA providing guidance, encouragement, inspiration and support to the AIAA Greater Huntsville Section, fellow AIAA members, and the technical community."

John O. Lassiter, AIAA Greater Huntsville Section, "For over 38 years of sustained superior performance and technical contributions to AIAA at the section, region, and national levels."

James McBrayer, AIAA Central Florida Section, "For more than 50 years of sustained, significant service and dedicated contributions to the interests of the Institute."

Region 3

Ramana V. Grandhi, AIAA Dayton Section, "For sustained and dedicated service to AIAA through conference leadership, significant publicaitons in structural design, and leadership of the Multidisciplinary Design Optimization and Non-Deterministic Approaches Technical Committees."

Eric J. Jumper, AIAA Indiana Section, "For sustained service to AIAA as a member, Technical Committee member, Meeting Chair, prolific author, and Student Section Faculty Advisor."

The Sustained Service Award recognizes significant service and contributions to AIAA by members of the Institute. Nominations for the AIAA Sustained Service Award may be submitted to AIAA no later than **1 July** of each year. For more information about the AIAA Honors and Awards program or the Sustained Service Award, please contact Carol Stewart at 703.264.7623 or at carols@aiaa.org.

AIAA ANNOUNCES 2014 ASSOCIATE FELLOWS

AIAA is pleased to announce the selection of the AIAA Associate Fellows class of 2014. The 165 new Associate Fellows will be honored at the AIAA Associate Fellows Dinner on Monday, 13 January 2014, at the Gaylord National Harbor Hotel and Convention Center, North Harbor, Maryland, in conjunction with the AIAA SciTech Forum.

"The individuals comprising this year's class of Associate Fellows represent outstanding achievement and leadership in the international aerospace community. Each can be very proud of their accomplishments, and their admittance to the rank," said AIAA President Mike Griffin. "Their creativity, ingenuity and relentless pursuit of excellence have ignited the spark of progress within our community, and each helps make our world better for all humanity."

To be selected for the grade of Associate Fellow an individual must be an AIAA Senior Member for at least 12 months prior to the current deadline for Associate Fellow nomination, with at least twelve years professional experience, and be recommended by a minimum of three current Associate Fellows. By AIAA Region and Section, the 165 AIAA members newly selected to become Associate Fellows are:

REGION I

Connecticut
Ebad Jahangir, Pratt & Whitney
Tianfeng Lu, University of Connecticut
Lubomir A. Ribarov, Hamilton Sundstrand

Hampton Roads
Zachary T. Applin, NASA Langley Research Center
Ponnampalam Balakumar, NASA Langley Research Center
Joseph R. Blandino, Virginia Military Institute
Gregory M. Buck, NASA Langley Research Center
Kenny B. Elliott, NASA Langley Research Center
William Jones, NASA Langley Research Center
Renjith R. Kumar, AMA Inc.
James Van Laak, Federal Aviation Administration
Douglas M. Nark, NASA Langley Research Center
Natasha Neogi, National Institute of Aerospace/University of Illinois at Urbana–Champaign
Sriram K. Rallabhandi, National Institute of Aerospace
Hans Seywald, AMA Inc.
Eric J. Sheppard, Hampton University
Clayton Turner, NASA Langley Research Center

Mid-Atlantic
Robert F. Behler, Software Engineering Institute
Faye I. Francy, Boeing Engineering Operations & Technology
Sarah-Jane Frankland, St. Vincent College
Xiaofeng Liu, Johns Hopkins University

National Capital
Gary P. Barnhard, National Space Society
Thomas A. Becher, The MITRE Corporation
Douglas A. Comstock, NASA Headquarters
Iris W. Curtis, CENTRA Technology, Inc.
John D. Evans, Lockheed Martin Corporation
Vadim N. Gamezo, Naval Research Laboratory
Michele Gates, NASA Headquarters
Marillyn A. Hewson, Lockheed Martin Corporation
Chunlei Liang, George Washington University
Sandra H. Magnus, AIAA
Christine G. Matthews, SGT, Inc.
James R. O'Donnell Jr., NASA Goddard Space Flight Center
Matthew J. O'Kane, Office of Management and Budget/Executive Office of the President
Chris Raymond, The Boeing Company
William C. Raynor, U.S. Naval Research Laboratory
Troy C. Welker, U.S. Air Force

New England
Tye Brady, Draper Laboratory
Kenny S. Breuer, Brown University
William R. Davis, Massachusetts Institute of Technology
Christopher J. Hegarty, The MITRE Corporation
Paulo C. Lozano, Massachusetts Institute of Technology
Nicholas Roy, Massachusetts Institute of Technology

Niagara Frontier
Ephrahim Garcia, Cornell University

Northeastern New York
Carl P. Bannar, Lockheed Martin Electronic Systems
Xiaoqing Zheng, General Electric Company

Northern New Jersey
Mikhail N. Shneider, Princeton University

Armed Forces Post Office – Armed Forces Europe
Kevin Bollino, Air Force Office on Scientific Research

REGION II

Atlanta
Charles T. Burbage, Lockheed Martin Aeronautics

Cape Canaveral
Joseph T. Mayer, Lockheed Martin Corporation

Greater Huntsville
John Dankanich, Aero Dank, Inc.
Andrew J. Sinclair, Auburn University
Gang Wang, University of Alabama – Huntsville
Robert J. Wingate, NASA Marshall Space Flight Center
Qiuhai Zuo, University of Alabama – Huntsville

Greater New Orleans
Michael J. Martin, Louisiana State University

REGION III

Dayton/Cincinnati
James Haas, U.S. Air Force Research Laboratory
David E. Munday, University of Cincinnati
Michael Stepaniak, U.S. Air Force Institute of Technology
Eric J. Tuegel, U.S. Air Force

Indiana
Alina Alexeenko, Purdue University
Mat O. French, Rolls-Royce Corporation
Robert A. Ress, Florida Turbine Technologies

Illinois
Daniel J. Bodony, University of Illinois at Urbana–Champaign
Michael S. Selig, University of Illinois at Urbana–Champaign
Michigan: Patrick J. McNally, VI-Grade, LLC;
James R. Murphy, NASA Ames Research Center

Northern Ohio
Amy Fagan, NASA Glenn Research Center
Brenda S. Henderson, NASA Glenn Research Center
Daniel A. Herman, NASA Glenn Research Center
George R. Schmidt, NASA Glenn Research Center
Ruben Del Rosario, NASA Glenn Research Center

REGION IV

Albuquerque
Jeremy Banik, U.S. Air Force
Daniel T. Griffith, Sandia National Laboratory
Alan Lovell, Air Force Research Laboratory
Svetlana Poroseva, University of New Mexico
Lawrence Sher, Kirtland Air Force Base
Peter Vorobieff, University of New Mexico

Houston
Kauser S. Imtiaz, Boeing Defense, Space & Security
Stephanie D. Wilson, NASA Johnson Space Center

North Texas
Jennifer C. Byrne, Lockheed Martin Corporation
Daniel J. Clancy, Lockheed Martin Aeronautics
Joseph Davis Jr., Saddle Butte Systems
Michael R. Griswold, Lockheed Martin Aeronautics
Jeffrey Allen Moorehouse, Lockheed Martin Corporation (awarded posthumously)
Art Tank, Lockheed Martin Aeronautics

Oklahoma
Khaled A. Sallam, Oklahoma State University

Southwest Texas
Behcet A. Acikmese, University of Texas at Austin

REGION V

St. Louis
William H. Alban III, Boeing Defense, Space & Security
Darryl W. Davis, The Boeing Company
Robert M. Dowgwillo, Boeing Engineering Operations & Technology

Twin Cities
Demoz Gebre-Egziabher, University of Minnesota
David J. Myren, AERO Systems Engineering, Inc.

