November 2014

AEROSPACE AMERICA

ORION

The 4-hour flight and fiery re-entry that could give NASA its mojo back
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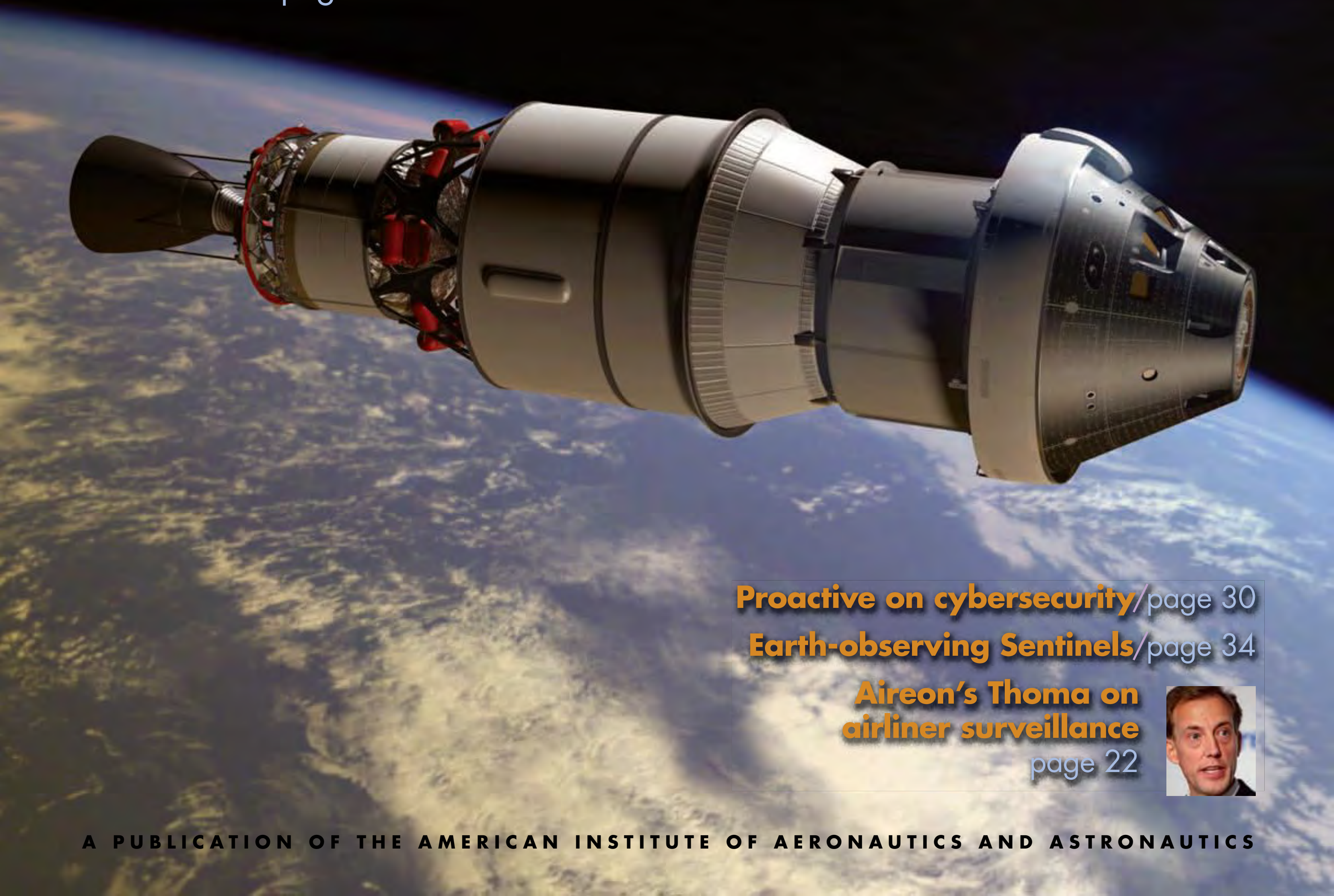

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A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

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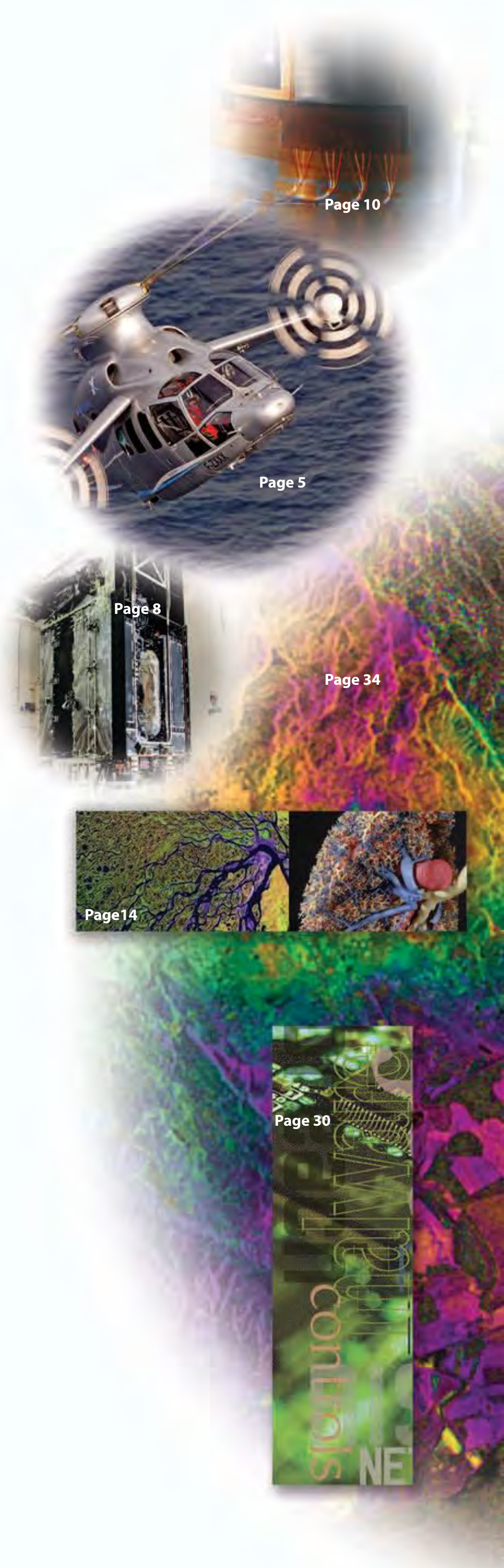

DEPARTMENTS

FEATURES

BULLETIN

Aerospace America (ISSN 0740-722X) is published monthly by the American Institute of Aeronautics and Astronautics, Inc. at 1801 Alexander Bell Drive, Reston, Va. 20191-4344 [703/264-7577]. Subscription rate is 50% of dues for AIAA members (and is not deductible therefrom). Nonmember subscription price: U.S., $200; foreign, $220. Single copies $20 each.
Postmaster: Send address changes and subscription orders to address above, attention AIAA Customer Service, 703/264-7500. Periodical postage paid at Herndon, Va., and at additional mailing offices.

40,000 copies of this issue printed. This is Volume 52, No. 10

AEROSPACE AMERICA®

is a publication of the American Institute of Aeronautics and Astronautics

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October 2014, Vol. 52, No. 10

AIAA
The World's Forum for Aerospace Leadership

Editor's Notebook

The stakes for Orion

Everyone loves a good drama, and Orion's flight in December promises to be that, given the capsule's planned orbit through the Van Allen radiation belt and high velocity re-entry.

It's good to see that NASA's technology managers haven't shied away from a bold unmanned test, despite what is probably a strong desire on the policy side of the house for an exciting but ultimately triumphant splashdown in the Pacific Ocean in front of the American public, lawmakers and bloggers.

Missions like Exploration Flight Test-1 are expensive, so lessons must be gleaned that could not have been learned in test chambers or ranges here on Earth. That said, one reason for choosing a capsule-and-rocket design was to ensure faster and cost-efficient development of a system that can be trusted to carry astronauts. Success will mean that NASA and Lockheed Martin learn valuable technical lessons even as they validate the basic strategy of dusting off and modernizing the Apollo blueprint.

This will not be a publicity stunt rigged for success, that's for sure. Engineers at Lockheed Martin and NASA will be gauging the ability of Orion to withstand radiation and protect astronauts from it. The capsule will need to survive 4,0000-degree Fahrenheit re-entry speeds with a repaired thermal protection system. NASA and its contractors stand to draw significant performance facts and lessons for future versions of the capsules.

As exciting as all that is, there's more riding on EFT-1 than technical outcomes. The mission will provide NASA managers and members of Congress with their best gauge yet of the public's willingness to support human spaceflight as a national priority for the 21st century. Early indications show significant media interest in the mission, judging by the online coverage of sea recovery tests conducted earlier this year with Orion mockups.

The truth is that bringing large national projects like Orion to fruition must always involve doing more than what might be popular at the moment. Leadership and wise engineering will be required, as will recognition that ultimately agencies like NASA and their contractors work for the America people.

Ben Iannotta
Editor-in-Chief

Women engineers and the workplace culture

A response to "*Wanted: More diversity in engineering*" [September, page 11]

I've been in engineering since 1986 and often one of the few women in the workplace. It is my opinion that one of the factors that keeps girls from entering engineering and women from staying has to do with the culture of the workplace or academic institution, rather than interest or aptitude. This culture isn't necessarily one of discrimination, but it is more about how people within engineering organizations interact with one another. Women haven't put their mark on the organizations, and so we continue, after all these years, to fit into a culture that doesn't fit many of us. I believe the combined attributes of the existing and new cultures will serve all best, but I don't know that anyone is really trying to study those effects.

Having worked in several companies and two industries (energy and aerospace), I still see that the women who succeed have adapted to the culture created by men and have not tried to make the culture change. Until this happens — for women or those from other backgrounds — engineering will continue to be an unfriendly work environment. Talking about diversity helps people understand that cultural norms vary, but it doesn't talk about how people should be treated. Treating everyone just like you treat everyone else is not the solution, if you treat people poorly.

I would like to see some studies address this aspect.

Thank you for bringing the issue to the audience of Aerospace America.

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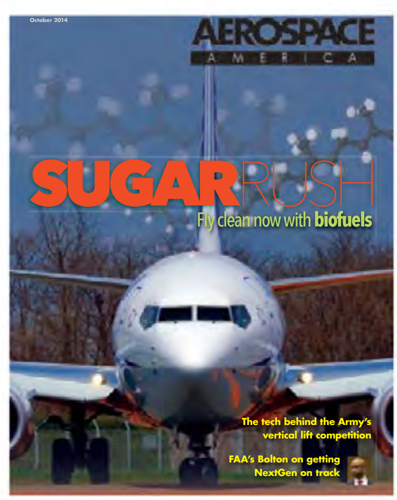
What's lost with renewable fuels



The article on synthetic fuels was very informative and encouraging in certain respects ["Biofuels now," October, page 30].

However, we cannot label such fuels as "renewable" if they are derived from the destruction of wildlife habitat. Recently in the Wall Street Journal we read that the World Wildlife Federation and Zoological Society of London announced the results of their joint study finding that we have lost 50 percent of the mass of wild animals (all vertebrate) worldwide over the last 40 years.

The greatest effects were in Central America, losing 83 percent of wild animals, largely due to destruction of rain forest and jungle.

We can reasonably ask if some of the habitat loss was associated with the cultivation of plants destined to become "renewable" fuels.

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Correction

The article "Collateral Damage" [September, page 36] gave an incorrect date for Russia's annexation of Crimea. The article should have said the annexation occurred in March.

All letters addressed to the editor are considered to be submitted for possible publication, unless it is expressly stated otherwise. All letters are subject to editing for length and to author response. Letters should be sent to: Correspondence, Aerospace America, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, or by email to: beni@aiaa.org.

From Finland to Brazil, biofuels take off

Cooking fat, household waste and tobacco are three of the latest raw ingredients for new types of biofuel being pioneered by airlines and their industry partners.

In September, Finnair announced it would operate a flight from Helsinki to New York with an Airbus A330 powered by biofuel partly manufactured from cooking oil recycled from restaurants. According to the airline: "The biofuel mixture powering the flight to New York, provided by SkyNRG Nordic" — the Swedish arm of the Amsterdam-based biofuel supplier — "is an example of a biofuel alternative to ordinary jet fuel that significantly reduces net greenhouse gas emissions while also being sustainable in its own right."

Finnair is among the airlines exploring the use of new types of biofuels made with waste products and nonfood plants.

Airbus

The airline said carbon dioxide emissions could be reduced 50 to 80 percent by using biofuels. Finnair and its partners also say they are using biofuel sources that neither compete with food production nor damage biodiversity.

Finnair's decision to release more information about its use of biofuels could be in response to skepticism about biofuels among some environmentalists. "As yet, there is no sign of technological advances that could achieve sustainable aviation biofuels," wrote environmental activist and author Rose Bridger in July on the website of the World Development Movement, a U.K.-based anti-poverty organization that argues that production of some biofuels drives up food prices. "And burning vast amounts of biomass will only provide a small percentage of global jet fuel use, which stands at five million barrels per day."

Finnair is among multiple airlines investing in research on new types of biofuel. In August, the Amsterdam office of SkyNRG announced that South African Airways and Boeing would be putting money into a plan in South Africa to produce aviation fuel from a nicotine-free energy tobacco crop called Solaris. According to SkyNRG, Solaris can be used as a bio jet fuel feedstock that can help to significantly reduce price levels toward fossil parity and has the potential to reduce CO2 emissions by 80 percent compared with conventional jet fuels. "The teams are working on a product which will meet the criteria of the Roundtable of Sustainable Biomaterials standard identified by the World Wildlife Fund and other international non-governmental organisations as the strongest sustainability guarantee on the market," according to the SkyNRG statement.

And in April, British Airways announced it had made a long-term commitment to purchase 50,000 metric tons a year of fuel made from recycled waste that would otherwise be destined for landfills or incineration. When complete in 2017, the GreenSky refinery being built at the Thames Enterprise Park outside London will start converting 575,000 metric tons of post-recycled waste a year into 120,000 metric tons of clean burning liquid fuels for a wide range of transport applications, including aviation.

According to the Geneva-based Air Transport Action Group, there are now 15 airlines that have used biofuel from a number of sources. In 2011, Continental Airlines (now United Airlines) flew a Boeing 737-800 between Houston and Chicago using a blend of algae-derived biofuel and conventional jet kerosene The Brazilian airline GOL made 200 flights during the 2014 soccer World Cup using a fuel based on inedible corn oil, used cooking oil and conventional kerosene.

The industry is now working with global standards organizations, such as the Roundtable on Sustainable Biomaterials and ASTM International, formerly known as the American Society for Testing and Materials, to independently validate the sustainability of the fuels being researched. Some airlines are going further still. Netherlands-based KLM has set up a partnership with the environmental group the World Wide Fund for Nature to achieve a 100 percent renewable energy supply in 2050, and as a first step plans to have 1 percent of the fuel used by its fleet be biofuel in 2015.

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Europe aims for hybrid helo production in a decade

The high-speed helicopter demonstrator that Airbus Helicopters of Marignane, France, will develop under the European Union's Clean Sky initiative is meant to clear the way for a commercial version by 2024 and will be based on the company's internally funded X-3 helicopter, a hybrid aircraft with fixed wings, propellers and rotor blades.

The aim of the new research program, called LifeRCraft for Low Impact Fast & Efficient RotorCraft, will be a helicopter with a cruise speed of 220 knots (410 kilometers per hour) and an environmental footprint greatly reduced from today's rotorcraft. By comparison, a Eurocopter AS350 Squirrel helicopter has a fast cruise speed of 140 knots.

LifeRCraft is intended to mix the speed of a turboprop airplane with the versatility of a helicopter and serve as a bridge to a production version for search and rescue, border patrol, military special operations missions and other uses. LifeRCraft "will be more than a technology demonstrator," said Tomasz Krysinski, head of research and innovation for Airbus Helicopters, in an email. The craft will be a "new configuration" that will demonstrate "mission performance capabilities," he said.

There will be three critical areas of research, according to a presentation given by François Toulmay and Philippe Cabrit of Airbus Helicopters at a Clean Sky event in September. Incorporating new weight reduction components and systems will be critical as LifeRCraft will need wings, engines, propellers and a complex drive train not found in conventional helicopter designs. Maximizing aerodynamic efficiency will require new low drag, high lift-to-drag ratio fuselage designs. Cost targets will require researchers to develop a vehicle that is cheaper to operate and maintain than a conventional helicopter.

Once the demonstration phase is complete, Airbus expects to need about four years to get ready for production and earn flight certification for the aircraft. The fuselage design program will cost €7.5 million and last 5½ years while drive system research will cost €6.5 million over the same period.

Managers of the Clean Sky initiative gave the go-ahead in July for Airbus to start work.

The X-3, during a campaign from 2010 to 2013, achieved a level flight speed of 255 knots (472 kilometers an hour), using a pair of turboshaft engines to power both a five-blade main rotor and two propellers installed on short-span fixed wings.

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Airbus Helicopters began its research into high-speed hybrid helicopters with the X3, which flew from 2009 to 2013.

Airbus Helicopters

Flying cars gain traction

Terrafugia of Woborn, Mass., expects to make the first delivery of one of its Transition flying cars in 2016.

The latest prototype has been flown for over 100 hours. Another prototype, which will include the same Rotax 912-IS engine and 10-inch Dynon avionics display as in the production model, is currently in the final design phase.

The main challenge for designers is that the vehicle has to be roadworthy with four tires, four sets of suspension, a crash cage and a crumple zone, headlights, taillights, turn signals and airbags, which are not typically found on aircraft.

"Automobiles tend to be heavy and they are required to be crash-resistant," said Richard Gersh, Terrafugia's vice president of business development. "Aircraft tend to be very light and not designed to provide crash-worthiness in the same way as an automobile. We are using a propulsion system that powers both the propeller in the air and the wheels on the ground."

Then there are the regulatory issues. Vehicle taxation, insurance and motor vehicle registration will all need to be finalized at state and national government levels before the first customer aircraft can be handed over.

Terrafugia

Terrafuggia believes the market for its Transition flying automobile could reach 600 vehicles a year by 2020.

Given the number of technical and regulatory challenges involved, a critical factor could be the ability of the company to sustain its investment in research and production over several years before significant money from customers rolls in. "Our market research suggests there could be anywhere from 200 units a year to 600 units a year by the fourth year of production, in 2020," said Carl Dietrich, Terrafugia's chief executive officer. "But our goal is to set profitability at a very low rate of production, one vehicle a week. We believe the market is certainly there as we already have 100 people in line to buy the Transition." A Transition will cost $279,000.

Dietrich sees the Transition as a first step toward a change that will take a generation to accomplish: bringing general aviation to a much wider part of the population. "Our investors are in it for the long haul, not just the three- to five-year window that most venture capitalists use. We are talking about building an enterprise over the course of a generation," he said. "In the long run we believe the market for these sorts of products could dwarf the size of today's entire general aviation industry."

Flying automobiles are already operating outside the U.S. In December 2012, France's Direction Générale de l'Armement military procurement office placed an order for a Pegasus concept vehicle from Vaylon of Strasbourg, France. The two-seat, flying dune-buggy with a parafoil wing was delivered in December 2013. So far, the company has aimed the Pegasus mainly at the military market. At the Paris Eurosatory show in June, it marketed the vehicle as an ultralight aircraft convertible all-terrain vehicle, capable of flying to an altitude of 10,000 feet with a three-hour endurance and able to glide silently.

And operating above the rain forests of Ecuador is a similarly designed Maverick, developed by the Indigenous People's Technology and Education Center, a Christian missionary organization located in Dunnellon, Florida. The Maverick, which has a top road speed of 100 miles an hour and a flying speed of 40 miles an hour, has been certified by the FAA as a light sport aircraft and is being marketed to the general public by Dunnellon-based Beyond Roads with a purchase price of $94,000.

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T-X pilot trainer to include non-U.S. players, simulators

With the Department of Defense wanting to forge ahead on an $11 billion fleet of new T-X jet trainers, teams of U.S. and non-U.S. companies are ready to compete.

General Dynamics and Alenia Aermacchi have proposed the T-100 — a variant of the M-346; Lockheed Martin and Korean Aerospace Industries are bidding the T-50 Golden Eagle; Boeing and Saab plan to offer an all-new design; and BAE Systems, Northrop Grumman, L-3 Link Simulation & Training and Rolls-Royce are offering the Hawk Advanced Jet Training System. In September, The Wichita Eagle reported that Textron AirLand was considering proposing a new variant of its Scorpion jet trainer.

The Defense Department wants to spend $600 million in fiscal 2015 on the T-X, a proposed system of aircraft and ground simulators to replace the Northrop-supplied T-38 Talons first delivered to the service in 1961. There are currently more than 500 T-38s in service in the U.S., but they are rapidly becoming obsolete due to maintenance costs and the additional training requirements for network-enabled aircraft such as the Lockheed Martin F-35.

"The T-38 will reach the end of its life in 2020 or 2021," said Col. Lance Bunch, commander of the Air Force's 80th Flying Training Wing, at a military training symposium in London in September. "There will be an airframe upgrade to replace the longerons and the wings, but no more avionics. We haven't yet formalized the T-X requirements."

Current plans call for the purchase of 350 T-X trainers. Each is intended to be a total training system comprising simulators and other flight training devices to ensure that the pilot is given the right skills in the most cost-effective way.

The cost advantages of mixing in more ground training could be substantial. Analyst Ian Strachan, who spoke at the London event, estimates a savings ratio of 1-to-30 for a Boeing C-17 (meaning a dollar spent in a simulator would equal $30 for equivalent training in the air) to a ratio of 1-to-10 or 1-to-20 for a frontline fighter pilot. And as simulator technology improves in realism, the opportunities multiply to train on the ground.

As for the best mix of simulator and airborne training, the Royal Canadian Air Force is aiming to move from the current 70-to-30 ratio of live-to-synthetic training with simulators or other devices, to a 50-50 ratio over the coming years for frontline fighter pilots. In contrast, trainee pilots at the Euro-NATO Joint Jet Pilot Training Program at Sheppard Air Force Base, Texas — which trains fighter pilots from 10 NATO countries — normally spend 103 hours on a simulator before graduation and 211 hours in the air learning equivalent skills, according to Bunch. This amounts to a ratio of 32-to-68 synthetic-to-live training.

Northrop Grumman

The Air Force wants a replacement for the T-38 Talon, which has been used to train new pilots for more than half a century.

Alenia Aermacchi's M-346 trainer entered service in 2013 in Italy and Singapore. The company will submit a variant, the T-100, for the Air Force's T-X jet trainer competition.

Alenia Aermacchi

Other military aircraft operators face the same challenge as the U.S. Air Force in finding the most cost-effective way of bridging the capability gap between aging two-seat jet trainers and the new single-seat fifth-generation fighters coming into operational service. In June 2013 the first U.K. Royal Air Force fast-jet students graduated from the United Kingdom's Military Flying Training System, in which a private joint venture between Lockheed Martin and Babcock International Group is providing the facilities and flight training for a wide range of military pilots alongside the U.K. Ministry of Defence. This allows the cost of training to be spread across several years without the need for a large initial outlay in educational facilities and aircraft.

Identifying the most cost-effective and operationally successful way to match synthetic and live training facilities and the exact role of private contractors will play in the process will be two of the first priorities for T-X program officials.

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Prototype targets U.S. Army market

By the end of the year, Sikorsky Aircraft plans to start flying the first of its two S-97 Raider prototype helicopters — a $200 million demonstration of technology the company hopes will eventually replace the U.S. Army's OH-58D Kiowa Warrior and special operations MH-6 Little Bird helicopters.

Sikorsky unveiled the Raider — with two overhead rotors and a rear push propeller — in an Oct. 2 event in West Palm Beach, Florida, where the company is building the aircraft. Ground testing and then flight testing of the first Raider are scheduled to begin before 2015 and assembly of the second S-97 would begin in January.

The S-97 weighs 11,000 pounds and is 37 feet long, with overhead 34-foot-long rotors, and a cockpit for two pilots seated side-by-side and enough cabin space for six soldiers. As a prototype, it will fly like a production model would, but it isn't equipped with the flight systems or sensors, or the ballistic tolerance — the ability to absorb damage from bullets — of a battle-ready helicopter, said Steve Engebretson, Sikorsky's director of advanced military programs.

The S-97 uses the design of Sikorsky's experimental X2 helicopter, with rigid coaxial rotors spinning in opposite directions on the same axis to provide vertical lift and a rear propeller providing forward motion. The X2 was flown for about 20 hours from 2005 to 2011 and set the unofficial speed record for a helicopter, at 291 mph, in 2010. Sikorsky pegs the S-97's cruise speed at up to 253 mph.

"That [X2] aircraft was our physics demonstrator. We needed to prove the physics of combining a rigid coaxial rotor system with a pusher prop to demonstrate not only high-speed flight, but high efficiency helicopter capabilities," Engebretson said.

"What you've just now developed is a highly efficient rotorcraft system that completely changes the way we operate a helicopter. With a rigid coax system, we've now got a rotor system that will do things you can't do with a conventional helicopter," he said.

With its rigid coaxial rotors and pusher prop, the S-97 prototype is expected to have a cruise speed of about 250 mph.

Sikorsky

Besides the speed, the design allows the helicopter to be more efficient, with better performance as a hovering aircraft, in low-speed maneuvers and at high altitudes, Engebretson said.

One challenge with conventional helicopters is the imbalance between the lift of the advancing rotor blade — the right side, as it spins counterclockwise — and the retreating blade on the left side. For an aircraft flying forward at 100 mph and a rotor spinning at 200 mph, the advancing side will have 300 mph of air flowing over the blade, compared with 100 mph of relative air flowing over the retreating-side blade. The advancing blade has to be made inefficient to stay in balance with the retreating blade.

With the coax system, advancing blades balance each other, so the helicopter's designers don't have to build inefficiency into the rotors. Also, the rigidity of the blades allows the designers to stack them more tightly together than with other coax designs, such as with Russian Kamov helicopters, which are considered much less efficient with their taller masts and increased weight and drag.

Sikorsky hopes that the S-97 and its $150 million investment in the program, along with $50 million contributed by its 54 supplier partners, will show the U.S. Army that a replacement is ready and available for its Kiowa Warrior, and "inspire" the government to move forward with a replacement program, Engebretson said. Currently, there isn't a replacement program.

Sikorsky is also partnering with Boeing to build a demonstration helicopter for an Army-administered competition for replacing medium-sized U.S. military helicopters, including the UH-60 Black Hawk and AH-64 Apache. That helicopter, the SB-1 Defiant, also uses the X2 coax-and-push-prop design, but weighs 30,000 pounds.

"What we're trying to show is that with this next-generation capability, with any helicopter that's out there today that's flying with a main rotor and a single tail rotor, we can design an X2 technology platform that will go do that mission, but do it at a whole new level of capability," Engebretson said.

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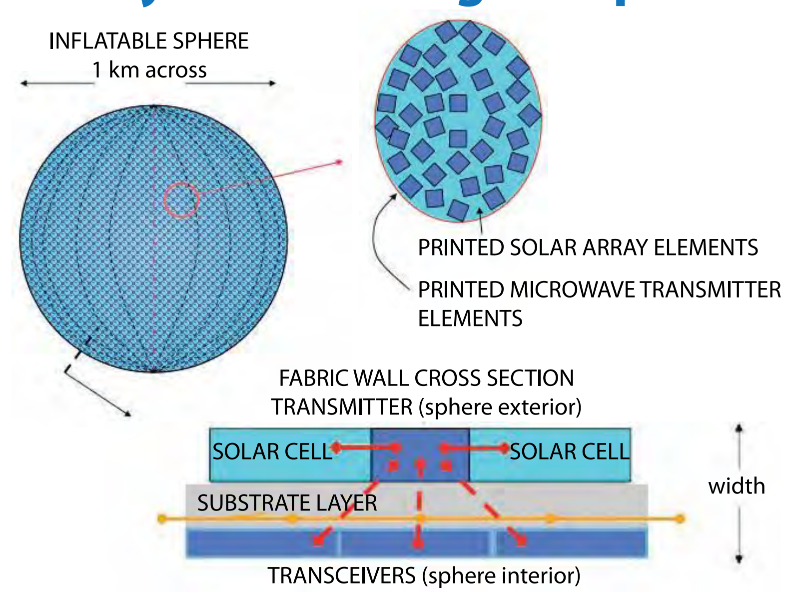
A modern take on an old idea

The idea of beaming solar power to Earth from space was pioneered during the oil price spikes of the 1970s by American aerospace engineer Peter Glaser, who died in May.

Glaser's patented concept called for deploying large dish-shaped solar collectors from one or more geosynchronous satellites, converting the energy to microwaves and beaming the energy to sites on Earth. It never happened. Once the oil crisis subsided, "Dr. Glaser's long-term alternative came to be seen as technologically and financially daunting," the New York Times wrote earlier this year in an article about Glaser's life.

Enter David Hyland, an aerospace engineering professor at Texas A&M University. Hyland is seeking a patent for an alternative design, called Power Star, that he says is "a revolutionary concept for space solar power" — one that is less technically daunting. Hyland wants to print solar cells and microwave circuits on the surface of an inflatable sphere and transmit the collected energy using beam-forming techniques already employed on communications satellites.

Hyland's beaming concept



SELLING POINTS

- FITS INTO MANY LAUNCH VEHICLES
- NO MOVING PARTS
- DYNAMICALLY STABLE
- NO SPACE ASSEMBLY OR CONSRUCTION
- GATHERS SUNLIGHT AT ANY ANGLE

Source: David C. Hyland

Hyland explained the concept to me at the International Astronautical Congress held in Toronto, Canada, from Sept. 29 to Oct. 3.

The system would combine the old technology of the inflatable sphere (used for NASA's Echo satellites of the early 1960s) and the new technology of printed photovoltaics and patch antennas (arranged in modules called collectennas). Power produced by the cells would be radiated at microwave frequencies within the empty sphere from transceivers on the sun-side to equivalent devices on the Earth-facing side, which would then route the power to exterior transmitters.

According to Hyland, where other concepts call for "gigantic, complex, articulated structures [with] numerous moving parts," Power Star would combine "very new and very old technologies to obtain the simplest possible structure with no moving parts." All that would move are the "electrons and photons," he said with a smile. No in-orbit construction would be needed, and Hyland said a "starter system" could be deployed by a single launch vehicle. By his calculations, a 1-kilometer-diameter sphere could be expected to produce 3 to 4 megawatts of power, based on an aggregate array and transmitter efficiency of 2 percent. He expects to increase this to about 4 percent, giving 6 to 10 megawatts.

Because printed cell technology is still at an early stage of development, he foresees that the 1 kilometer balloon might be capable of 30 to 50 megawatts. The next step in the development process, said Hyland, would be to develop and test prototypes of what he calls "the Solar-Microwave fabric."

The Power Star concept was hosted at the IAC trade exhibition by the Heinlein Prize Trust, which awards prizes to encourage and reward progress in commercial space activities. Heinlein trustee and space entrepreneur Arthur M. Dula said, "Power Star space generating systems could be as important to providing clean energy as communications satellites were to providing cost-effective international communications."

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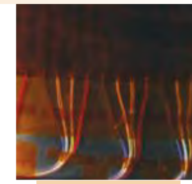
(Continued on page 13)



Demystifying "Plasma Magic"

Mechanical flight control surfaces are one way to affect the airflow around aircraft. Generating and controlling plasma on the surface of a wing could have a role, too, if research led by the Air Force Research Lab in Ohio goes as planned.

Researchers here in the U.S. took notice in 1994 when Russian engineers published an article in Military Parade magazine describing a novel hypersonic flight vehicle concept they called Ayaks, or Ajax (said to be named after the chief designer's dog). The authors described how plasma, a mixture of electrically charged molecules and free electrons, could be produced around the vehicle to weaken the shock waves generated during hypersonic flight.

The technique was based on the results of wind tunnel experiments, but was dubbed "plasma magic" because the science behind the concept was not well established. The current consensus is that the shock weakening is an effect of heating. The Air Force Office of Scientific Research quickly assembled an international team to experiment with creating and controlling plasma through electrodes, magnets and other devices attached to the wings or fuselage of an aircraft.