Rocky Mountain
Richard F. Ambrose, Lockheed Martin Corporation
Daniel N. Baker, University of Colorado – Boulder
David J. Barnhart, U.S. Air Force
Matt A. Bille, Booz Allen Hamilton
John R. Eiler, Stellar Solutions, Inc.
Eric W. Frew, University of Colorado – Boulder
Russell Howard, Sierra Nevada Corporation
Patricia A. Remias, Sierra Nevada Corporation
James D. Rendleman, Joint Functional Component Command for Space
John Roth, Sierra Nevada Corporation
Mark Valerio, Lockheed Martin Space Systems

REGION VI

Antelope Valley
M. Christopher Cotting, U.S. Air Force Test Pilot School
Clifton C. Davies, Lockheed Martin Aeronautics

China Lake
Ying-Ming Lee, Department of the Navy

Los Angeles – Las Vegas
Jeff Eldredge, University of California Los Angeles
Arthur C. Grantz, The Boeing Company

Stephen V. Kowalski, Northrop Grumman Information Systems
Gregory V. Meholic, The Aerospace Corporation
Robert W. Seibold, The Aerospace Corporation
Robert Shishko, Jet Propulsion Laboratory

Orange County
Daryl G. Pelc, Boeing Defense, Space & Security
Philip E. Ridout
Kamal M. Shweyk, Boeing Engineering Operations & Technology

Pacific Northwest
Robert J. McIntosh, Boeing Commercial Airplanes
Rolf T. Rysdyk, Insitu, Inc.
Patrick M. Shanahan, Boeing Commercial Airplanes
James R. Underbrink, The Boeing Company
James E. Vasatka, The Boeing Company
Brent A. Whiting, Boeing Engineering Operations & Technology

Phoenix
M. Brett McMickell, Honeywell International

Sacramento
Timothy F. O'Brien, Aerojet Rocketdyne
Robert D. Parker, Hughes Space and Communications

San Diego
Philip E. Smith, Space Grant Education and Enterprise Institute

San Fernando Pacific
Qingjun Cai, Teledyne Scientific
Rupert C. Stechman, Aerojet
John W. Vinson, Lockheed Martin Aeronautics

San Francisco
Iris F. Bombelyn, Lockheed Martin Corporation
Robert K. Heffley, Robert Heffley Engineering
Christopher A. Kitts, Santa Clara University
Nateri K. Madavan, NASA Ames Research Center
Mark A. Pasquale, Lockheed Martin Space Systems

San Gabriel Valley
Larry Bryant, Jet Propulsion Laboratory
Glenn E. Cunningham, Boeing Satellites Systems
Gregory L. Davis, Jet Propulsion Laboratory
Roger E. Diehl, Jet Propulsion Laboratory
Douglas G. MacMartin, California Institute of Technology
Robert M. Manning, Jet Propulsion Laboratory
Beverley J. McKeon, California Institute of Technology
Paul D. Ronney, University of Southern California

Tucson
Erdogan Madenci, University of Arizona

Utah
Randal W. Beard, Brigham Young University
David K. Geller, Utah State University

Vandenberg
Timothy R. Coffin, JFCC Space USSTRATCOM

REGION VII

Australia
Michael Spencer, Royal Australian Air Force

Canada
Michael Kokkolaras, McGill University
Franz T. Newland, Com Dev.
Inna Sharf, McGill University
Zheng Hong Zhu, York University

China (PRC)
Zhiqiang Wan, Beihang University
Hong Yan, Northwestern Polytechnical University

France
Jean-Jacques Dordain, European Space Agency

Germany
Hannes G. Ross, IBR Aeronautical Consulting

India
Shashi Verma, National Aerospace Laboratory

Netherlands
Max Mulder, Delft Technical University of Technology

Portugal
Anna Guerman, University of Beira Interior

Russia
Igor V. Sorokin, S. P. Korolev Rocket-Space Corporation Energia

South Korea
Sung Nam Jung, Konkuk University
Rho Shin Myong, Gyeongsang National University
JeongYeol Choi, Pusan National University

Turkey
Erdem Acar, TOBB ETU

United Kingdom
Luke Brooke, Tensys Ltd.
Yufeng Yao, Kingston University

SPECIAL SECTION: AIAA COLLABORATION WITH CHINA

Two major aerospace events were held in Beijing, China, at the end of September: the 64th International Astronautical Congress (IAC) and the 1st Aviation Science and Technology Conference. AIAA's presence at these events was a great opportunity to further engage a number of Chinese organizations. A delegation of AIAA senior volunteer and staff leadership, which included Vigor Yang, Vice President – Publications; Susan Ying, Vice President – International Activities; Sandy Magnus, Executive Director; Klaus Dannenberg, Deputy Executive Director; and Megan Scheidt, Managing Director, Technical Activities, traveled to China with a number of clearly defined objectives to advance AIAA's strategy in China.

This trip allowed AIAA's leadership to engage in dialogues that will strengthen the Institute's presence in the global aerospace community. Not only were the members of the delegation able to participate in these two events but they were able to discuss with our Chinese partner organizations further cooperation on a number of fronts. In addition, AIAA was able to spend time gaining a better understanding of how other U.S.-based societies operate in China, which will help us work to better meet the needs of our members based in China.

This special section provides summaries of the various activities that the delegation participated in and updates about AIAA's presence in China.

AIAA Membership in China

- 140 Professional Members (*6 Associate Fellows, 57 Senior Members*)
- 99 Student Members
- 2 Student Branches (*Nanjing University of Aeronautics and Astronautics, Northwestern Polytechnic University*)

AIAA Participates in International Aviation and Space Events

The International Astronautical Congress (IAC) is the annual event of the International Astronautical Federation (IAF) and its partner organizations, the International Academy of Astronautics (IAA) and the International Institute of Space Law (IISL). The event includes ancillary activities that help make the IAC an important forum for the international space community to meet and engage. Many AIAA members participate in the IAC and some are active in the committees that comprise the IAF, IAA, and IISL. AIAA members Lyn Wigbels of RWI and Ray Johnson of Lockheed Martin are elected IAF Vice Presidents.

On the opening day of the IAC, AIAA hosted a reception, providing members and conference attendees an informal opportunity to interact with the AIAA delegation. The reception was held in the AIAA exhibit booth, where AIAA's new messaging theme, "Ignite and Celebrate," was showcased in both English and Chinese. The reception celebrated the aerospace industry and allowed AIAA leadership to hear the perspectives and viewpoints of the students and young professionals, individual professionals, and corporate members of AIAA who were in attendance.

As a former astronaut, Sandy Magnus participated in the IAC panel session entitled "Women in Space: A 50-Year Success Story." The panel featured: Russia's Valentina V. Tereshkova, the first woman to fly in space; Japan's Chiaki Mukai, the first Japanese woman in space and the first Japanese citizen to fly on two spaceflights; Malaysia's Mazlan Othman, director of the United Nation's Office for Outer Space Affairs and founding Director General of the Malaysian National Space Agency; Liu Yang, the first Chinese woman in space as part of the Shenzhou 9 mission crew; and Wang Yaping, the second Chinese woman in space as the mission commander of the Shenzhou 10 mission. During the session, the panelists discussed their experiences in space and their experiences as women working in the space industry.

During the same week as the IAC, the Chinese Society of Aeronautics and Astronautics (CSAA) hosted the 1st Aviation Science and Technology Conference in Beijing as part of the Aviation Expo China 2013. The conference was co-hosted by a number of Chinese aviation companies and universities and organized by China Aviation Publishing & Media Group (CAPM). During this conference, Susan Ying presented a keynote address focused on "ABC of Commercial Aviation: Technology Insertion Rewards and Challenges." In this keynote, she remarked that "new large airplane companies need to compete with Airbus and Boeing to succeed in the commercial aviation marketplace. These new companies face tremendous challenges on many fronts." She also stated "both Airbus and Boeing have decades of experience with these processes and have demonstrated successes in improving their products' performance and efficiency... New competitors in commercial aviation must carefully adopt innovative and potentially disruptive technologies while managing the associated risks." Ying's presentation provided some examples of technology insertion rewards and challenges (e.g., 3D-printing and partially autonomous systems) that will become essential for future success.

The AIAA delegation meets with representatives of the Chinese Society of Aeronautics and Astronautics (CSAA), discussing specific areas of collaboration between the two societies.

AIAA Titles Translated into Chinese

Since 2009, AIAA has collaboratively produced publications with two Chinese organizations. On the aviation side, we have had a strong partnership with the China Aviation Publishing and Media Group, which has resulted in 13 titles being fully or partially translated into Chinese. On the space side, AIAA worked with the China Astronautics Publishing House, which is associated with CSA. This collaboration has produced two titles. To date, the following AIAA titles have been partially or fully translated into Chinese.

John D. Anderson, *The Airplane: A History of Its Technology* (Library of Flight)
John D. Anderson, *Hypersonic and High-Temperature Gas Dynamics, Second Edition* (Education Series)
Richard L. Bielawa, *Rotary Wing Structural Dynamics and Aeroelasticity, Second Edition* (Education Series)
Maher N. Bismarck-Nasr, *Structural Dynamics in Aeronautical Engineering* (Education Series)
Claudio Bruno and Antonio G. Accettura, *Advanced Propulsion Systems and Technologies, Today to 2020* (Progress Series, Vol. 223)
Mark E. Dreier, *Introduction to Helicopter and Tiltrotor Flight Simulation* (Education Series)
Link Jaw and Jack Mattingly, *Aircraft Engine Controls: Design, System Analysis, and Health Monitoring* (Education Series)
Ralph D. Kimberlin, *Flight Testing of Fixed-Wing Aircraft* (Education Series)
Ray D. Leoni, *Black Hawk: The Story of a World Class Helicopter* (Library of Flight)
Curtis Peebles, *Road to Mach 10: Lessons Learned from the X-43A Flight Research Program* (Library of Flight)
Vincent L. Pisacane, *The Space Environment and Its Effect on Space Systems* (Education Series)
J.S. Przemieniecki, *Finite Element Structural Analysis: New Concepts* (Education Series)
Robert K. Remple and Mark B. Tischler, *Aircraft and Rotorcraft System Identification* (Education Series)
Frederick Smetana, *Flight Vehicle Performance and Aerodynamic Control* (Education Series)
Mark P. Sullivan, *Dependable Engines: The Story of Pratt & Whitney* (Library of Flight)

AIAA Expands Collaboration with Chinese Partners

AIAA has formalized Memoranda of Understanding with the primary aerospace professional societies in China: in 2010, with the Chinese Society of Astronautics (CSA), and in 2011, with the Chinese Society of Aeronautics and Astronautics (CSAA). Continued collaboration was discussed with both organizations during meetings that occurred while the delegation was in Beijing.

AIAA delegation members also met with China Aviation Publishing and Media Group (CAPM), AIAA's aviation publishing partner in China since 2009. During the meeting it was noted that since 2010 CAMP has published 13 AIAA book titles as either partial or full translations, and that more translations are either in process or planned for the future. Additional subjects of conversation included potential collaboration in the areas of conferences and continuing education.

AIAA Meets with Other Societies with Operations in China

AIAA staff leaders took the opportunity to meet with representatives from the local ASME and IEEE offices to better understand their activities and operations in China. During the meetings, staff members were able to ask about professional societies in the Chinese culture; how Chinese industry, government, and academia relate and work together; membership concentration and activities of these societies in China; and the prevailing market for Chinese language journals, publications, and events in China.

Magnus Engages Students and Young Professionals

The trip to Beijing offered a number of opportunities for Sandy Magnus to engage with students and young professionals about her experiences as an astronaut and working in space. See below for a summary of these activities:

- Magnus sat on a panel for the IAC's Young Professional Program that looked at the future of space exploration and the contributions made to exploration by the International Space Station (ISS). Joining Magnus on the panel were Bill Gerstenmaier, Associate Administrator, Human Exploration and Operations Directorate, NASA; Masazumi Miyake, ISS Program Manager, JAXA; Thomas Reiter, astronaut and Director of Human Spaceflight Operations, European Space Agency (ESA); and Fei Junlong, a Chinese astronaut. Magnus urged attendees to "live a life you won't regret," and illustrated that point by talking about her pursuit of a career as an astronaut.

AIAA Executive Director Sandy Magnus and Chinese Society of Astronautics Vice President Wu Yansheng exchange gifts during the meeting between AIAA and CSA.

- As part of the IAC's Global Networking Forum, students and young professionals had the chance to ask Magnus about her experiences as an astronaut. She answered questions from audience members in the room as well as via Twitter.
- Magnus and Chinese astronaut Liu Yang participated in "A Dialogue between Female Astronauts of China and United States." Organized and hosted by the Beijing University of Aeronautics and Astronautics, and cosponsored by AIAA and CSA, the event featured a lively discussion between the two astronauts in front of nearly 300 students from selected grade schools and major universities throughout Beijing. The discussion allowed Magnus and Liu to discuss their experiences during their individual space missions, with Magnus focusing on her time aboard STS-135 and Liu on the Shenzhou-9 mission.
- During the public day of the IAC exhibition, the Global Networking Forum featured a panel of astronauts who shared their experiences in space. Joining Magnus on the panel were Dorin Prunariu, a retired Romanian astronaut who flew on the Soyuz 40 mission; Chiaki Mukai; and Christer Fuselang, a Swedish physicist and ESA astronaut who flew on STS-116 and was the first Swedish citizen in space. Magnus contrasted the differences between living in and visiting space, comparing her Space Shuttle missions with her time on the ISS.

CALL FOR PAPERS OPEN !

TOPICS INCLUDE

Advanced Propulsion Concepts for Future Flight
Aerospace Power Systems
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Energetic Components & Systems
Energy Conversion Device Technology
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Energy Storage Technology
Gas Turbine Engine
High Speed Air-Breathing Propulsion
Hybrid Rocket Propulsion
Hypersonic & Combined Cycle Propulsion Application
Liquid Propulsion
Nuclear & Future Flight Propulsion
Propellants & Combustion
Propulsion Education
Solid Rocket Propulsion
Space & Earth-to-Orbit Vehicle Systems
System Concepts & Supporting Propulsion Technologies
Terrestrial Energy Systems
Thermal Management Technology

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14 JANUARY 2014

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For more information on sponsorship opportunities, contact Merrie Scott at merries@aiaa.org. For exhibits contact Chris Grady at chrisg@aiaa.org.

AIAA

AIAA ANNOUNCES SECTION AWARD WINNERS

AIAA has announced its 2012–2013 Section Award winners. The Section Awards annually honor particularly notable achievements made by member sections in a range of activities that help fulfill the Institute's mission. The Institute believes that vital, active sections are essential to its success. Section awards are made in five categories based on size of membership. Each winning section receives a certificate and a cash award. Below are the first-place winners for this year.

Outstanding Section

The Outstanding Section Award is presented to sections based upon their overall activities and contributions through the year. The winners are:

Very Small: **Sydney, Michael West, section chair**. The AIAA Sydney Section is awarded first place for Outstanding Section based on their wide spectrum of events including technical dinner meetings, professional development courses, STEM K–12 activities and support of student branches including a new student branch at the University of South Wales. They are also actively involved in the development of Australia's first national space policy and the first Defence space policy.

Small: **Savannah, Terry Richter, section chair**. The first place Outstanding Section award is given to the Savannah Section for the Section's dynamic and diverse activities including its numerous programs for the general membership, its engagement in community outreach and with local schools, its cooperative relationship with local aerospace business, and its overall strong membership participation.

Medium: **Tucson, Kirk Hively, section chair**. The first place Outstanding Section award is given to the AIAA Tucson section for the number of section members that they provided value and service to throughout the year, including consistent council meetings, technical dinner meetings, and social activities that included families, students, and educator associates.