As a result of this extraordinary international collaboration, researchers in the U.S. and France are on the cusp of giving aircraft designers plasma actuators that can be added to existing aircraft, for example, to reduce their vulnerability to aerodynamic stall. The greatest benefits of plasma technology will come when it is incorporated at the conceptual design stage.

In 1994, western researchers quickly realized that if plasma could damp a shock wave, it could impart all sorts of effects on the air flowing around a vehicle and over its wings. Since the first Weakly Ionized Gases Workshop in 1996, the Air Force Research Laboratory has been working with many companies and universities (Boeing, Lockheed Martin, Rutgers, Princeton, Ohio State, Notre Dame, Ecole Centrale Paris and the U.S. Air Force Academy, to name a few) to conduct experiments in subsonic and supersonic wind tunnels with plasma devices. We need to identify the safest options for generating plasma on wings and fuselages, and the most effective methods to produce plasma effects on the air flow.

After much testing, we are growing confident that plasma actuators can generate vorticity to keep the air flow from separating from a wing and causing loss of lift and stall. We also want to see if plasma actuators can augment or replace conventional flight control surfaces in some cases.

Technology readiness levels stand at best at 5 or 6 — well short of TRL 8 in which a technology is considered mission qualified. But we are making progress in small-scale tests. In fall 2008, we incorporated a plasma actuator panel into the Mission Adaptive Compliant Wing and carried out tests in the AFRL Subsonic Aerodynamic Research Laboratory subsonic wind tunnel. (See the accompanying figure.) These plasma actuators are called AC-DBD, short for alternating current, dielectric barrier discharge. Electric current coursing through the electrodes creates a strong electric field and plasma in the airflow over the panel. In our test, we were able to detect the onset of airfoil stall using hot film sensors, and automatically turn on the actuator panel to increase lift.

The AC-DBD actuators are just one concept for generating plasma on a wing. AFRL has funded experiments with direct current, radio frequency, microwave and spark discharges, as well as electrical arcs and high-voltage coronas.

In terms of the physics, there are two primary ways to control flow via plasma. A body force (as opposed to a surface force, like pressure) can be imparted to a region of the flow over the aircraft through the action of electromagnetic fields on charged particles in the air. Alternatively, current running through the ionized air can generate heat, as can the relaxation and recombination of molecules excited and broken apart in the discharge. The field is still evolving, and a variety of actuator concepts are currently being explored.

As flush-mounted electronic devices with no moving parts, plasma actuators offer the possibility of very fast response times and low profile. Use of these actuators has been explored for reattachment of separated flow, supersonic and transonic shock mitigation, control of shock/shock and shock/boundary-layer interactions, delay of laminar to turbulent transition, and other effects that reduce drag, enhance lift and eliminate undesirable transient phenomena in off-design conditions. In re-entry flight, where plasma is generated through aerodynamic heating, the plasma layer can be manipulated with on-board magnets for electrical power generation, flight control and heat transfer mitigation.

We are pushing the technology readiness levels in a number of ways.

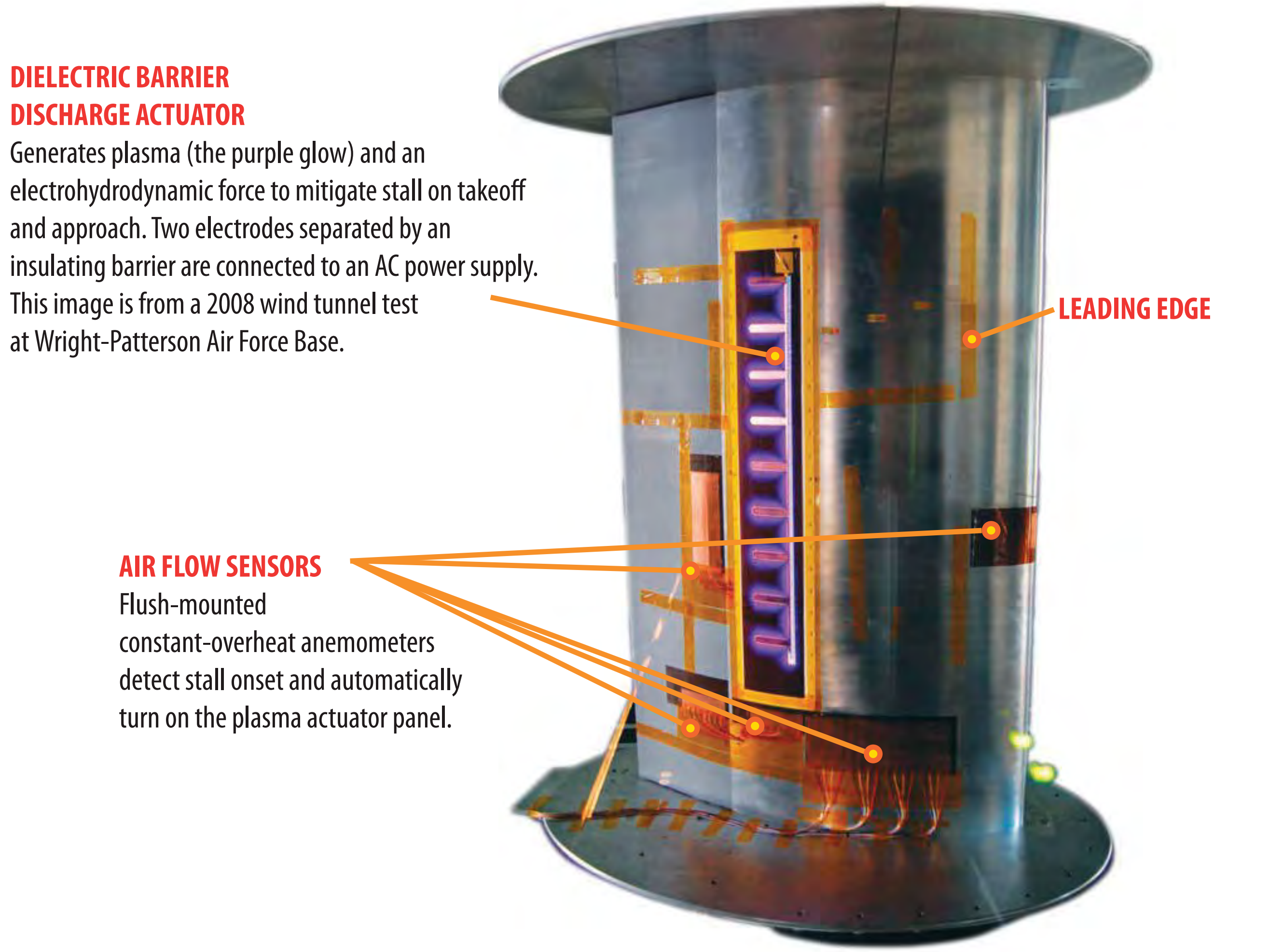
We are studying high-voltage pulsed discharge and new dielectric materials to improve the control authority of plasma devices. We are reducing their electrical power requirements and overall weight by exploiting fluid dynamic instabilities to get a large effect from a small input. Small-scale, localized flow control reduces the system impact of the device and minimizes the trace pollutants, such as ozone, generated in the discharge.

We are capitalizing on conceptual work over the past several decades on other techniques for creating and maintaining desired flow patterns. Flow control techniques should be chosen based on several factors, including the flow configuration, Mach number and Reynolds number. Whether plasma or something else, successful flow control endeavors always require an understanding of both the flow physics and the actuation technique.

A flow control device may be active, like plasma actuators, or passive. Passive control almost always involves geometrical modifications, such as vortex generators on a wing or chevrons on an exhaust nozzle. Passive control device are always in operation, regardless of need or performance penalty. Active flow control, on the other hand, involves the regulated addition of energy or momentum to the flow. Active control can be turned on or off as needed, but it involves greater effort and cost.

Actuators are at the heart of active flow control implementation, and have been the weakest link in the de-

Plasma actuator on wing segment



Source: Air Force Research Lab, Wright-Patterson Air Force Base velopment of flow control technology. Plasma actuators are able to address some of this deficiency; they offer the possibility of low weight, low profile, no moving parts, energy efficiency, durability, ease of use, scalability, high amplitude, wide bandwidth and rapid response.

Nanosecond-pulse, dielectric barrier discharge (ns-DBD) plasma actuators are similar in configuration to AC-DBD actuators, but their input waveform is a short pulse instead of a sinusoidal waveform. Their flow control effect is primarily a result of heating; the body force generated by current ns-DBD designs is only a small fraction of that of an AC-DBD. The rapid heating of the air near the actuator generates compression waves and introduces streamwise vorticity. In flow over an airfoil, these perturbations can trip a laminar boundary layer to turbulence, which can mitigate separation. Further, an ns-DBD actuator can attach separated flows under stall conditions by exciting the instabilities in the separated shear layer. This concept shows promise for improving aircraft performance in takeoff and approach.

To date, most plasma actuator experiments have been carried out in wind tunnels. Exceptions include a test of separation control on an SZD 48-3 Jantar Std. 3 sailplane in 2008 by a group in Novosibirsk, Russia. Ongoing tests of in-flight transition delay are being carried out on a Grob Aircraft G109b motorized glider by a group at the Technical University of Darmstadt, Germany, and on a Cessna O-2A aircraft by Texas A&M University.

Localized arc filament plasma actuators (LAFPAs) also operate through gas heating, and have a flow effect similar to that obtained with ns-DBDs. They use a spark discharge across pin electrodes to generate high-amplitude, short-duration perturbations to the flow. An alternative configuration introduces transverse plasma filaments into the flow, with a repetition frequency tuned to flow instabilities. Researchers at Ohio State University have demonstrated the use of LAFPAs to mitigate jet noise in laboratory experiments.

The spark jet, or pulsed plasma jet, is a hybrid actuator. It employs a spark discharge across electrodes housed in a small cavity. When the actuator fires, the rapid heating generates a synthetic jet out of the cavity, which injects high-momentum fluid into the flow. These actuators can introduce a strong perturbation into the flow, and have been successfully applied to shock-wave/boundary-layer interaction control.

While plasma actuators have been demonstrated to be very effective in laboratory environments, they are subject to reliability and scalability concerns that have inhibited their widespread adoption for flight applications. Some of the chief concerns include electromagnetic interference, weather effects, durability and maintenance. For many actuator designs, performance deteriorates over time through electrode erosion and plasma-initiated chemical degradation of the dielectrics, which must remain relatively pristine to avoid high voltage arcs and failure. Steady progress is being made, but additional emphasis needs to be placed on addressing such concerns.

Future efforts in plasma-based flow control must balance emphasis on specific applications and fundamental physics. In the former, the focus must be on reliability, scaling, efficiency and miniaturization. This will require collaboration among experts in fluid dynamics, plasma physics, power supply engineering and materials science. More fundamental research will serve to provide a more thorough understanding of the actuators and their influence on the flow field, leading to better designs, targeting specific applications. Study of applications and fundamentals must be closely linked for long-term success.

For aerodynamic processes, plasmas can be created on or off the surface. Surface discharges are being studied for the control of boundary-layer separation, control of laminar to turbulent transition, drag reduction and suppression of local heating. Off-body and volumetric plasmas are being studied for drag reduction, reduction of heat transfer rates, vehicle steering, power extraction and reduction of sonic boom.

New methods for magnetohydrodynamic (MHD) control and power extraction are already leading to innovative designs for hypersonic vehicles. Flight control and reduced surface heating can be achieved through the use of a magnetic field interacting with the bow shock, and the concept is currently being implemented for flight tests by Airbus Group. Power extraction during re-entry may also be possible through the use of MHD interactions with internal or external flows. Internal flows benefit from shock interactions for ionization, and for these flows the technology is potentially applicable at lower Mach numbers.

Increased effectiveness of surface plasma actuators is anticipated with new electrode configurations, optimized dielectrics and optimized high voltage driving waveforms. Breakthroughs are expected to occur with multi-electrode configurations for thrust generation and shock-wave focusing. Further breakthroughs may arise from new surface materials that allow changes in the fundamental structure or the temporal evolution of the discharge. Additional surface-based concepts can make use of plasma arrays that are capable of generating shock waves that propagate away from the surface and coalesce to generate vorticity or drive acoustic waves for control of near-surface flows. Plasma-generated far-ultraviolet radiation may also be of use for rapid near-surface energy addition through direct absorption and molecular dissociation of oxygen.

After 20 years of research in the west, plasma-based flow control seems quite feasible, particularly for local flow control applications where power consumption is low.

Further reading: Read the white paper prepared by the AIAA Plasma Aerodynamics Discussion Group: aiaa.org/PlasmaAeroWhitePaper_June2014/.

Jonathan Poggie is a senior aerospace engineer at the Air Force Research Laboratory in Ohio, vice chair of the AIAA Plasmadynamics and Lasers Technical Committee and chair of the AIAA Plasma Aerodyanmics Discussion Group.

(Continued from page 9)

Missile defenders make case for testbed satellite

About three dozen foreign countries admit to having a ballistic missile program, up from a dozen in 1991, and the missiles are becoming faster and more mobile and increasingly have dimmer exhaust plumes, making them harder to see from space.

That's the alarming proliferation scenario painted by U.S. Air Force Col. John Wagner, who commands the wing that operates America's missile-warning satellites, at an Oct. 3 Air Force Association seminar in Washington, D.C.

The U.S. military is worried about more locations around the globe, so the Air Force wants to build an instrument called the Wide Field of View Testbed, or WFOV. The idea is to send WFOV to orbit on a small geosynchronous satellite and test technologies and processing methods that might be incorporated in the satellites that will succeed the Space Based Infrared System satellites, which the Air Force is now launching as the primary U.S. missile-warning satellites.

A key challenge will be to figure out how to handle the vast volumes of data that a wide-field sensor would generate. The military needs to determine "what that data set is going to look like" and then "build the algorithms to detect a missile threat out of that," said Air Force Col. Michael Guetlein, system program director for the service's Remote Sensing Systems Directorate, according to a transcript of the seminar provided by the Air Force Association.

The orbiting test bed is expected to take advantage of technology that has become available since the Air Force began developing SBIRS in 1996. For instance, the Leidos-built Commercially Hosted Infrared Payload, or CHIRP, instrument, which the Air Force operated on the SES-2 commercial communications satellite for 27 months ending in December 2013, showed that a wide-field-of-view staring sensor could help the military understand "short duration infrared events," according to the Air Force.

The WFOV sensor would be launched on an unspecified geosynchronous satellite as early as December 2016, according to the Air Force's fiscal 2015 budget request. The results of the test bed effort could help the Air Force decide what will follow the six SBIRS satellites it is buying to replace the aging Defense Support Program constellation.

However, the House-passed fiscal 2015 defense authorization bill would withhold some of the money requested for the test bed until the Air Force completes a broader study, or analysis of alternatives, on what should come after SBIRS. That study is due to be completed next year.

Work on the SBIRS satellites, meanwhile, is well underway. The first two satellites are in geosynchronous orbit, the third is undergoing ground tests and the fourth is in final assembly. The Air Force awarded a $1.9 billion contract to Lockheed Martin in June to finish building the fifth and sixth satellites. The program has also launched two payloads on host satellites.

Lockheed Martin

The Wide Field of View Testbed is expected to take advantage of technology that has become available since 1996 when the Air Force began developing the Space Based Infrared System (shown here at the Lockheed Martin facilities in Sunnyvale, Calif.).

Marc Selinger
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A bird? A plane?

It's all evolution

The paper, "The evolution of airplanes," created a media stir earlier this year when it was published online by the Journal of Applied Physics. The authors contend that the similarities seen across aircraft designs are a manifestation of the same law that drives the evolution of biological creatures and terrain features like river basins. Lead author Adrian Bejan of Duke University describes the methodology behind the paper and the predictive value of the constructal law, the theory he developed 19 years ago to explain the "oneness" he sees in the evolution of living and non-living systems.

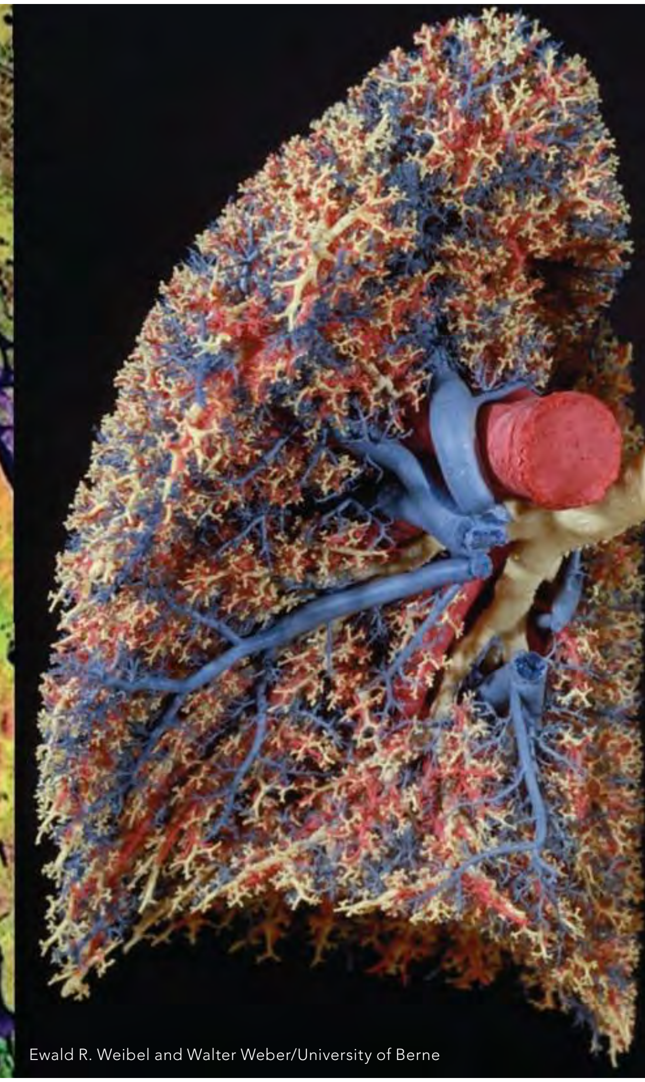
What is evolution and why does it exist in the biological, geophysical and technological realms — in short, everywhere? Why is there a time direction — a time arrow — in the changes we know are happening every moment and everywhere?

I have been theorizing about these questions for two decades as an offshoot of my specialty in thermodynamics. Most recently, I and two colleagues — Boeing engineer Jordan Charles and civil engineer Sylvie Lorente of the Université de Toulouse — collected dimension and performance data on 100 different models of airplanes. When we plotted the data, we observed common relationships just as we predicted would be the case under the constructal law, a law of physics I conceived in 1995 to account for design evolution in biology, geophysics and technology. No matter the model of the plane, engine mass should be proportional to body mass, for example, and the data in "The evolution of airplanes" reflect this.

VIEWPOINT

BY ADRIAN BEJAN

The value of the constructal law is this predictive capability. This was not an empirical data-mining experiment. We expected the data to line up as it did. Aircraft are flow systems: Mass is carried over the Earth within them; air rushes around them and currents course through them in the form of electricity to drive motors that move flight control surfaces. Fuel and air combine to produce combustion gases that turn turbines or drive pistons. A



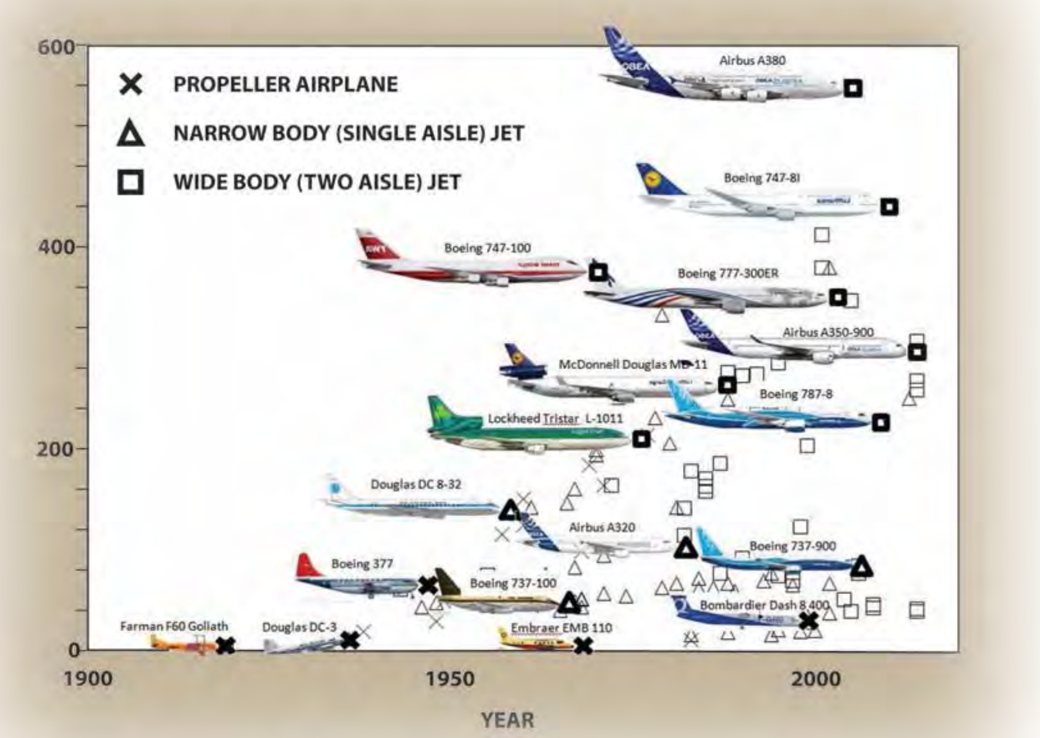
Coincidence or a law of physics? Siberia's Lena River delta, left, shown in a Landsat 7 image, suggests design similarities to a plastic model of a human lung.

river is a flow system, too, consisting of water and sediments that can, over time, produce a delta whose branches deliver water, nutrients and life to the sea. Our lungs are a flow system of chemical energy exchange between air and blood. The visible design similarities among flow systems are not a product of chance. They arise from distinct mechanisms, including genetic mutations, geophysical interactions and technological experimentation by humans. But the solutions exhibit a design oneness toward improving the flow of currents within these systems.

Consider the wording of the constructal law:

For a finite-size flow system to persist in time (to live), its configuration must evolve (freely) in such a way that it provides easier access to the currents that flow through it.

Without power, nothing moves. There is a unifying tendency across all domains to produce and use power more efficiently, to overcome friction and other forms of resistance. My experience as an engineer in the thermodynamics discipline helped me recognize this unifying fact in 1995 during a flight back from Europe. With the constructal law, researchers worldwide are now showing that evolutionary flow architectures are present and predictable throughout nature, whether animate, inanimate or human-made. Constructal Law Conferences have been organized every two years. The 2011 event was held in Brazil; the 2013 conference was in China; and the ninth Constructal Law Conference is scheduled to be held in Parma, Italy, in May. We can see the constructal law in snowflakes, Earth's climate, lungs, body insulation, breathing rhythm, city traffic, the shape of the pyramids and many more.



Airliner evolution
New airliners come in a variety of sizes, but "the biggest airplanes of one decade are joined by even bigger models in the next decade," according to the paper, "The evolution of airplanes."

A better airliner

The pace of technology allows us to witness our own evolution in our lifetimes in the following sense: We are attached to and empowered by our contrivances, including historical artifacts, new machines, and our social organizations and the rule of law. We are what I call the *human & machine species*, and we are evolving with each improvement to aircraft and other machines. In the biological realm, evolution occurs on a timescale immensely longer than our lifetimes. We, the observers, are latecomers to the movie of animal evolution, and we are challenged to imagine the plot. But in the "The evolution of airplanes" we take a bird's-eye view of evolution, and we see that the dimensions and performance of aircraft dating back to the Farman F.60 Goliath of 1919 are as predicted by the constructal law. There is a unity with the animal and geophysical worlds:

- Speeds should be proportional to body mass raised to the fractional exponent 1/6, and this is just like the speeds of all animals (fliers, runners, swimmers).
- Engine mass should be proportional to body mass, just like the proportionality between muscle mass and body mass in all animals, and between motor mass and body mass in road vehicles.
- Fuel load should be proportional to body mass and engine mass, just like the proportionality between food intake and animal body mass.
- Distance traveled (the range) should be proportional to body mass, just as with animals, rivers, atmospheric currents and rolling stones. The bigger travel farther and live or last longer.
- The fuselage length and the wing span should be almost equal, which is also exhibited by flying animals.
- There should be a geometric similarity between the fuselage profile and the wing profile. Both profiles should fit in slender rectangles with the aspect ratio 10:1.

Organ size

Key is the question of why an organ (engine, fuel or wing, for example) should have a characteristic size. The answer, it turns out, is at the heart of why humans are attracted to technology, and why they have the instinct to change it, to improve it, which means to evolve it.

Think of an aircraft or ground vehicle

that consumes fuel and moves across the world map, and ask how large one of the organs of this vehicle should be, for example, the engine, or a duct with fluid flowing through it, or the heat exchanger surface of the environmental control system. Because the size of the organ is finite, the vehicle is penalized in fuel terms by the component in two ways:

First, the organ is alive with currents that flow by overcoming resistances of many kinds. In thermodynamics, this universal phenomenon is called irreversibility, entropy generation or destruction of useful energy (exergy). This fuel penalty is smaller when the organ is larger, because larger means wider ducts and larger heat transfer surfaces. In this limit, larger is better.

Second, the vehicle must burn fuel and destroy more exergy in order to transport the organ. The fuel penalty for carrying the organ is proportional to the weight of the organ. This second penalty suggests that smaller is better, and it comes in conflict with the first penalty. From this conflict emerges the purely theoretical discovery that the organ should have a characteristic size that is finite, not too large, not too small, but just right for that particular vehicle. The organ size recommended by this trade-off is such that large organs (engines, fuel loads) belong on proportionally large vehicles and small organs belong on small vehicles.

The need to move

Air and land vehicle evolution is about the evolving design of human movement from one place to the next. People, goods, materials, construction and mining equipment must all be moved. As the whole vehicle or animal evolves toward becoming better at moving mass on or over the landscape, the organs remain imperfect, because each organ has a finite size. The whole vehicle or animal is a construct of organs that are imperfect only when examined in isolation. The vehicle design evolves over time and becomes a more efficient construct for moving the vehicle mass on the world map.

The history of commercial air travel confirms this trend. Over the last half century, aircraft have become an order of magnitude more efficient measured by the liters of fuel required to carry one person 100 kilometers. There has been a 1.2 percent annual decrease in fuel burn per seat on average. Commercial airplanes satisfy an insatiable need of the human & machine species to move as many people as possible a specified distance while using as little fuel as possible.

The arrow of time

New technologies emerge so that they offer greater access to what flows — greater access to the available space, areas and volumes, and persistence in time. As a special class of evolving designs, humanity today is kept moving sustainably by the power and movement produced in our contrivances: engines and vehicles. The designs morph with us.

Design change keeps spreading across the human landscape in the form of better science, cognition, knowledge, security, technology, health care and much more. Knowledge means flow-design change that is useful and the ability to make the change happen. Knowledge spreads through a territory naturally. The boundary between those who know more and those who know less is shifting in the direction of more knowledge. Knowledge (the ability to make useful design changes) is penetrating the low, because knowledgeable people are more mobile than the low. Technology evolution is about us, about the evolutionary design of all the flows and movements that facilitate human flow, which means life on the Earth's surface (people, goods, etc.). The evolution of airplanes illustrates this convincingly. What works is kept. Flow architectures that offer greater access persist and are joined by even better ones. Together, the vascular tapestry of old and new carries the human flow easier and farther than the old alone. Air mass transport by new and old airplane models mixes the global sphere more effectively than would be the case in the absence of new models.

Flow architectures are evolving right now, throughout nature and in our technologies. The legacy of all animate and inanimate flow systems is this: They have moved mass — they have mixed the Earth's crust — to a greater degree because of design evolution.

Adrian Bejan is a professor of mechanical engineering at Duke University and author of the 2012 book "Design in Nature."

Commercial

NASA's choice of companies to ferry crews to the International Space Station suggests that the agency placed a premium on experience. Teal Group analyst Marco Caceres examines NASA's Commercial Crew decision in light of history and the strained U.S. relations with Russia.

ANALYSIS
BY MARCO CACERES

Looking at NASA's Commercial Crew selections, it makes sense that NASA would choose the two companies with most experience in space operations — Boeing and SpaceX — to start transporting crews to the International Space Station in 2017. Boeing stands to receive $4.2 billion from NASA to continue with development of its CST-100 capsule, while SpaceX would receive $2.6 billion to keep working on a crew version of its Dragon cargo capsule, called the Dragon V2.

NASA would have assumed unacceptable risk if it had not included Boeing, one of the U.S. government's most important legacy space launch providers. Boeing has been a major contractor on every U.S. human spaceflight program since the 1960s, namely the Saturn 5 rocket and the space shuttle program. Boeing was the prime contractor for the space station program for a quarter of a century, and it was one-half of the United Space Alliance joint venture that oversaw management and operations of the shuttle fleet for the last 15 years of that program. NASA would have had a difficult time explaining to Congress how it could have left out Boeing and all of its engineering and operational expertise.

The selection of SpaceX was also logical, given its success launching space station cargo resupply missions in recent years. Under contract with NASA as part of the Commercial Resupply Services program, SpaceX has launched five Falcon 9 rockets with its unmanned Dragon capsule to dock with the station since 2012. An obvious case could be made to support building on the track record of the Falcon 9/Dragon combination. The significant cost advantages offered by SpaceX may have given the company an additional edge. It is already well-established within the launch services industry that SpaceX is able to market its Falcon 9 at prices roughly half that of United Launch Alliance's Atlas 5 rocket.

Another indication of SpaceX's lower costs is the difference in the value of the Commercial Crew contracts. SpaceX's contract value is 38 percent lower than that of Boeing, despite the fact that the work requirements are the same. "The companies proposed the value within which they were able to do the work, and the government accepted that," Kathy Lueders, NASA's Commercial Crew program manager, said at a Sept. 16 news conference announcing the awards. The value of SpaceX's proposal was 21 percent lower than Sierra Nevada Corp.'s bid of $3.3 billion, which NASA rejected.

Quite simply, Sierra Nevada, with its winged Dream Chaser vehicle, was the odd company out. The company could not

Crew Insights

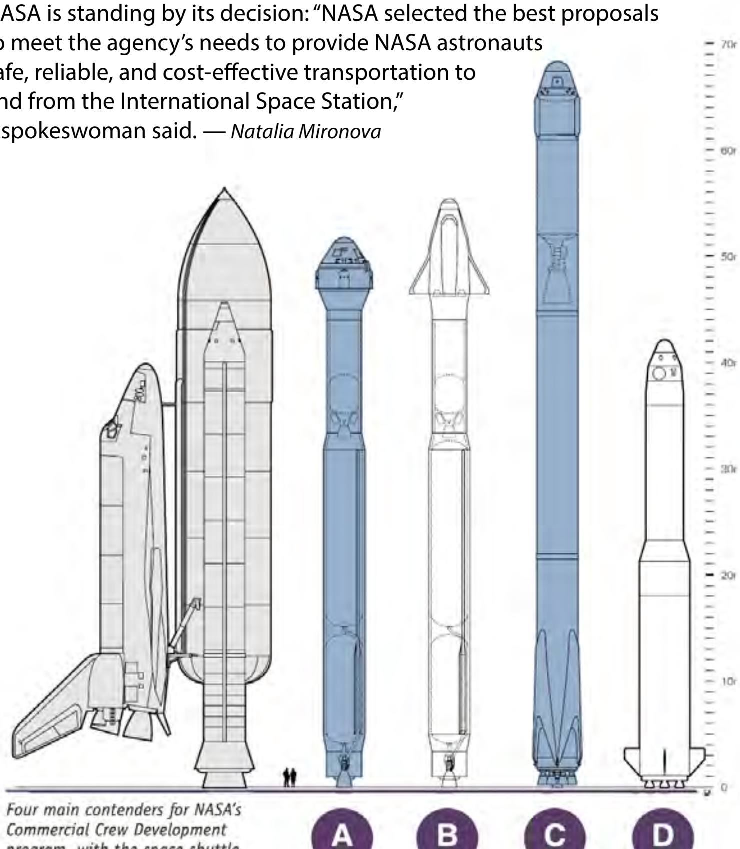
The contenders

True believers in winged space plane designs might not want to give up, despite NASA's choice to rely on capsules to carry astronauts to and from the International Space Station starting in 2017 under the Commercial Crew program. Sierra Nevada Corp. has protested that decision to the Government Accountability Office and is vowing to press ahead with its winged lifting-body Dream Chaser regardless of the outcome.