Large (tie): **Northern Ohio, Kevin Melcher, section chair**. The AIAA Northern Ohio Section is awarded the first place Outstanding Section honor based on significant impacts in outreach to STEM K–12 and university students, significant AIAA honors and awards received by Section members, major improvements to Section communications, and leadership of the Ohio delegation for Congressional Visits Day.

Atlanta, Cameron Miller, section chair. The Atlanta Section is awarded first place for Outstanding Section for the Section's dynamic and diverse activities including its numerous programs addressing wide membership interests and encouraging increased member participation, its engagement with local schools and the AIAA Student Chapter at Georgia Tech, and its promotion of the Georgia aerospace business community.

Very Large: **Hampton Roads, Courtney Spells Winski, section chair**. The AIAA Hampton Roads Section is awarded the first place Outstanding Section honor based on their exceptional, diverse technical and social programs for their professional members, young professionals, retirees, students and educators, and their dedicated engagement in STEM/K–12 related activities.

Career and Workforce Development

The Career and Workforce Development Award is presented for section activities that focus on career development, such as time management workshops, career transition workshops, job benefits workshops, and technical versus management career path workshops. The winners are:

Very Small: **Sydney, Michael Spencer, career and workforce development officer**. The AIAA Sydney Section is awarded the first place Career and Workforce Development honor based on their sponsorship of the Aerospace Futures Conference, presenting multiple personal and professional development events and publishing career information for their section AIAA members.

Very Large: **San Francisco, Steven Cerri, career and workforce development officer**. The AIAA San Francisco Section is awarded the first place Career and Workforce Development honor based on presenting multiple personal and professional development events and making audio recordings of the presentations available to AIAA members.

Communications

The Communication Award recognizes sections that develop and implement an outstanding communications outreach program. Winning criteria include level of complexity, timeliness, and variety of methods of communications, as well as frequency, format, and content of the communications outreach. The winners are:

Very Small (tie): **Sydney, Michael West, section chair**. The AIAA Sydney section is awarded the first place Communications honor based on their frequent communications with their members through the use of a designated email address, Facebook, posting notices on bulletin boards at universities and distributing posters and emails advertising upcoming events within their employer's internal networks.

Delaware, M. David Rosenberg, newsletter editor. The AIAA Delaware Section is awarded the first place Communications honor based on using modified newsletter format (clickable links to AIAA homepage, Quick Response Code to section pages) and for using LinkedIn, Twitter, Facebook, newspapers and corporate member sites to solidify communication to STEM K–12 sector, congressional offices, and area professionals.

Small: **Utah, Jeffrey Boulware, chair and Spencer Brown, communications officer**. The AIAA Utah Section is awarded the first place Communications honor based on their proactive use of SharePoint and Facebook to promote the AIAA message and the local chapter highlights including section awards and useful links for their membership.

Medium: **Tucson, Mike Wethington, webmaster and STEM K–12 officer**. The AIAA Tucson section is awarded the first place Communication honor based on their outstanding consistency in delivering email newsletters and the conviction to call individuals that require special attention, along with their introduction of postings on several social media outlets such as Twitter, Facebook, and e-news.

Large: **Northern Ohio, Edmond Wong, communications officer**. The AIAA Northern Ohio Section is awarded the first place Communication honor based on the effective communication of Section events and activities, the development of new professional-quality Section communications and promotional materials, and the implementation of a commercial server for distributing Section email communications.

Very Large: **Hampton Roads, John Lin, newsletter editor**. The AIAA Hampton Roads Section is awarded the first place Communications honor based on timely, frequent, and comprehensive communications with their membership through a high-quality newsletter, up-to-date, and effective use of electronic messaging and social media, and strategic inclusion of commercial media.

STEM K–12

The Harry Staubs Precollege Outreach Award is given to sections that develop and implement an outstanding STEM K–12 outreach program that provides quality educational resources for K–12 teachers in the STEM subject areas of science, technology, engineering, and mathematics. The winners are:

Very Small: **Wisconsin, Todd Treichel, section chair and acting STEM K–12 outreach officer**. The Wisconsin Section is awarded the first place Harry Staubs award based on their outreach to K–12 students and Educator Associates with an emphasis on Rocket Science, teaching educators how to build rockets and then supporting a team rocket competition for 6th–8th graders.

Small: **Savannah, Francois Hugon and Craig Willis, STEM K–12 outreach officers**. The Savannah Section is given first place for the Harry Staubs award in recognition of their willingness to help local school develop STEM specific programs as well as 12 visits to local schools (K–12) to represent the aerospace profession, and their leadership in providing tours, engineering support, and materials at local STEM-related events along with judges for science fairs.

Medium: **Tucson, Mike Wethington and Tia Burley, STEM K–12 outreach officers**. The Tucson Section received the first place for the Harry Staubs award based on their continuation of the monthly Kids Club events, which include STEM-related field trips, design challenges, and STEM-related speakers/discussions, as well as their ongoing recognition of Educator Associates within the section, including a nomination for the Institute-level Educator Achievement award.

Large: **Phoenix, Mike Mackowski, STEM K–12 outreach officer**. The Phoenix Section is awarded the first place Harry Staubs award based on their strong contingency of Educator Associates and the continued support the Section provides through training and outreach and the development of a tabletop cardboard wind tunnel with support materials that can be used in schools and as part of event booths, as well as the STEM K–12 outreach activities that were spearheaded and supported by the Section membership.

Very Large: **Dayton/Cincinnati, Carl Tilmann, STEM K–12 outreach officer**. The Dayton-Cincinnati Section is given the first place Harry Staubs award based on their ongoing nurturing of Educator Associates (EA) through multi-day training programs and the K–12 outreach activities within the Section that included technology days, science fairs, design challenges, and the execution of the AIAA Educator Academy Cargo Plane challenge, all leading to a 20% increase in EA membership, 13 section members who were new to participation in section activities, and the involvement of non-AIAA members in aerospace-related learning.

Public Policy

The Public Policy Award is presented for stimulating public awareness of the needs and benefits of aerospace research and development, particularly on the part of government representatives, and for educating section members about the value of public policy activities. The winners are:

Very Small: **Delaware, Timothy Dominick, public policy officer**. The Delaware Section is awarded first place for Public Policy based on their ongoing involvement in public policy events. The Section has provided input to their state Senator on missile defense, NASA reauthorization, and STEM education legislation as it pertains to local constituents. Two of their members participated in Congressional Visits Day and the Section cohosted a town hall meeting with Representative Dr. Andy Harris.

Small: **Utah, Jeffrey Boulware, section chair and Ron Thue, public policy officer**. The Utah Section is awarded first place for Public Policy based on their participation in August is for Aerospace where Congressman Jim Matheson spoke about Washington, DC's perspective of the technology industry (in particular, aerospace) and how it affected Utah. They also sent a member to Congressional Visits Day to present a Utah perspective to the congressional representatives.

Medium: **Long Island, Frank Hayes, public policy officer**. The Long Island Section is awarded first place for Public Policy based on their activities such as cosponsoring the biannual Pilot Safety Seminars presented by the Air Safety Institute/AOPA and sending a team of five to Congressional Visits Day where they had 29 briefings with members of the Senate and the House.

Large (tie): **Phoenix, Tracey Lou Dodrill, public policy officer**. The Phoenix section is awarded first place for Public Policy for their efforts in stimulating awareness of public policy issues through several events, especially their August is for Aerospace panel discussion at Arizona State University, which included not only state and local legislators and AIAA members, but also university students, who were involved in the planning.

Atlanta, **Ben Walker, public policy officer**. The Atlanta section is awarded first place for Public Policy for holding the Georgia Aerospace Legislative Breakfast, whose theme was "Aero Economics 101: The Dynamic Impact of Aerospace on Georgia," which attracted 50 industry leaders and over 40 legislators.