NASA expects a decision from GAO by Jan. 5, 2015. After Sierra Nevada's Sept. 26 filing, NASA told the winners — **Boeing** and **SpaceX** — to stop work on the Commercial Crew program, but retracted that order Oct. 9. NASA said it used its statutory authority to proceed with the contracts because program delays could jeopardize the International Space Station.

Sierra Nevada wants the GAO to take a fresh look at the bids, saying in a press release: "further evaluation of the proposals submitted will be that America ends up with a more capable vehicle, at a much lower cost, with a robust and sustainable future."

NASA is standing by its decision: "NASA selected the best proposals to meet the agency's needs to provide NASA astronauts safe, reliable, and cost-effective transportation to and from the International Space Station," a spokeswoman said. — *Natalia Mironova*



Four main contenders for NASA's Commercial Crew Development program, with the space shuttle shown for scale.

Illustration by John Bretschneider

A Boeing: Crew Space Transportation-100 (CST-100)

- Contract value $4.2 billion
- Weldless structure
- Reusable up to 10 times
- Up to seven crew or combination of cargo and crew
- Integrated with Atlas 5

"Boeing has been part of every American human space flight program, and we're honored that NASA has chosen us to continue that legacy," **—John Elbon, Boeing vice president and general manager for space exploration.**

B Sierra Nevada Corp.: Dream Chaser

- Winged lifting-body
- Roughly ¼ of the length of the space shuttle
- Reusable at least 25 times
- Up to seven crew
- Launches on Atlas 5 (SNC plans to partner with Stratolaunch Systems to develop a launcher for the Dream Chaser.)
- Horizontal landing on a conventional runway

C SpaceX: Dragon V2

- Contract value $2.6 billion
- Total launch payload mass 13,228 pounds
- Spacecraft payload volume 388 cubic feet
- Reusable
- Seats seven
- Three configurations: cargo, crew or DragonLab — an orbital research facility
- Integrated with the SpaceX Falcon 9 v1.1 rocket
- In 2012, Dragon became the first commercial spacecraft to deliver cargo to the space station and return to Earth

"SpaceX is deeply honored by the trust NASA has placed in us, and we welcome today's decision and the mission it advances with gratitude and seriousness of purpose." **— company statement.**

D Blue Origin space vehicle

- Biconic shape
- Reusable
- Launched with reusable first-stage booster

The company declined to provide any more information about its participation in NASA's Commercial Crew program and said it was not conducting media interviews.

Dragon V2

SpaceX

compete on experience with either Boeing or SpaceX, and it could not best SpaceX on cost. The main thing it had going for it was the unique design of its vehicle. Dream Chaser would be a reusable space plane, which although much smaller and less capable than the space shuttle orbiters, could arguably have stood the best chance of reigniting the public's fascination with human spaceflight. For all of their advantages, both the CST-100 and Dragon V2 are capsules, which gives the impression that U.S. human spaceflight has not advanced much since the Apollo era, and might even be regressing. A winged mini-shuttle with the ability to re-enter the atmosphere and glide back to earth for a horizontal landing on a runway, Dream Chaser would seem to have been the more obvious follow-on to the shuttle.

These days, however, NASA is much more concerned about time and costs than it is about cutting-edge technology. During 1996-2001, the agency, along with Lockheed Martin Skunk Works, invested about $1.5 billion in the X-33 VentureStar technology demonstrator program to try to come up with an advanced reusable space plane to replace the space shuttle. Some industry estimates placed the cost of developing an operational VentureStar vehicle as high as $35 billion. Both the technology and cost challenges were too much for the U.S. government, and the program was canceled. NASA subsequently came up with the more modest Orbital Space Plane program, which lasted only a couple of years until it was replaced in 2004 by the Constellation program. Constellation sought to develop the Ares 1 and 5 rockets and Orion capsule, until that program was canceled by the Obama administration in 2010.

The Orbiting Space Plane was NASA's last attempt to develop a reusable space plane, and since then the agency has adopted a much more conservative and pragmatic approach to developing an American human spaceflight capability, particularly since the final mission of the space shuttle in 2011 has left NASA dependent on Russia to transport U.S. astronauts to and from the station aboard Soyuz rockets and capsules. NASA is paying about $71 million for each round trip on a Soyuz capsule. The contract extension signed by NASA with the Russians last year is worth $424 million and runs through June 2017, for a total of six round-trip flights.

The need to eliminate U.S. dependency on Russia for its human spaceflight requirements has taken on greater urgency during the past year, as political tensions between the U.S. and Russian governments have increased over the conflicts in Syria and Ukraine. The U.S.-Russian relationship, which has remained stable for more than a decade and produced a cooperative and mutually beneficial partnership in space, notably on the station, has now become unstable and unpredictable.

Economic sanctions imposed against Russia by the Obama administration over its annexation of Crimea earlier this year have led to reduced contacts between

Sierra Nevada

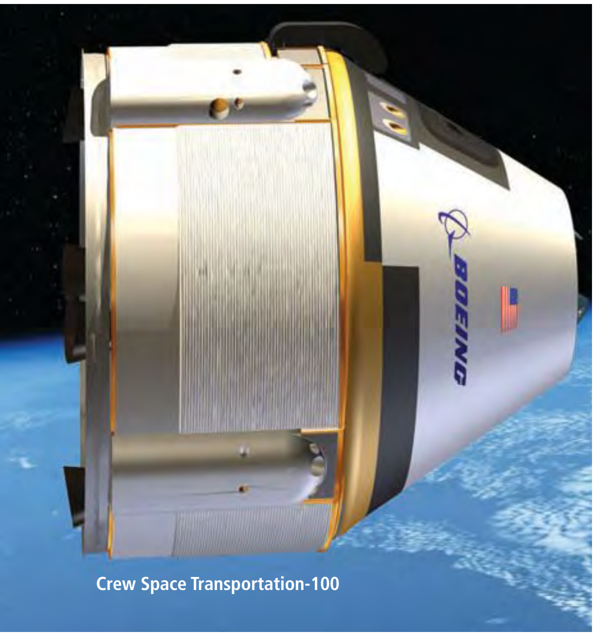
Dream Chaser

NASA and its Russian counterpart, Rosaviakosmos. There are concerns that the government of President Vladimir Putin may block sales of critical hardware such as Russia's RD-180 liquid-fuel engine for the Atlas 5 and might even go as far as refusing to sell NASA rides to the station. Not having access to the station, while watching Russian cosmonauts travel back and forth to the $100 billion largely U.S. taxpayer-funded facility, would pose a political nightmare for the U.S. government.

It was always unlikely NASA would again invest in a reusable space plane. The existing reliance on Russia made it even more improbable. The window for having U.S. human spaceflight capability ready is too narrow now, and reusable technology is too unpredictable from both a time and cost standpoint, as well as level of difficulty.

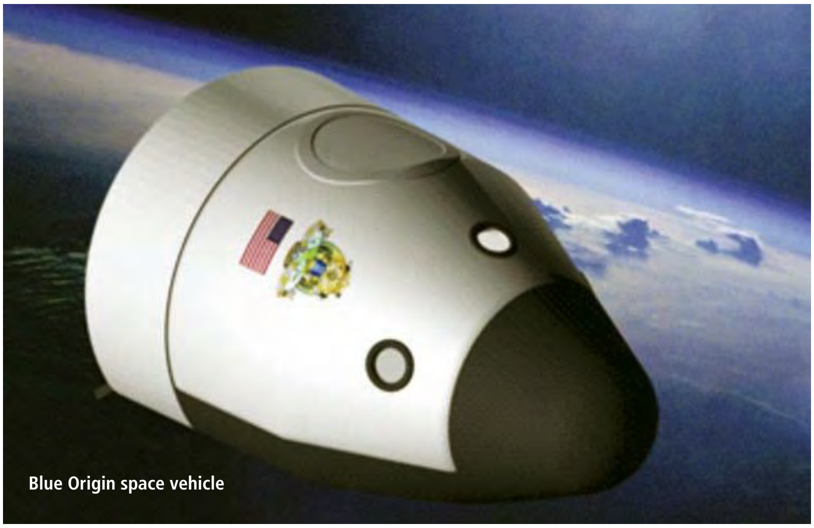
The fact that Dream Chaser, like the CST-100, was also designed to be launched by Atlas 5 rockets did not help Sierra Nevada's competitive position. If NASA was intent on picking two Commercial Crew providers, it was certainly going to go with companies that had different launch vehicles. Given that SpaceX's Dragon V2 is designed to be launched on the company's Falcon 9v1.1 rockets, the second provider had to be Boeing or Sierra Nevada. In a two-way competition against a vastly more experienced Boeing, Sierra Nevada was bound to come up short.

While NASA did state in its request for



Crew Space Transportation-100

Boeing


Blue Origin space vehicle

Blue Origin

proposals that price would be the main criteria for evaluating bids (thereby making Sierra Nevada's selection protest to the U.S. Government Accountability Office reasonable), it was almost inconceivable that the agency would select two vehicles that depend on the Atlas 5. Note again that one of the primary reasons for NASA to move forward with Commercial Crew is to eliminate U.S. dependency on Russia in spaceflight. Ironically, by awarding one of the contracts to Boeing, whose vehicle uses the Atlas 5, which is powered by the RD-180 engine, a new partial dependency on the Russians is in the process of being created. Had NASA chosen the Boeing and Sierra Nevada proposals, this new dependency would be total, assuming no available replacements for the Atlas 5 or the RD-180.

Despite its perfect record of 49 successful launches since 2002, the Atlas 5 is the Achilles' heel of the Commercial Crew program, just as it is for the U.S. Air Force's Evolved Expendable Launch Vehicle rocket program. It is unclear how NASA will address this glaring problem, other than to hope that SpaceX's Falcon 9v1.1/Dragon V2 will be so superior — both in terms of performance and cost — that it will be the workhorse vehicle, while the Boeing Atlas 5/CST-100 combination will either become the backup or eventually cease to be used altogether. An alternative would be to launch the CST-100 on the Delta 4, but that would nearly triple the launch costs for NASA. Then again, NASA would have two separate and fully independent systems produced in the U.S.

Preventing airliner mysteries


AIAA

Don Thoma, president and CEO of Aireon

Before MH370 went missing in March, Aireon's plan to track airliners with antennas on next-generation Iridium satellites was viewed mostly as a potential cost-saver for the airlines. Planes could fly closer to each other on straighter routes over oceans and mountains if authorities knew where they were at all times. The disappearance of the Malaysia Airlines jet has given airliner surveillance a new relevance. Ben Iannotta spoke with Aireon President and CEO Don Thoma about a key orbital test planned for 2015 and the company's September announcement that in 2018 it will be ready to aid authorities in emergencies at no charge.

Tell me how your free ALERT [Aircraft Locating and Emergency Response Tracking system] will work?

Knowing the events of MH370, we started thinking: "In the event that an emergency occurred, what would we do with [our airliner surveillance] data?" The answer would be very clear for our customers like Nav Canada, or NATS in the U.K. or the Irish Aviation Authority. But what about the organizations that have not contracted with us? We said, "You know, we really need to be prepared for this." Over the last several months, we've done some internal reviews and evaluations here to make sure that we could technically provide air traffic control organizations or search and rescue organizations, or airlines, with the last known position or the current position of an aircraft and the last flight track. And we determined that we could do that.

Run through for me how this would work in an emergency.

Let's say it's the end of 2017. We've got this capability in place and an aircraft operator or an air traffic control organization, who isn't a customer of Aireon, loses communications with an airplane. They would have preregistered with us so that we would know how to authenticate them and make sure they were an authorized entity. They could go to a secure online application and put in the code to the aircraft and get the current position or last known position and flight track of that aircraft from us. If they didn't have the data interface capability, then they could call a 24/7 operations center.

So, not necessarily a customer ...

It could be something like the Malaysia Air Traffic Control Authority that might not be a customer of our service but we want to make sure that in the event of an emergency they can get access to the data.

How is the funding situation for Aireon?

This February, we announced new investors in place with the Irish Aviation Authority; ENAV, the Italian air traffic control company; and Naviair, which is the Danish air traffic control company. With those commitments, that provides all the funding that Aireon needs to deploy the satellite-based component, the ground-based systems for processing and distributing the data to the air traffic control organizations, and to fund operations in 2018 when we go commercial with the service. It was a very important milestone back in February. It was all staged investment, so Aireon had to hit a number of milestones for the various amounts of money to come in. Nav Canada has committed and put in their $120 million out of the 150 that they've signed up to, and the other three investors have put up $75 million of the 120 million that they've committed to.

What are the remaining milestones?

The remaining milestones are really around launch — launch of the first satellites about a year from now in mid-2015, and then the last launch that occurs in 2017. We'll launch two satellites [in 2015], test out the satellite design, and then once that's done, roughly five, six months later we'll begin launching 10 at a time on a Falcon 9 SpaceX rocket out of California. And then they'll take seven SpaceX launches to complete the first wave, if you will — a full network. So that will be 66 operational satellites plus six on-orbit spares.

How do those investors feel about your ALERT announcement?

All of our investors are extremely supportive of what we're doing. The business proposition of Aireon is not to make money on missing aircraft. It's really to provide real-time surveillance for improved air traffic control capabilities. We thought the right thing to do was to work with the aviation community to make sure we understood all the intricacies and complexities and work with them to deploy this application once the system is up and operational.

Interview by Ben Iannotta

So that I understand the overall business plan, when you're fully up and running, will the air navigation service providers become subscribers?

They would subscribe. Basically Nav Canada and NATS will buy the service from us, they'll provide a better, closer separation and more efficient routing for the airlines as they cross the North Atlantic to save $125 million a year in fuel. They'll charge a small fee to the airline for this improved service to cover the cost of what they pay us for the service. So [the airlines] get the majority of the benefit from the fuel savings and they're happy to pay that to save 2 percent fuel savings in the journey across the oceanic part of the North Atlantic.

ICAO [the International Civil Aviation Organization] had a task force looking at airliner tracking. I'm guessing you were involved.

We certainly participated with them. We feel that [ALERT] was kind of independent of that. The opportunity we saw was: We're going to have the data so let's engage the industry, or stakeholder community, early, and our point is that this is, the right thing to do is to make this a public service for emergency tracking.

If the task force says ACARS and Inmarsat are best for emergency tracking, wouldn't this sort of threaten your business model?

Well, no. For one, we're not going to charge for this emergency tracking service. So [ALERT] will have no impact on our core business. The key difference here is [that Aireon's tracking service] will cost the airlines nothing to get this capability. To outfit with satcom, with ACARS, ADS-C type services will cost the airlines a significant amount of money and there's certain [companies] that will never equip with satcom that would enable that capability. So, we see [Aireon] as a complete, comprehensive solution. It covers a significant majority of the global fleet, not just the wide-body aircraft, and it doesn't cost the airlines or the [air navigation service providers] anything to get the capability in the event of an emergency.

I want to talk about history a little bit. How did you guys think of this idea — listening to ADS-B signals in space?

I've been with Iridium since 2001, and in planning for our next-generation system, part of that effort was to look at how could you use this network for applications other than two-way voice and data communications. We quite by happenstance ran into an organization that was doing some study work on space-based ADS-B, experimental-wise, and they asked [Iridium] to participate with them in that study. We did, and the more we looked at it, we said there's a business opportunity here. We made a pretty bold decision back in 2010 when we didn't have any contracts or any specific customers for hosted payloads to design the space, weight, power, into the design of the satellites to host these additional payloads.