Very Large (tie): **Greater Huntsville, Tom Hancock, public policy officer**. The Greater Huntsville section is awarded first place for Public Policy based on the creation and implementation of their inaugural civil space symposium, "Civil Space 2013: Accelerating Tomorrow's Commercial Space Marketplace."

Rocky Mountain, Pamela Burke, public policy officer. The Rocky Mountain section is awarded first place for Public Policy for their focus on issues affecting Colorado in particular, including their Colorado Space Economy Forum and the revival of Capital Aerospace Day, held to remind statehouse representatives of the key role that the aerospace industry plays in Colorado's economy.

Membership

The Membership Award is presented to sections that have increased their membership by planning and implementing effective recruitment and retention campaigns. The winners are:

Very Small: **Sydney, Amelia Greig, membership officer**. The AIAA Sydney Section is awarded the first place Membership honor based on their extensive member recruitment and retention efforts, including active engagement with local universities, recruiting many new Student Members, and highlighting the value of AIAA membership through social media.

Small: **Utah, Jeffrey Boulware, section chair and Charlie Vono, membership officer**. The AIAA Utah Section is awarded the first place Membership honor based on their outstanding membership recruitment and retention activities, including sponsoring many Educator Associate Members, reaching out to university students, and promoting membership through mass-mailings and incentive programs.

Medium: **Cape Canaveral, Susie Allen-Sierpinski, vice chair**. The AIAA Cape Canaveral Section is awarded the first place Membership honor based on their efforts in strengthening ties to local student chapters (at FIT and ERAU) and the local aviation community, sponsoring many new Educator Associates, hosting numerous creative, membership-focused social activities throughout the year, and nominating deserving members for national awards.

Large: **St. Louis, Frank Youkhana, section chair**. The AIAA St. Louis Section is awarded the first place Membership honor based on their extensive activities, perseverance, and hard work, which materialized in an outstanding number of submitted member-upgrade applications, as well as in numerous recruitment/retention mass-mailings and membership incentive programs.

Very Large: **Hampton Roads, Marlyn Andino, membership officer**. The AIAA Hampton Roads Section is awarded the first place Membership honor based on their extensive member recruitment and retention efforts, including an outstanding number of submitted member-upgrade applications and National Award nominations.

Young Professional

The Young Professional Activity Award is presented for excellence in planning and executing events that encourage the participation of the Institute's young professional members, and provide opportunities for leadership at the section, regional, or national level. The winners are:

Very Small: **Sydney, Michael West, Sydney chair and young professional activities officer**. The AIAA Sydney Section is awarded the first place Young Professional Activity Award because of their exceptional organization, integration of YP-focused activities in wider Section events, and speaker events uniquely targeted to YP issues and interests.

Large: **Phoenix, M. Brett McMickell, at large representative**. The AIAA Phoenix Section is awarded the first place Young Professional Activity Award because of its clear, well-managed focus on reaching out to YPs to get the most value out of their AIAA membership and increasing their participation in the broader AIAA community.

Very Large: **Dayton/Cincinnati, Robert Mitchell, young professional activities officer**. The AIAA Dayton/Cincinnati Section is awarded the first place Young Professional Activity Award because of their comprehensive program for consistently engaging YPs across a wide variety of events and activities.

Outstanding Activity Award

The Outstanding Activity Award allows the Institute to acknowledge sections that have held an outstanding activity deserving of additional recognition. The winners are:

AIAA China Lake Section Outstanding Activity

Very Small (tie): **Sydney, Michael West, section chair—Aerospace Futures Conference**. This conference brought together university students from across Australia with representatives from the Australian and international space industry to discuss current research, careers, and future prospects in the aerospace sector. As part of the conference, the Section also hosted an evening public panel discussion on the roles of government and industry in Australia's nascent space sector..

China Lake, Ying-Ming Lee, section chair—50 Years of AIAA at China Lake. The Section celebrated its 50th anniversary with a special celebration honoring both the history of the Section and its members. The program began with a presentation by Section officer, Jeff Scott, followed by an award ceremony for members with special focus on five individuals who have been AIAA members for 50 years. Capping off the evening was a multimedia presentation by guest speaker, Wallace Martin. Inspired by the recently installed AIAA Historic Aerospace Site plaques, this presentation featured pictures, videos, and personal stories highlighting the most important contributions made by scientists and engineers at China Lake in the history of the facility.

Small: **Northwest Florida, Ben Dickenson, section chair—Eglin Air Force Base Flightline Tour**. The Section organized and led an educational tour of Eglin AFB with the first state-funded STEM Center. Seventy-three students and ten chaperones learned about the F-35, F-15, and F-16, with an emphasis on the use of electromagnetic spectrum for flying operations. While touring the aircraft the students were placed in teams of five to

AIAA Sydney Section Outstanding Activity

AIAA Los Angeles/Las Vegas Section Outstanding Activity

AIAA Northwest Florida Section Outstanding Activity

answer a 20-question quiz. The quizzes were graded and the top two teams were awarded prizes.

Medium: **Central Florida, Randal Allen, section chair—Wings 'n' Things**. This was a STEM K–12 event held at the Florida Air Museum at Sun 'n' Fun in Leesburg, FL, in which Cub Scouts, Boy Scouts, and their sisters built and flew model rockets. Approximately 300 youth took part in this full-day event. In the morning session, they built their model rockets. After lunch, they launched their rockets, some multiple times—until they ran out of engines. Section members and AIAA/UCF students participated in this full-day activity.

Large: **Northern Ohio, Kevin Melcher, section chair—Young Astronauts Day**. The Section, NASA Glenn Research Center, and Sierra Lobo Inc. hosted 350 students (15 middle/high school teams and 15 elementary teams) from 19 different communities and schools for the 20th anniversary edition of Young Astronauts Day. Throughout the day-long event, students were challenged with various hands-on (STEM) activities. Demand for participation in this event is high—the 30 team slots fill fast and there is always a waiting list!

Very Large (tie): **Los Angeles/Las Vegas, Nicola Sarzi Amade, programs officer—Annual Awards Dinner and Book Signing**. This event had the largest attendance in recent Section history with 259 people participating. As a result of this dinner, the Section recruited 2 new professional members and 24 new student members. Guest speakers Buzz Aldrin & Francis French had a book signing. The event was both successful and profitable.

Greater Huntsville, Tom Kmiec, section chair—Civil Space Symposium. This symposium, held for the first time, was billed as "Civil Space 2013: Accelerating Tomorrow's Commercial Space Marketplace." It was a two-day event to bring together government and industry to discuss the mutual goal of efficient, effective, and reliable access for payload and crew to near-Earth space. The conference was unique in that the focus was not on exploration, but on Earth orbital concerns and solutions. It served as a working-level conference designed to highlight some of the biggest challenges facing the market today, including technology gap, market stability, obsolescence, and integration and safety standards.

AIAA Northern Ohio Section Outstanding Activity

AIAA Central Florida Section Outstanding Activity

AIAA Greater Huntsville Section Outstanding Activity

CALL FOR PAPERS FOR *JOURNAL OF AEROSPACE INFORMATION SYSTEMS*

Special Issue on "Estimation and Information Theory Applications for Resilient and Distributed Operations of Aerospace Systems"

The *Journal of Aerospace Information Systems* is devoted to the applied science and engineering of aerospace computing, information, and communication. Original archival research papers are sought that include significant scientific and technical knowledge and concepts. In particular, articles are sought that demonstrate the application of recent research in computing, information, and communications technology to a wide range of practical aerospace problems in the analysis and design of vehicles, onboard avionics, ground-based processing and control systems, flight simulation, and air transportation systems.

Information about the organizers of this special issue as well as guidelines for preparing your manuscript can be found in the full Call for Papers in Aerospace Research Central (ARC); arc.aiaa.org. The journal website is **http://arc.aiaa.org/loi/jais**.