Can you tell me more about that meeting? What was happenstance about it?

There was a meeting at the Canadian Embassy on ship-tracking, and one of our colleagues here ran into a person from the German space agency who was doing this study. They got talking and our colleague here at [what is now] Aireon made the suggestion: Why wouldn't we look at putting this kind of receiver onboard all of the Iridium Next satellites because you would have contiguous coverage and real-time capability. There has to be very shortly latency — seconds — between the time the aircraft emits its signal and when it has to show up on an air traffic controller's screen to be safe. And that's exactly what Iridium can provide. Ultimately it turned into the largest hosted payload program ever in that case.

Does Aireon have its own offices?

Currently we're co-located with Iridium in Tysons Corner, Virginia, right outside the Beltway — on the Beltway, actually. We're growing, we're hiring. We'll go live in 2018, so we'll expect to have our own facilities by then. We'll be adding some additional people here in the not-too-distant future who will be some key people to help us deploy the system.

How do you know this technology is going to work?

Part of the investment milestones I talked to you about had to do with making sure the right work was done to mitigate that risk. At this stage, everything we've seen from the qualification testing of the satellites and the analysis that Exelis and others have done for us shows that not only will it meet the requirement to support this more efficient [aircraft] routing, but we think it'll exceed that and provide a very robust surveillance capability for air traffic control.

So what other satellites did you use to make sure that these signals could be received in orbit?

There was a satellite that was launched in 2013 by the University of Aalborg [in Denmark] that Com Dev up in Canada supported. We worked with them and they provided us with some data from that satellite to help us understand better what could be seen from that system. So that was a small part of it. The bigger part of it obviously is the analytical work and testing that we did with Harris and Exelis at the full system level.

How do you handle cybersecurity?

We built it into our design. We followed industry standards that the FAA and other ANSPs use, into the system. Obviously Iridium has been doing this for years and has sophisticated and good practices in place for protecting its network and command and control links, et cetera.

Preparing to install Orion's heat shield at Kennedy Space Center in anticipation of its Dec. 4 liftoff.

TIME TO FLY

If NASA is going to deliver astronauts to Mars or an asteroid, Lockheed Martin is designing the crew capsules that will take them there. The Orion project has been unfolding for years in board rooms and cleanrooms, but things will get real on Dec. 4 when an unmanned test version blasts off from Florida. Natalia Mironova describes the road to Exploration Flight Test-1 and the technical challenges to come.

If all goes as planned, an unmanned Orion multipurpose crew vehicle will splash down in the Pacific Ocean southwest of San Diego on Dec. 4, having ventured 3,600 miles into space, farther than any crew vehicle has gone since the Apollo 17 mission in 1972. This early version of an Orion capsule will be coming back hot because of a trajectory designed to partially mimic a deep-space mission. The craft will plow into the atmosphere at 6.8 miles per second — that's 80 to 85 percent of the velocity of a trip back from the neighborhood of the moon, where NASA plans to park an asteroid someday. The velocity will beat the 4.7 miles per second re-entry speed of the shuttle orbiters. The result will be melting-pot temperatures of 4,000 degrees Fahrenheit around some parts of Orion.

To survive this, Orion will enter base first like an Apollo capsule and it will be protected in part by an updated version of the same protective foamlike Avcoat material that shielded the Apollo capsules.

If following the Apollo template — but with a capsule 30 percent larger — was supposed to make it easy for NASA and Lockheed to get to Exploration Flight Test-1, that has not been the case. Textron, the Avcoat provider, had to repair cracks discovered in Orion's heat shield in 2013 after a curing process. Lockheed Martin and NASA engineers also had to change the shape of the capsule's launch abort aeroshell to reduce the aerodynamic noise astronauts would hear during an abort. Then there is the issue of spacecraft mass: The EFT-1 version of Orion is within its mass limit, but the Government Accountability Office cautioned earlier this year that mass could become a problem as NASA closes in on the first crewed launch in 2021.

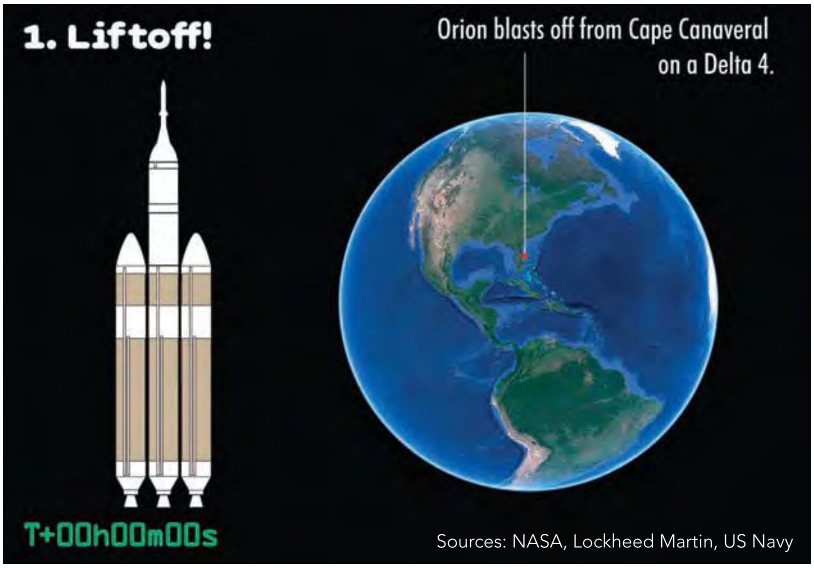
For Lockheed and NASA, the stakes on Dec. 4 could not be higher. A smooth mission would be a confidence builder that could shore up faith in the U.S.' decision to shelve its desire for a single-stage-to-orbit space plane in favor of a simpler capsule and rocket approach.

A maxim among engineers is that tests like EFT-1 are designed to find problems. No matter how things go, Orion advocates are confident they'll learn whatever technical lessons will be required to ultimately succeed. "If we do EFT-1 and the heat shield cracks on us and we end up having a problem because the heat shield failed, that's actually a good test because then we know the limits. We'll have enough instrumentation on there to be able to understand what happened," says Dan Dumbacher, a former NASA deputy associate administrator for exploration systems development and now a professor at Purdue University.

This artist concept shows Orion and its upper stage as they will appear in the Exploration Flight Test-1 mission.

NASA

By Natalia Mironova



Launch illustrations by Anatoly Zak

Survival plan

The attraction of Apollo was the shape's proven ability to handle high-speed re-entries. "We did look hard at other ideas, but it turns out the physics are the same and the shape still makes sense for this kind of mission," says NASA's Mark Geyer, the Orion program manager. Once the engineers determined that they would be using the basic capsule shape of Apollo, they could draw on actual flight data from the Apollo landings. Engineers "have the benefit of all of that previous history — 12 or so full-scale re-entries," says Larry Price, Lockheed's deputy program manager for Orion.

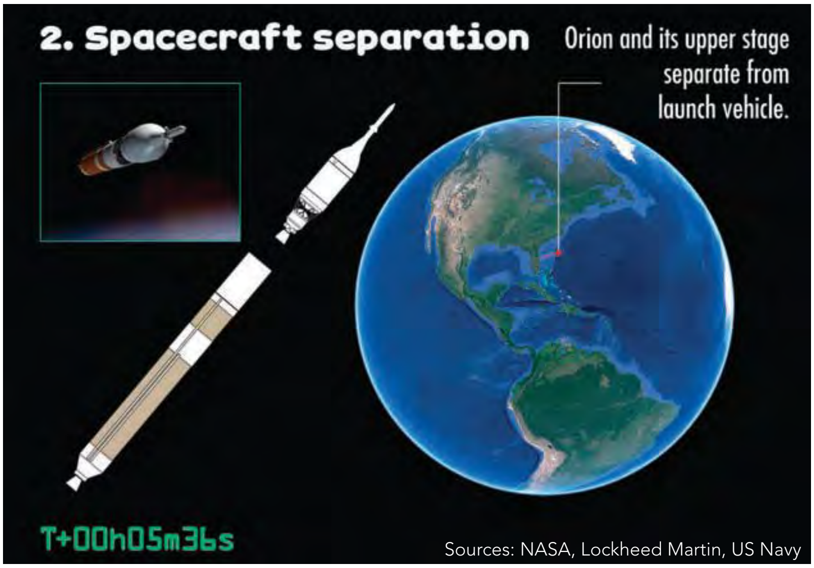
At the top of EFT-1's list of test objectives will be to evaluate its thermal protection system, which borrows from Apollo and also the space shuttle program. When Orion plows into the atmosphere, it will be protected by a dish-shaped, multilayered heat shield covered by Avcoat, an updated recipe of the ablative, or meltable, material that protected the Apollo capsules. Unlike Apollo, Orion will have shuttle-derived protective tiles instead of Avcoat on its conical back shell, which is possible because the back shell won't be subject to as much heat.

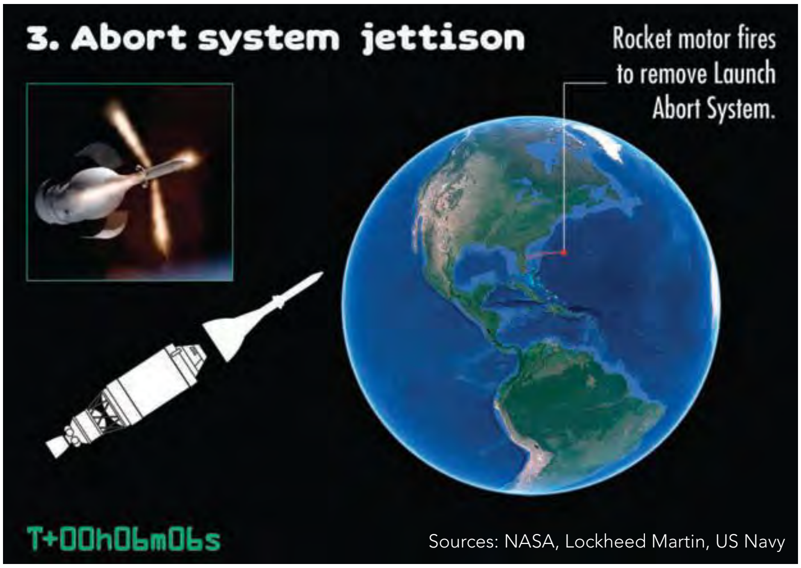
As with everything on Orion, mass was a big driver in the decision to use a combination of these technologies. The heat shield's foamlike Avcoat filler is fairly light, but the honeycomb framework and the titanium structure required to support it will bring the heat shield's weight to 4,000 pounds — that's on average 39 pounds per cubic foot compared with the tiles on the exterior of the shuttle orbiter that weigh 13 pounds per cubic foot.

Using both technologies — Avcoat and the tiles — made for a lighter overall thermal protection system. "If you are lighter you can go further for the same amount of propellant," explains Price.

Relying on a familiar heat-shield material had its advantages, but it also has brought its share of challenges. Avcoat is a mixture of epoxy and phenolic resins with several types of glass fibers and phenolic microballoons inside a glass-reinforced honeycomb structure. On Orion, this is bonded to a titanium framework covered in carbon fiber sheets up to 2 inches thick. GAO in its 2014 "Assessments of Large-Scale Projects," cautioned that thermal expansion during a flight could cause cracks to develop between the "ablative material and the underlying shield structure."

Textron says it used "Apollo proven techniques" to fix thermal expansion cracks that developed during curing, and that no cracking was found after stress tests on the Avcoat and its carrier structure.





withstand extreme pressure loads.

Even with all the efforts to shave mass, the GAO cautions that Orion is 2,800 pounds over the current maximum takeoff limit of 73,500 pounds for the next Orion launch, an unmanned flight called Exploration Mission-1 planned for 2017. "The mass of the spacecraft remains a top program risk," GAO says in its annual assessment. EM-1 will be the first flight of Orion on the new Space Launch System rockets, and GAO says NASA plans to solve the mass problem by relying on the performance of SLS and adjusting the load, mission duration and size of the crew on future crewed flights.

Lockheed says it is fully aware of the mass issue. "For Exploration Mission-1, we have a design that closes on mass, however we have identified some threats to that plan. Those threats are typical for a spacecraft development program and we do not anticipate any issue meeting the mass requirement," says Carol Martin, Lockheed Martin's Orion Exploration Mission director, by email.

A separate concern is that micro-cracks could develop within the Avcoat because of the long-term exposure to deep space. These micro-cracks ultimately were not a problem for Apollo or later missions, but Orion will be in the cold of space longer and will re-enter hotter.

Lockheed doesn't expect micro-cracking to be a problem during EFT-1 because, at just over four hours, the flight won't be long enough to subject Orion to extreme cold, and the company says it is looking at "potential modifications" to prevent micro-cracking on longer missions. But it's impossible to perfectly recreate deep space in a lab, so engineers will still be interested in inspecting the shield for signs of cracks after the December test flight. "We want to gather data in flight and see how Avcoat performs at 4,000-nautical-mile entry as well as future flights and determine if the cracking is a problem or not," says Price, who describes Avcoat as a brittle material.

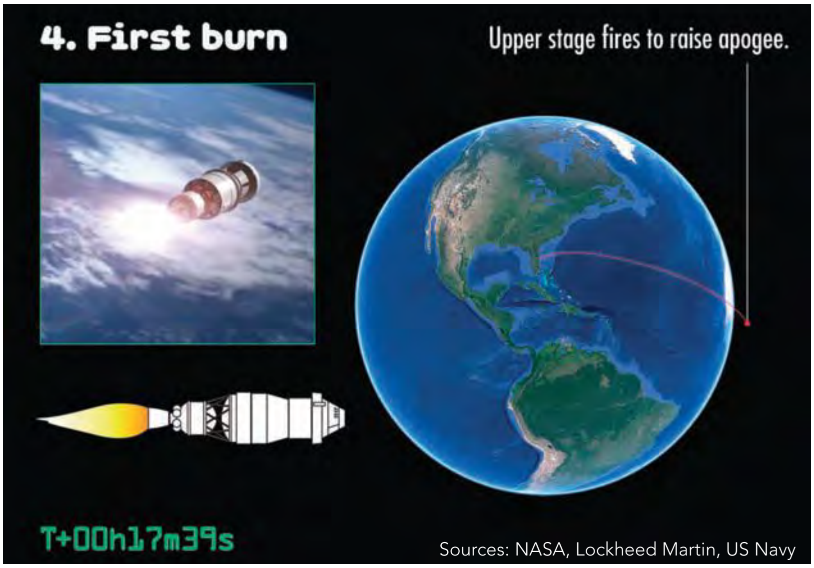
"There is a strong belief that as the material melts and ablates away, it would fill any of those micro cracks," he says. In the end, the team had to compromise to pick the best thermal protection material that was structurally solid and worked within the weight limitations. "Nothing is perfect."

Weight watching

Mass limits are hot on the team's mind too. Orion's pressure hull, for example, is made from aluminum lithium alloy — the same material used to build the shuttle's external tanks — because it is lightweight yet able to

Whisking astronauts to safety

Re-entry is risky, but so is launch. A detach-



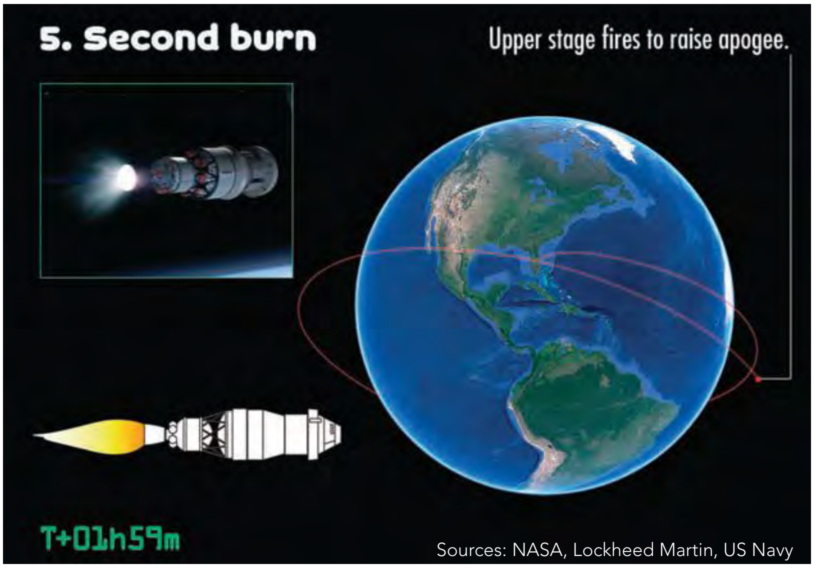
The launch abort system is lowered by crane for installation on the Orion spacecraft for Exploration Flight Test-1 inside the Launch Abort System Facility, at NASA's Kennedy Space Center.