Key research areas included in the special issue are:

- GPS-denied navigation and control
- Distributed estimation and control in uncertain environments
- Resilient navigation in presence of cyber attacks, GPS spoofing, and sensor takeover
- Information sharing in hostile, cluttered, or resource-constrained environments
- Collaborative multi-agent and multi-sensor navigation techniques for safe operation in cluttered, hostile, and GPS-denied environments
- Vision-based control for systems with fast-dynamics and resource constraints
- Flight validation of high-integrity manned/unmanned aircraft navigation and control in uncertain and GPS-denied environments
- Distributed parameter identification and environment model learning
- Bayesian learning and perception for aerospace applications

These areas are only indicative. The special issue is also open to manuscripts that are relevant to the applied science and engineering of aerospace computing, information, and communication but do not fit neatly into any of the above areas. We do envisage, however, that successful manuscripts will include experimental results, or at least sophisticated simulations of real-life mechanical or aerospace systems.

Estimation and information theory have traditionally played key roles in aerospace systems. They have been critical to the success of key aerospace breakthroughs, including long-range missiles and unmanned aerospace systems. The goal of this special issue is to bring together quality papers that focus on next-generation applications of estimation and information theory to aerospace systems.

Submission Deadline: **14 March 2014**.
Anticipated Publication Date: **July 2014**.
Contact Email: Girish Chowdhary, girish.chowdhary@okstate.edu; Rajnikant Sharma, rajnikant.sharma@usu.edu; or Adam Rutkowski, Adam.Rutkowski@eglin.af.mil

REUBEN H. FLEET SCHOLARSHIPS AWARDED BY THE SAN DIEGO SECTION IN MAY

At the AIAA San Diego Section Honors and Awards Banquet on 23 May 2013, the AIAA San Diego Section Reuben H. Fleet Scholarships were awarded. Since 1983, 159 students have received the scholarship, which is made possible by the Reuben H. Fleet Foundation at The San Diego Foundation.

The 2013 Reuben H. Fleet Scholarship recipients (left to right): Alex Fleet (Grandson of Reuben H. Fleet), Jack Goodwin (UCSD), Steven Tran (SDSU), Scott James (SDSU), Robert Bertino (UCSD), Rauno Cavallaro (UCSD/SDSU), Matthew Berg-Johnson (Del Norte High School), Alexander Weiss (SDSU), Sean Davis (SDSU), Robin Felver (UCSD), Juan Avila (SDSU), and Jennifer Rhymer (AIAA San Diego Section Chair).

AIAA PARTNERS WITH STATE OF GEORGIA AND GEORGIA'S TECHNOLOGY LEADERS TO DISCUSS UNMANNED SYSTEMS POLICY

State, industry, and university leaders gathered at the Georgia Tech Research Institute on 20 November to discuss the current and future state of unmanned systems policy. The Unmanned Systems Policy Symposium was hosted by the Georgia Centers of Innovation for Aerospace and Logistics, programs of the Georgia Department of Economic Development, and the Georgia Tech Research Institute with sponsorship from the AIAA Atlanta Section. The event addressed the key challenges for the future commercial unmanned systems market including global competition, privacy concerns, legal issues and regulation of unmanned vehicles.

"It's important for us to discuss current and future unmanned systems policy information with key leaders in government, industry and academia to make sure we all are on the same sheet of music," said Steve Justice, Director of the Georgia Center of Innovation for Aerospace and a member of the AIAA national Public Policy Committee. "We're preparing Georgia to be the leader in the unmanned systems industry and the policy side of the equation will be crucial to our companies."

Dr. Lora Weiss, principal research engineer and technical director for the Georgia Tech Research Institute's Autonomous Systems Initiative, opened the event with a keynote address on self-driving cars. Dr. Weiss discussed emerging technologies within vehicle-to-vehicle communication, driver assistance, self-regulating tires, and the ultimate mobile device—the "Smart Car".

The event featured two panels—unmanned aerial systems (UAS) and unmanned ground vehicles. The panels were made up of numerous industry, legislative, and academic participants and discussed the policy matters specific to their focus including the need for creating awareness among the public about the beneficial uses of commercial unmanned systems. The Air Vehicle Panel, moderated by AIAA Region II Deputy Director for Public Policy Steve Justice, included AIAA members Dr. Eric Johnson (Georgia Tech), Dr. Nick Alley (Area-I), and Ms. Amy Hudnall (Center of Innovation for Aerospace)

RECORD AUDIENCE ATTENDS AIAA/OAI DISTINGUISHED LECTURE WITH DR. TOM MARKUSIC

Dr. Thomas Markusic, Vice President for Propulsion at Virgin Galactic, offered an entertaining glimpse into commercial space during a July 12th presentation entitled "Playing with Fire: The Promise and Peril of Newspace." Dr. Markusic, a native Ohioan and Ohio State graduate, spoke from a unique background. In his career, he has worked as a civil servant performing research in advanced propulsion for the Air Force and NASA, followed by stints at SpaceX (he developed the Merlin 1C engines for the Falcon 1 and Falcon 9 spacecraft), Blue Origin, and now at Virgin Galactic, working on the next-generation liquid rocket engines for Spaceship 2.

Dr. Markusic discussed the cultures of the Newspace companies, which included: hiring the best, trusting them to do their job, and getting the job done no matter how many hours it takes. He also pointed out the differences in management and approach that he had observed: SpaceX was driven, with strong leadership from its president, Elon Musk, and many decisions made by individuals rather than committees. Blue Origin was more measured, with a long-term plan guiding each activity. Finally, Virgin Galactic was most businesslike, benefiting from the overall Virgin empire's expertise in running a diverse portfolio of companies.

He identified the potential benefits, and the pitfalls, of the Newspace model: Benefits included lower-cost space access, an industry not directly beholden to government, and a potential new market to grow economies. The pitfalls were the current lean, and hardworking, paradigm that in some companies leads to high turnover. For instance, the "do what it takes" attitude may hide the actual labor cost for "cheap" access to space.

Dr. Markusic also discussed his personal views of the future of space travel, both government and industry. This extended to his analysis and evaluation of propulsion for Mars missions, leading to a conclusion that an effective approach would be to use nuclear thermal rockets for crew, and solar electric propulsion for cargo. He stressed that this portion of his lecture was not based on any interest expressed by Virgin Galactic.

With an audience of 170—split between college-age students and summer interns, experienced working engineers and retirees—Dr. Markusic provided a variety of interesting information, spanning career insights to technology projections and assessments. All of these topics were explored during the discussion period after his lecture, with refreshments provided by AIAA.

Young Professionals' Luncheon and Q&A

In addition to presenting a well-attended lecture, Dr. Markusic also graciously spent time with members of the AIAA Northern Ohio Section Young Professionals for an enlightening discussion, over lunch, about career opportunities and choices in the modern aerospace era. He provided his insight into the relative merits between time spent in the field and time spent in the classroom as it relates to various career paths. He also shared anecdotes and impressions of his time working at SpaceX, Blue Origin, and Virgin Galactic.

Dr. Tom Markusic presented his perspective on the benefits and pitfalls of the Newspace model and its impact on the future of space travel to a record audience of 170 attendees, nearly filling the auditorium at the Ohio Aerospace Institute (OAI).

CALL FOR AWARD NOMINATIONS

Recognize the achievements of your colleagues by nominating them for an award! Nominations are now being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 February**. Awards are presented annually, unless other indicated. However AIAA accepts nomination on a daily basis and applies to the appropriate year. Any AIAA member in good standing may serve as a nominator and are urged to read award guidelines to view nominee eligibility, page limits, letters of endorsement. All nominations must comply with the limit of 7 pages for the nomination package; see details on the webpage (**https://www.aiaa.org/secondary.aspx?id=230**).

Aerospace Communications Award is presented for an outstanding contribution in the field of aerospace communications.

Aerospace Power Systems Award is presented for a significant contribution in the broad field of aerospace power systems, specifically as related to the application of engineering sciences and systems engineering to the production, storage, distribution, and processing of aerospace power.

Air Breathing Propulsion Award is presented for meritorious accomplishment in the science of air breathing propulsion, including turbomachinery or any other technical approach dependent on atmospheric air to develop thrust, or other aerodynamic forces for propulsion, or other purposes for aircraft or other vehicles in the atmosphere or on land or sea.

The industry-renowned **Daniel Guggenheim Medal** was established in 1929 for the purpose of honoring persons who make notable achievements in the advancement of aeronautics. AIAA, ASME, SAE, and AHS sponsor the award.

Energy Systems is presented for a significant contribution in the broad field of energy systems, specifically as related to the application of engineering sciences and systems engineering to the production, storage, distribution, and conservation of energy.

George M. Low Space Transportation Award honors the achievements in space transportation by Dr. George M. Low, who played a leading role in planning and executing all of the Apollo missions, and originated the plans for the first manned lunar orbital flight, Apollo 8. (Presented even years)

Haley Space Flight Award is presented for outstanding contributions by an astronaut or flight test personnel to the advancement of the art, science, or technology of astronautics. (Presented even years)

J. Leland Atwood Award recognizes an aerospace engineering educator for outstanding contributions to the profession. AIAA and ASEE sponsor the award. *Note*: Nominations due to ASEE by **14 January**.

Jeffries Aerospace Medicine & Life Sciences Research Award is presented for outstanding research accomplishments in aerospace medicine and space life sciences.

Missile Systems Award—Technical Award is presented for a significant accomplishment in developing or using technology that is required for missile systems.

Missile Systems Award—Management Award is presented for a significant accomplishment in the management of missile systems programs.

Propellants and Combustion Award is presented for outstanding technical contributions to aeronautical or astronautical combustion engineering.

New Lectureship in Aerospace Engineering Seeks Nominees!

The Yvonne C. Brill Lectureship in Aerospace Engineering has been established in the memory of Yvonne Brill, pioneering rocket scientist, AIAA Honorary Fellow, and NAE member. Nominations are now being solicited for the inaugural lectureship in September 2014. The ideal nominee should have a distinguished career involving significant contributions in aerospace research and/or engineering and will be selected based on technical expertise, originality, and influence on other important aerospace issues such as ensuring a diverse and robust engineering community. NAE or AIAA members are eligible to place a nomination. Contact carols@aiaa.org to request the nomination form. Nominations are due to AIAA on or before **31 January 2014**.

Space Automation and Robotics Award is given for leadership and technical contributions by individuals and teams in the field of space automation and robotics. (Presented odd years)

Space Science Award is presented to an individual for demonstrated leadership of innovative scientific investigations associated with space science missions. (Presented even years)

Space Operations and Support Award is presented for outstanding efforts in overcoming space operations problems and assuring success, and recognizes those teams or individuals whose exceptional contributions were critical to an anomaly recovery, crew rescue, or space failure. (Presented odd years)

Space Processing Award is presented for significant contributions in space processing or in furthering the use of microgravity for space processing. (Presented odd years)

Space Systems Award recognizes outstanding achievements in the architecture, analysis, design, and implementation of space systems.

von Braun Award for Excellence in Space Program Management recognizes outstanding contributions in the management of a significant space or space-related program or project.

Theodor W. Knacke Aerodynamic Decelerator Systems Award recognizes significant contributions to the effectiveness and/or safety of aeronautical or aerospace systems through development or application of the art and science of aerodynamic decelerator technology. (Presented odd years)

The **William Littlewood Memorial Lecture**, sponsored by AIAA and SAE, perpetuates the memory of William Littlewood, who was renowned for the many significant contributions he made to the design of operational requirements for civil transport aircraft. Lecture topics focus on a broad phase of civil air transportation considered of current interest and major importance.

Wyld Propulsion Award is presented for outstanding achievement in the development or application of rocket propulsion systems.

For further information on AIAA's awards program, please contact Carol Stewart, Manager, AIAA Honors and Awards, carols@aiaa.org or 703.264.7623.

OBITUARIES

AIAA Fellow Ballhaus Died in August 2013

Dr. William F. Ballhaus, Sr. died on 16 August, one day after his 95th birthday. He had a profound respect for education and learning, loved engineering and mathematics, and, as a leader, took accountability and got results.

Dr. Ballhaus earned a BA in general engineering and the degree of Engineer in Mechanical Engineering, both from Stanford University. While working at Douglas aircraft in the late 1940s designing Navy airplanes, he attended Caltech and earned a Ph.D. in Aerodynamics and Mathematics.

He subsequently worked for Convair in Ft. Worth. Known as a problem solver, Dr. Ballhaus was hired as chief engineer at Northrop in 1952 to help solve problems with the F-89 fighter and Snark Missile. As chief engineer, he was responsible for the design of the T-38 Air Force Supersonic Trainer, still in use today by the Air Force and the NASA Astronaut Corp. In 1957 Ballhaus was elected a corporate vice president and general manager of Northrop's new Nortronics Division, successfully growing it from 4,000 to 11,000 employees over a 4-year period. As a result of his success leading Nortronics, in 1961 he was elected executive vice president of Northrop and elected to its Board of Directors.

In 1965 Ballhaus became president of Beckman Instruments and a member of its Board of Directors. While at Beckman, he carefully reduced the company's government Space and Defense businesses, and reinvesting the savings, created a fast growing commercial Medical Instruments Division. In the last ten years of his management, earnings grew at a rate in excess of 25% each year. Beckman was acquired by Smith Kline, and Ballhaus was named vice chairman and chief executive officer.

Dr. Ballhaus retired from Smith Kline Beckman in 1983. During his time at Beckman, he also successfully helped key members of Congress understand the impact of tax policy on economic growth, which resulted in lowering the capital gains tax by 43% in the 1978 tax law, the first such reduction in 40 years. After retirement, he served on the boards of Northrop, Union Oil of California, and others.

In 1973 he was elected a member of the National Academy of Engineering and served for 6 years on its Council. He was elected a distinguished alumnus of Caltech in 1978. Dr. Ballhaus endowed prizes at both Stanford and Caltech, awarding cash prizes each year for the outstanding Ph.D. dissertation in aerospace engineering. He and his son, Honorary Fellow Dr. William F. Ballhaus, Jr. were the first father and son elected AIAA Fellows. They were also the first father-son elected to the National Academy of Engineering. His grandson, Dr. William L. Ballhaus, has also been elected an AIAA Fellow.

AIAA Fellow Ivanov Died in August 2013

Mikhail Ivanov, a world-renowned expert in the field of rarefied gas dynamics, high-altitude aerothermodynamics, and shock physics passed away in Novosibirsk, Russia, on 31 August 2013 at the age of 68.

At age 17, Mr. Ivanov was admitted to Moscow State University, the premier Soviet university for sciences and mathematics. Upon graduation from the Department of Mechanics and Mathematics in 1968, Ivanov was assigned a research position at the Institute of Theoretical and Applied Mechanics (ITAM). Ivanov worked at ITAM for 45 years until his death.

Mr. Ivanov defended a dissertation for the degree of Candidate of Science (equivalent to a Ph.D.) in 1979 and became a Doctor of Science in 1994. He became the Head of Computational Aerodynamics Laboratory in 1995. Under his leadership the Laboratory developed some of the most powerful computational software systems for prediction of satellite aerodynamics (RAMSES, RuSat) and rarefied gas dynamics (SMILE). Under collaboration with Russian Rocket Corporation "Energiya", Ivanov's team developed software that became the major tool for the analysis and improvement design of space vehicle "Progress", reentry capsule "Soyuz", and development of the aerodynamic database for the International Space Station. His team participated in the design of aeroassisted controlled descent of Space Station "Mir", successfully performed in March 2001. In particular, Ivanov's team determined the optimal configuration of solar arrays to minimize disturbing aerodynamic torques and maximize drag.