NASA

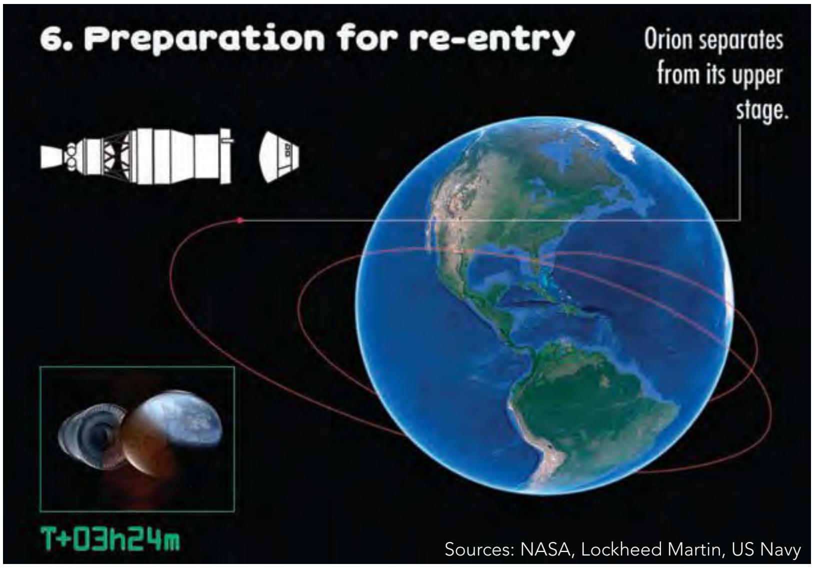
able system of solid rocket motors and an aeroshell will ride atop Orion during ascent and will pull the capsule away from an exploding or out of control Space Launch System vehicle. The GAO warns that a funding shortfall has pushed the next test of the abort system to 2018, which might not leave enough time to fix any problems before the first crewed flight planned for 2021. The launch abort system won't be fully operational in the December test.

The first abort test in May 2010 became something of an Internet video sensation. The Orion mockup is seen soaring a mile into the air. If humans had been aboard, they would have experienced a jolt of 15 Gs that would push them deep into their seats and make it difficult to move and even breathe for the 4.5 seconds of the abort motor burn. A variable-thrust attitude control motor keeps the stack correctly oriented until a jettison motor pulls the launch abort system off the crew module so the capsule can deploy its three parachutes. The 2010 test "was almost perfect. It's a very big deal," says NASA's Geyer. "All three of those motors had to work perfectly, the parachutes had to work, and it worked like a charm."

Engineers learned a valuable lesson from a static test with the abort motor. The noise inside the capsule would have been excessive for the astro-



Sources: NASA, Lockheed Martin, US Navy



Sources: NASA, Lockheed Martin, US Navy

nauts, so NASA and Lockheed decided to bend the walls of the aeroshell into a curved ogive shape. The 2018 flight would be the first abort test of the new shape. If something goes wrong during the launch in December, there will be no saving Orion, since it will fly with an inert abort and attitude control motor. Only the jettison motor will be operational because it must remove the aeroshell and stack from Orion once it is through the atmosphere.

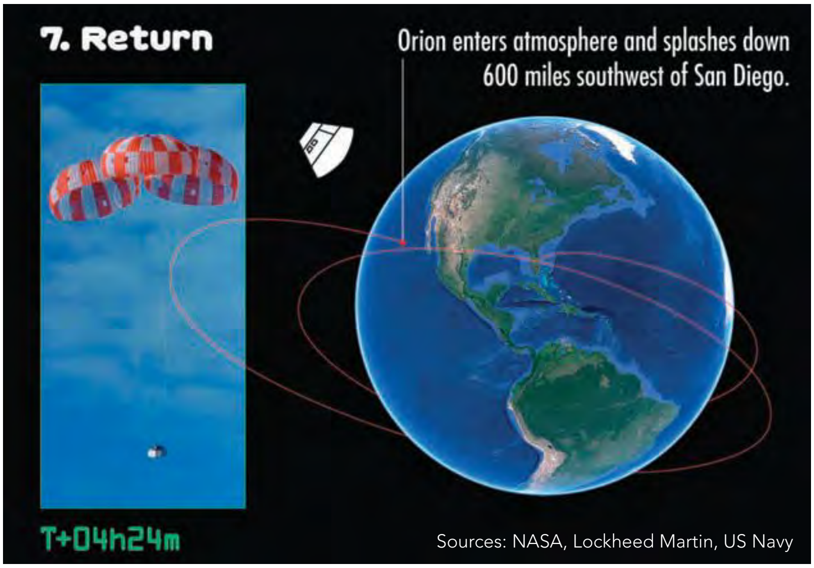
On the inside

The similarities to Apollo are obvious but mostly skin deep for Orion. "On the outside it may look like an Apollo spacecraft, but on the inside it's nothing at all like Apollo," NASA Administrator Charles Bolden told Aerospace America earlier this year.

Orion's interior will draw from the best of the computing revolution sparked in part by the technology investments of the Apollo program. "If you look at a picture of the Apollo control panel — it's fascinating — you see a lot of buttons and switches. So that's how they controlled things, through switches. Ours is now automated; it looks like a touch screen that you see with the fancier computers today and the crew can go through their critical procedures, do all their commands with those screens," says Geyer. Though they look like touch-screen panels, the crew members on future flights will use a mouse-like device in their seats or buttons along the side of the three panels to access the computer. This will avoid accidental pressing of touch-screen buttons by random objects floating around.

The crew interface system won't be used much on a mission that goes smoothly. Even the launch abort system was initially intended to be autonomous or triggered by mission control. Astronauts asked for and have received the ability to trigger it, one contractor says.

These crew interface panels won't be flying during EFT-1. Mass simulators will be used instead. The vehicle management computer — the avionics system supplied by Honeywell Aerospace — will be fully operational though. The VMC is a single electronics unit composed of four computer modules that execute flight control and connect to the communication and tracking equipment. The system is similar to the one currently flying on the Boeing 787 Dreamliner aircraft, beefed up to withstand the radiation, vibration and high temperature requirements of deep-space travel, according to Lockheed Martin's Orion avionics director, Paul Anderson. Some of the test flight objectives include learning how this new computer system will perform under the stresses of Van Allen belt radiation and high-speed re-entry.



One aspect that will always be challenging for the crew on a long mission is the volume of Orion. On a lunar-class mission, an Orion crew of four might have to spend up to 21 days in a space measuring 305 cubic feet — about twice the passenger volume of a Ford Explorer and eight times smaller than the 2,625-cubic-foot crew compartment of a seven-crew-member space shuttle orbiter. That's not as small as it sounds, suggests Geyer: "The great thing about zero G [is that] once you get into space you can use the ceiling. Normally on the ground there is all this unused space, but you're floating around and so it's actually much bigger volume when you are in zero G because people can be on the ceiling, on the floor, on the sides. You get to use the space much more efficiently."

The truth is that squeezing astronauts into an Orion is a problem that many at NASA are anxious to have. As much as anything EFT-1 will be a tangible step in that direction.

"If we're actually going to do this, if we're actually going to push out beyond the moon and try to go to Mars, it will take daring. It will not be something for the timid," says NASA's Todd May, program manager for the Space Launch System.

Ben Iannotta contributed to this report.

Your best cyber defense?

Infosharing

The commercial aviation industry is wiring up aircraft with modern networking equipment that will reduce time on the tarmac, shorten flight routes, hone crew communications and make passengers more comfortable. Plane makers and airlines are well aware that cyber criminals and terrorists are watching this trend, and the they have begun a proactive campaign to improve cybersecurity. Debra Werner looks at how the industry plans to stay ahead of the threat.

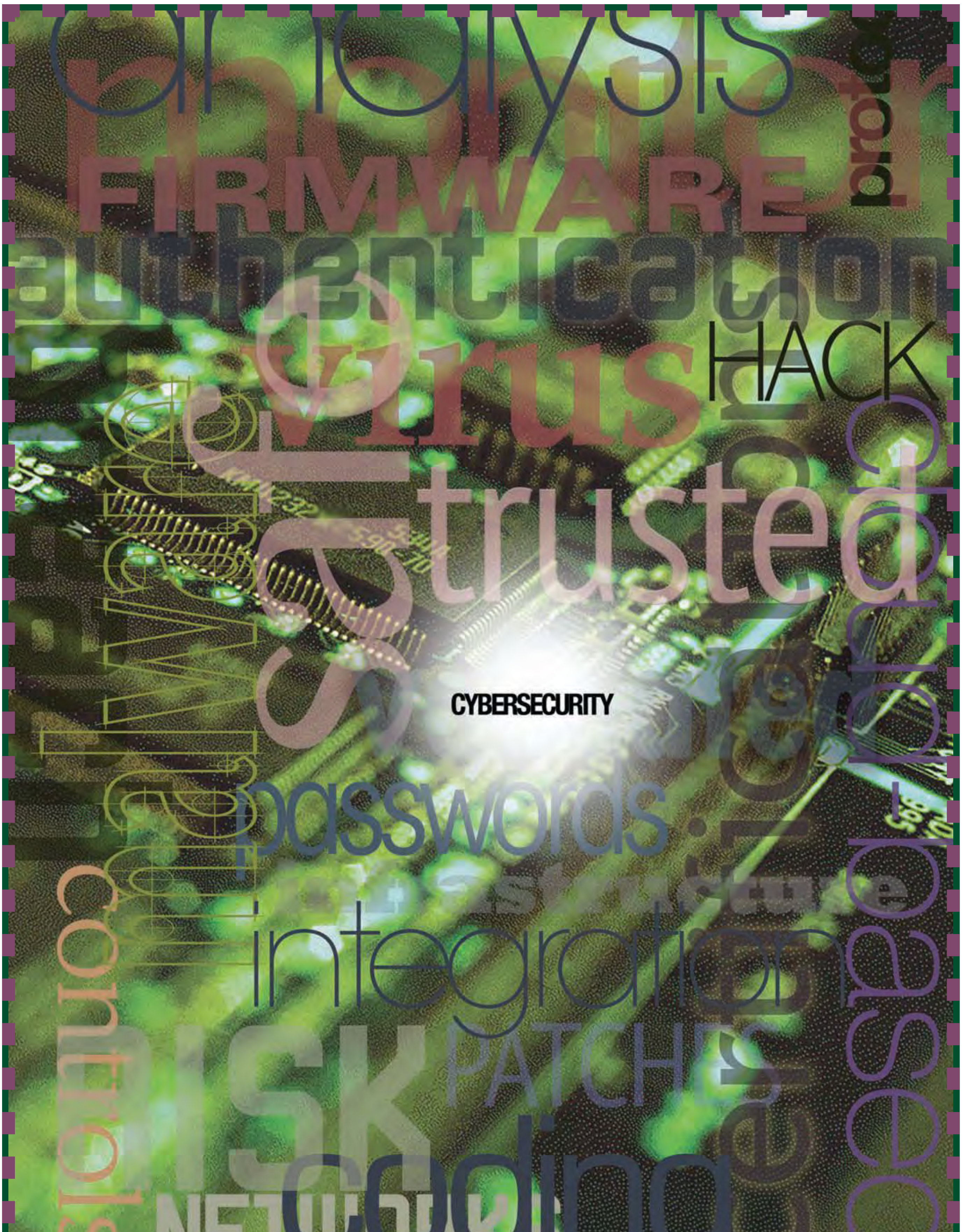
By Debra Werner

Earlier this year, cybersecurity researchers led by Ruben Santamarta of IOActive in Seattle recreated the permanent software known as firmware within various satellite communication terminals, including some used aboard commercial aircraft. The researchers then got to work looking for flaws that might compromise security. The results, which Santamarta reported at the August Black Hat conference in Las Vegas, were troubling. The satcom terminals had various degrees of protection but in some cases default passwords were hard coded in the firmware, a strategy designed to make it easier for administrators to access all devices on a network — but also leaving the devices vulnerable to anyone who discovers the password. In other cases, backdoors were intentionally programmed in to let administrators bypass authentication.

"I was expecting to find some issues but definitely not the kind of security vulnerabilities uncovered during the research," Santamarta says by email. "Satellite communication terminals pose an interesting attack vector since the ability to control the data that goes through these devices means that malicious actors can spoof messages, disrupt communications or create malicious network traffic."

It's not certain that this kind of lab experiment reflects a vulnerability in the real world. Aircraft manufacturers take pains to avoid providing entry points for unauthorized users by keeping the computers that support navigation and flight operations entirely separate from passenger entertainment systems and Wi-Fi, says Daniel P. Johnson, cybersecurity engineering fellow at Honeywell Aerospace Advanced Technology of Golden Valley, Minnesota.

Regardless, research like Santamarta's is taken seriously in the industry and is seen as indicative of the challenges the industry must overcome if it is to safely carry out a digital revolution aboard thousands of airliners. For passengers, the revolution means shorter waits, in-flight Wi-Fi, and more comfort through digital control of the temperature and humidity inside the cabin.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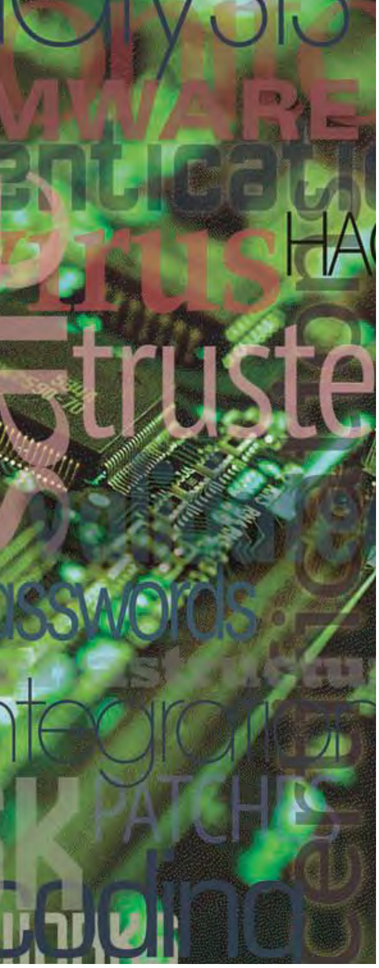


Airlines stand to save millions by tracking planes via GPS to straighten crooked flight routes and smoothing today's fuel-wasting stair-step descents. The industry has come to realize that for all this to unfold as they wish they must make cybersecurity integral to their operations.

"When I look at the data-driven world, I'm very excited by all the things we can do," says Sam Adhikari, an executive at Sysoft, a software engineering and consulting firm in New Jersey, and chairman of AIAA's Cybersecurity Working Group. "The problem is I cannot use the data if it's not accurate and if it's not secure."

Info-sharing plan

To sharpen cybersecurity, seven major U.S. airlines and aircraft manufacturers announced Sept. 29 that they have formed the Aviation Information Sharing and Analysis Center, or A-ISAC, in Annapolis Junction, Maryland. This nonprofit organization will have a mission of helping companies analyze and share information about cyber threats as well as physical threats. Boeing has publicly advocated for creation of an A-ISAC since at least 2012, and will participate in the effort.

The organization will work closely with the Department of Homeland Security's cyber crisis headquarters in Arlington, Virginia, called the National Cybersecurity Communications and Integration Center.

Also in Annapolis Junction, the Office of the Director of National Intelligence and the Transportation Security Administration in September opened the Air Domain Intelligence-Integration and Analysis Center to share top-secret intelligence with five representatives from the aviation industry who possess appropriate security clearances. The five representatives will assign analysts from their companies or industry organizations to help the intelligence community write "tear lines," or unclassified information about threats which can be disseminated quickly to the wider aviation community, Faye Francy, executive director of A-ISAC, tells Aerospace America.