Ivanov's signature contributions to high-speed flow physics include his pioneering work on hysteresis in Mach reflection. In steady supersonic flow there exists a region in Mach number shock angle space in which both regular and Mach reflection can exist. Predicted in 1979 by Hornung et al. on a theoretical basis, the hysteresis phenomena was elusive to the experimental attempts. In the 1990s Mr. Ivanov was able to prove the hysteresis occurence by DSMC computations. He then started an extensive experimental campaign in several Russian wind tunnels that eventually demonstrated the hysteresis experimentally with a very convincing schlieren movie. The hysteresis phenomenon is of practical importance in the design and operation of engine intakes in the high supersonic and hypersonic range.

Mr. Ivanov was a long-time member of the Thermophysics Technical Committee and an active participant in AIAA meetings, publishing over 100 papers in AIAA journals and conference proceedings and he had received two AIAA Best Paper awards. Ivanov was elected a Fellow of AIAA in 2010.

AIAA Senior Member Vogel Died in September 2013

John F. Vogel, 98, passed away on 28 September 2013. Mr. Vogel had been a member of AIAA since 1939.

Mr. Vogel graduated from the University of Michigan with a degree in Aeronautical Engineering. After being transferred to the Office of the Chief Signal Officer in the second wing of the Pentagon, he worked in staff positions at the AAF headquarters in Air Defense, Radar, and guided missile development. He resumed flight training and received both his private and commercial pilot's licenses. He served as a Lt. Colonel in the U.S. Air Force as well.

After leaving the Air Force, John worked as Chief Engineer in the FAA's Aircraft Division in New York. In 1967, he was transferred to Atlanta as Chief of Engineering and Manufacturing for the eight-state Southern Region of the FAA. His last major responsibility before retirement in 1976 was to lead a team of FAA Engineers to Brazil on behalf of the U. S. State Department and U. S. Secretary of State Henry Kissinger.

To submit articles to the *AIAA Bulletin*, contact your Section, Committee, Honors and Awards, Events, Precollege, or Student staff liaison. They will review and forward the information to the *AIAA Bulletin* Editor. See the AIAA Directory on page **B1** for contact information.

Upcoming AIAA Continuing Education Courses

Courses at AIAA Science and Technology Forum and Exposition 2014 (AIAA SciTech 2014)
www.aiaa.org/scitech2014courses

Saturday–Sunday, 11–12 January 2014

Decision Analysis

Instructor: John C Hsu

Decision analysis supports system life cycle development throughout all phases and system hierarchical levels. The course presents the trade study process as part of the systems engineering process, and introduces various decision analysis methods, including the traditional trade study methods, trade space for CAIV, AHV as a part of the ANP, PAPRIKA, and decision analysis with uncertain information/data.

Sunday, 12 January 2014

Introduction to Integrated Computational Materials Engineering

Instructor: David Furrer and Jason Sebastian

Designed to provide an overview of integrated computational materials engineering (ICME), this course offers a primer on the various types of models and simulation methods involved in ICME. It is aimed at providing a general understanding of the critical issues relative to ICME, with the goal of increasing participants' knowledge of materials and process modeling capabilities and limitations.

Saturday, 11 January 2014
Workshops at AIAA Science and Technology Forum and Exposition 2014 (AIAA SciTech 2014)
www.aiaa.org/scitech2014courses

1st AIAA Sonic Boom Prediction Workshop

Sponsored by the Applied Aerodynamics Technical Committee

The objective of the workshop is to assess the state of the art for predicting near field signatures needed for sonic boom propagation. Participants are requested to apply their best practices for computing solutions on the provided geometries. For more information, please visit the Sonic Boom Prediction Workshop website (**http://lbpw.larc.nasa.gov**).

Low Reynolds Number Workshop

Organized by Ming Chang, Lockheed Martin Aeronautics, and Michael OI, US Air Force Research Lab

The workshop aims to gather industry, academia, and government to assess new research directions and connection between the sciences and the applications. Outcomes aim to include an understanding of where the MAV community stands in 2014 relative to where we've been throughout the past 20 years, and how to begin bridging scientific/academic advances with the needs of industry and the user community. For questions, please contact Ming Change at 661.572.6228 or ming.chang@lmco.com, or Michael V. OL at 937.713.6650 or michael.ol@wpafb.af.mil.

To register for a course or workshop at AIAA SciTech 2014, visit www.aiaa.org/scitech2014 and select "Register Now".

February–June 2014
Home Study Courses
www.aiaa.org/homestudy

Introduction to Computational Fluid Dynamics

Instructor: Klaus Hoffmann

This introductory course is the first of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics. Completion of these three courses will give you the equivalent of one semester of undergraduate and two semesters of graduate work. The courses are supported extensively with textbooks, computer programs, and user manuals.

Key Topics

- Classification of partial differential equations (PDEs)
- Finite-difference equations
- Parabolic equations
- Stability analysis
- Elliptic partial differential equations
- Hyperbolic partial differential equations
- Scalar representation of the Navier-Stokes equations
- Incompressible Navier-Stokes equations

Advanced Computational Fluid Dynamics

Instructor: Klaus Hoffmann

This advanced course is the second of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics. Completion of these three courses will give you the equivalent of one semester of undergraduate and two semesters of graduate work. The courses are supported extensively with textbooks, computer programs, and user manuals.

Key Topics

- Grid-generation-structured grids
- Transformation of the equations of fluid motion from physical space to computational space

- Euler equations
- Parabolized Navier-Stokes equations
- Navier-Stokes equations
- Grid-generation-unstructured grids incompressible Navier-Stokes equations
- Finite volume schemes

Computational Fluid Turbulence

Instructor: Klaus Hoffmann

This advanced course is the third of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics with emphasis in fluid turbulence. Completion of these three courses will give you the equivalent of one semester of undergraduate and two semesters of graduate work. The courses are supported extensively with textbooks, computer programs, and user manuals.

Key Topics
- Introduction to turbulence and turbulent flows
- Reynolds average Navier-Stokes equations
- Parabolic equations
- Turbulence models
- Compact finite difference formulations
- Boundary conditions
- Large eddy simulation
- Direct numerical simulation

Missile Design and System Engineering

Instructor: Gene Fleeman

This course provides the fundamentals of missile design, development, and system engineering. A system-level, integrated method is provided for missile configuration design and analysis. It addresses the broad range of alternatives in satisfying missile performance, cost, and risk requirements.

Key Topics
- Key drivers in the missile design process
- Critical trade-offs, methods, and technologies in aerodynamic, propulsion, structure, seeker, warhead, and subsystems sizing to meet flight performance and other requirements
- Launch platform-missile integration
- Robustness, lethality, guidance, navigation & control, accuracy, observables, survivability, reliability, and cost considerations
- Missile sizing examples for missile systems and missile technologies
- Missile system and technology development process

Spacecraft Design and Systems Engineering

Instructor: Don Edberg

This course presents an overview of factors that affect spacecraft design and operation.

Key Topics
- History
- Design drivers
- Orbital mechanics and trajectories
- Systems engineering
- Design considerations
- Estimation, testing, and failure prevention

To register for any of these Home Study courses, visit www.aiaa.org/homestudy and select "Register Now".

14–15 June 2014
Workshop at AIAA Aviation and Aeronautics Forum and Exposition 2014 (AIAA AVIATION 2014)
www.aiaa-aviation.org

Third AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-III)

The major emphasis of this workshop will be coordinated computational, modeling, and measurement efforts based on collaborative definition of a hierarchical set of benchmark configurations representing major sources of airframe noise; joint development of datasets that would eventually achieve benchmark quality.

31 July–1 August 2014
Workshop at AIAA Propulsion and Energy Forum and Exposition 2014 (AIAA Propulsion and Energy 2014)
www.aiaa-propulsionenergy.org

2nd AIAA Propulsion Aerodynamics Workshop

This workshop is being held so that various groups from industry and academia can look at a given set of Propulsion Aerodynamic problems and come up with an agreed set of solutions to the problems.

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