A-ISAC and the ADIAC intelligence center were established to address widespread concern among government and industry executives that the nation's growing dependence on information systems makes it increasingly vulnerable to cyber attack. President Barack Obama's Presidential Policy Directive 21 and Executive Order 13636, signed in February 2013, direct public and private agencies to work together to devise methods to combat threats to critical infrastructure, including cyber attacks.

"There has been a call to action for the private sector to engage amongst ourselves as private companies but also to engage with the government and other strategic industries," Francy says. "Aircraft owners, operators, manufacturers, suppliers and airports need to improve information sharing and collaboration to ensure that we are implementing best practices across the sector to protect that infrastructure."

By sharing information, the aviation community fended off a major cyber attack in 2013. The nonprofit Center for Internet Security, based in East Greenbush, New York, reported in June that hackers tried to break into the computer networks of 75 U.S. airports with advanced persistent threats, a type of malware designed to remain undetected for months or years while secretly gathering information.

Behind the scenes, it was wake up call.

When that threat was detected in two airport networks, the Center for Internet Security's Multi-State Intelligence Sharing and Analysis Center worked with the National Cybersecurity Communications and Integration Center to mitigate the damage and prevent additional airport networks from being breached. The groups shared detailed information with likely targets in the aviation community on the hackers' tactics. The hackers used phishing emails or messages that appear to come from a trusted source but actually are designed to steal passwords or personal data from recipients, according to the Center for Internet Security's report.

"That is a great example of how collaboration works," Francy says. "Because of the quick sharing of information at an unclassified level, we were able to mitigate the damage to other airports." The A-ISAC is meant to ensure that this kind of collaboration becomes the norm.

In addition to working with government agencies and aviation companies, the A-ISAC will compare data with the information and analysis centers that the federal government has encouraged other industries to create, such as those in communications, rail, surface transportation and financial services. This is done through the National Council of Information Sharing and Analysis Centers, which brings together representatives for monthly meetings.

"What we have seen is these cybersecurity threat actors are utilizing very similar tactics, techniques and procedures in various sectors," Francy says. "They use them, find them to be successful and then go on to use them in another sector. So being able to share information in a timely way helps us to protect each other."

The Connectivity Challenge

The steps taken in 2014 are the culmination of years of work. Information sharing is a key aspect of the Framework for Aviation Cybersecurity issued in August 2013 by AIAA's Cybersecurity Working Group. That 10-page document, "The Connectivity Challenge: Protecting Critical Assets in a Networked World," includes a detailed description of the cyber threat and recommends steps the global commercial aviation industry should take to defend itself, including identifying the critical systems that require the most protection.

"Affecting cabin lighting is less critical than affecting a flight control computer," says Honeywell's Johnson. "So you spend a lot more time worrying about isolating the cabin from the cockpit than you might separating the passengers from some of the lighting controls, but not the emergency lighting controls because those are safety critical."

The FAA requires companies to perform security analyses and to safeguard critical networks by issuing special conditions, a type of regulation related to a particular aircraft or engine that is released when the agency determines that existing airworthiness regulations do not adequately address a potential safety issue.

The agency issued the first special condition related to aviation cybersecurity in March after the disappearance of Malaysia Airlines flight 370. Manufacturers were directed to ensure that passengers with access to in-flight entertainment and wireless Internet services could not interfere with the plane's avionics. In September, the agency issued additional special conditions calling on aircraft manufacturers to prevent any unauthorized person outside a plane from gaining access to the aircraft's computers through external networks, including airport and airline networks.

Rather than telling companies what specific steps to take to address potential cyber threats, the FAA requires them to prove that they have evaluated potential dangers thoroughly and devised safeguards. In time, the industry is likely to move toward more standard procedures and fixed rules, but developing those and identifying the most effective solutions will take time, Johnson says. Until then, airlines, airports, aircraft manufacturers, suppliers and government agencies will devise their own procedures to enhance the security of their networks.

The FAA's Security Operations Center routinely scans its network for vulnerabilities. The agency also exchanges information with the Department of Homeland Security's U.S.-Computer Emergency Readiness Team, known as US-CERT, and other federal agencies. "When potential risks are identified, corrective actions are implemented as needed," says FAA spokeswoman Tammy Jones.

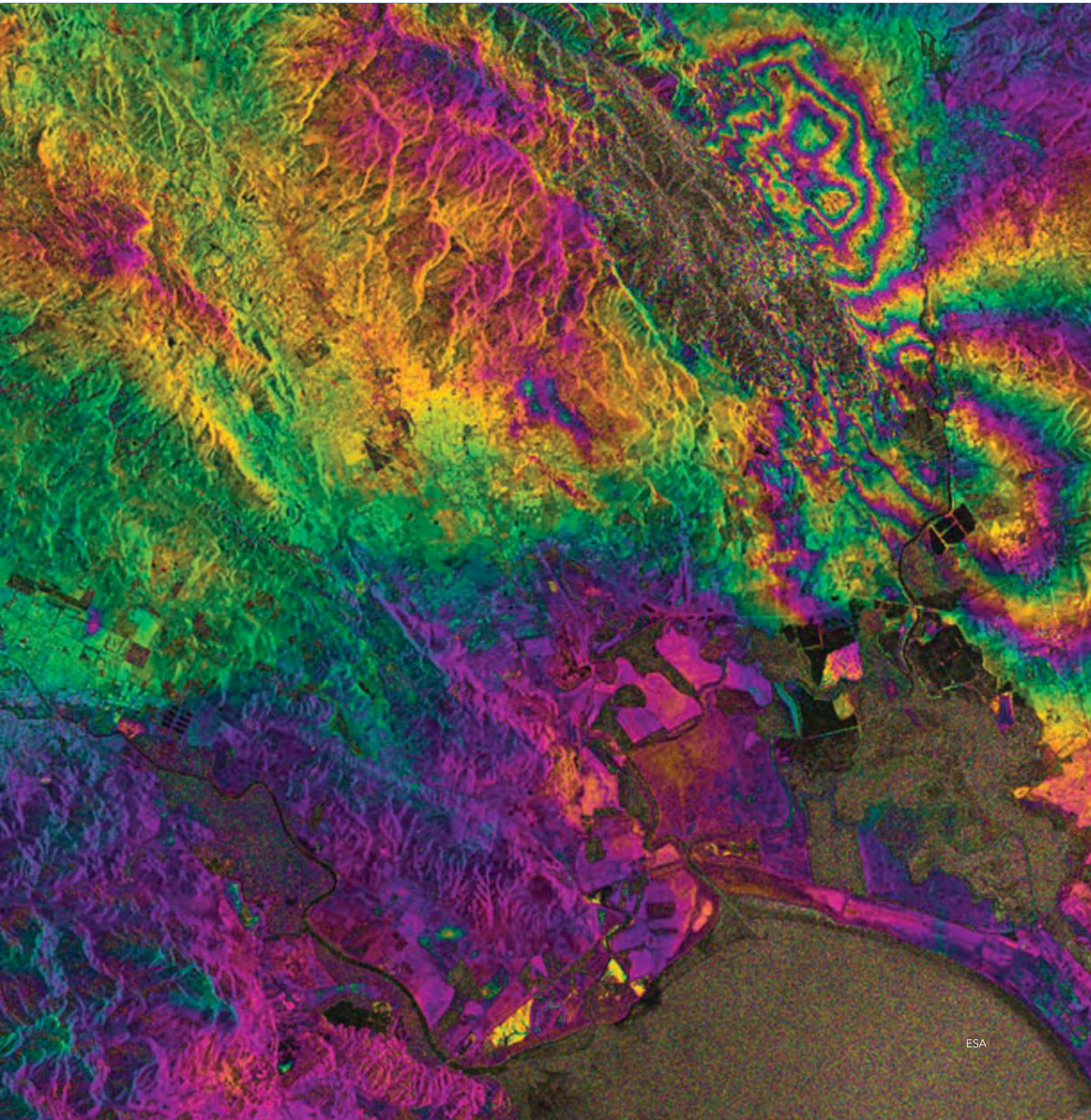
> **"Because of the quick sharing of information at an unclassified level, we were able to mitigate the damage to other airports."**
> — Faye Francy, executive director of A-ISAC

Despite the progress individual companies and government agencies are making in addressing cyber threats, the long-term goal is systemic safeguarding of critical networks. "The challenge for aviation is the complexity of the ecosystem and unfortunately there is not a Director of Intelligence for the industry," says Larry Dietz, managing director of information security for TAL Global, a security consulting firm in San Jose, Calif. "You have passengers and cargo, maintenance and supply, fuel, airports, air traffic control, not to mention the computers networks and software."

Since those networks are linked, airlines can't simply secure their own networks. They need to make sure the networks they interact with also have acceptable levels of security, one cybersecurity professional notes. .

The ultimate nightmare would be a cyber attack that brings down one or more planes. The industry aims to keep that from happening.

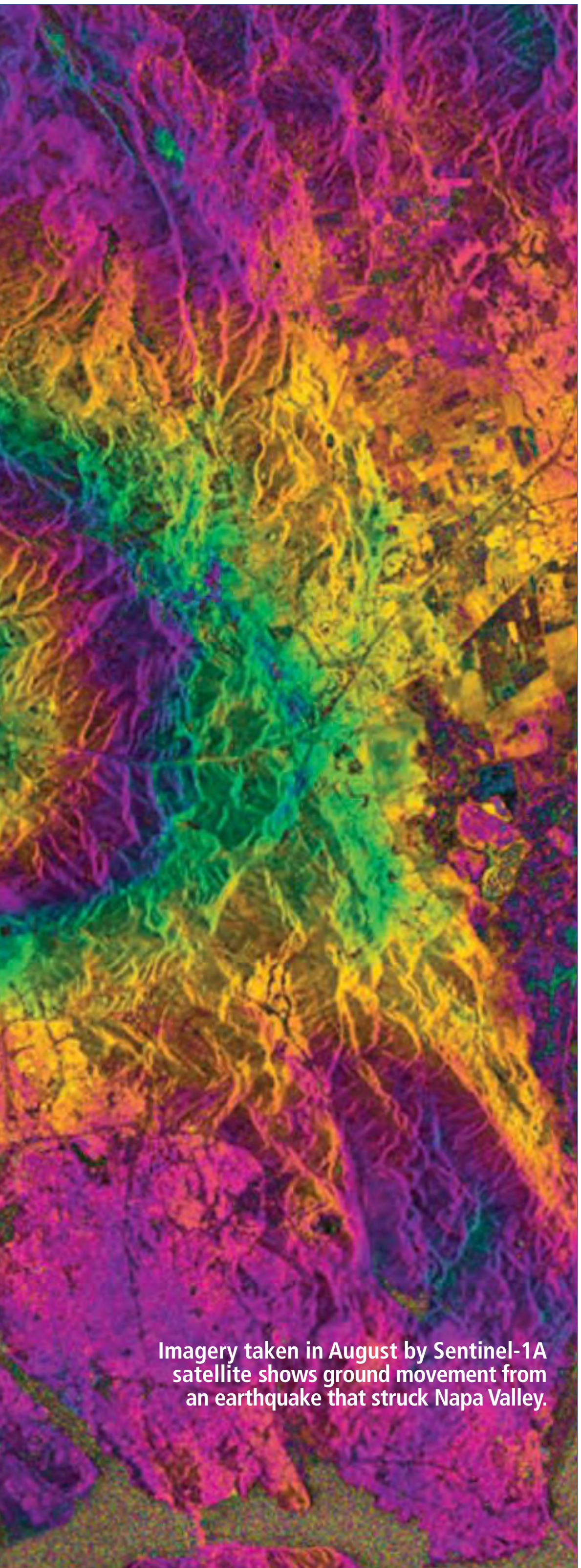
Europe's Mission to



ESA

Earth

Europe plans to field a fleet of 15 satellites and five hosted payloads that would monitor Earth's environment continually for many years to come. Some instruments would measure air pollution that is contributing to climate change. Others would watch for rising sea levels or shifts in the land that could portend earthquake risk. NASA once had a similarly ambitious Earth-observing plan but was unable to complete it. Marc Selinger says Europe is confident that it can get its Sentinel constellation to orbit.


Imagery taken in August by Sentinel-1A satellite shows ground movement from an earthquake that struck Napa Valley.

British scientist Tim Wright was thousands of miles away from California when a major earthquake rattled the state's Napa Valley wine country in August. Pictures from Europe's Sentinel-1A, a 2,300-kilogram radar satellite launched in April, helped him quickly assess the rupture.

By comparing images taken days before and after the quake, Wright and his colleagues confirmed that the West Napa Fault, previously thought to be benign, had triggered the upheaval. Their analysis also revealed that the fault extends farther north than once thought.

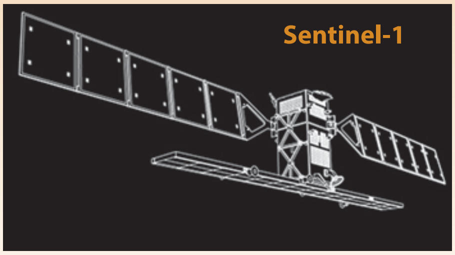
Before Sentinel-1A, such discoveries would have been all but impossible.

"The big difference about Sentinel-1 is that it will be acquiring data systematically for all of the seismic belts, and so we should be able to see almost every earth-

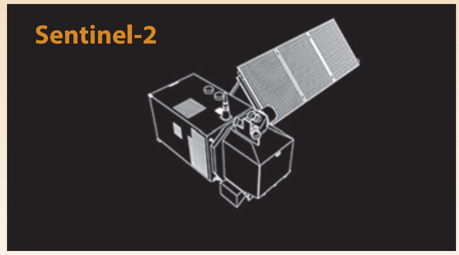
By Marc Selinger

ALL EYES ON EARTH

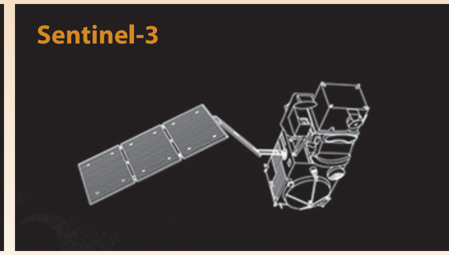
Europe's Sentinel satellites will gather everything from pollution readings to sea surface heights.



Sentinel 1A, 1B, 1C, 1D
Polar-orbiting satellites equipped with imaging radars.
Purpose: Track sea ice, oil spills, marine wind, ocean waves, land-use changes and land deformation. Aid emergency response to earthquakes and floods.
Launch Dates: **1A:** April 2014
1B: 2016
1C: 2021
1D: 2023



Sentinel 2A, 2B, 2C, 2D
Polar-orbiting satellites equipped with multispectral sensors.
Purpose: Monitor vegetation, soil and water cover, inland waterways and coastal areas.
Launch Dates: **4A:** 2015
4B: 2016
4C: 2022
4D: 2023



Sentinel 3A, 3B, 3C, 3D
Multi-instrument satellites.
Purpose: Measure sea-surface and land-ice topography, sea- and land-surface temperature, and ocean and land color.
Launch Dates: **3A:** 2015
3B: 2017
3C: 2023
3D: 2024

quake that causes damage in the continents," says Wright, a professor at the University of Leeds and the director of the Centre for the Observation and Modeling of Earthquakes, Volcanoes and Tectonics, or COMET. "Other satellites can make the same kinds of measurements, but they do not have the capacity to be switched on all the time. Or they are semi-commercial systems that require tasking, which would be fine if we knew where and when the earthquakes were going to happen."

ULA

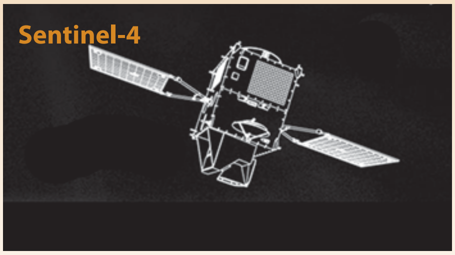
United Launch Alliance's Atlas 5 is one of the three candidates under consideration to be the launch vehicle for the Sentinel-6 satellites.

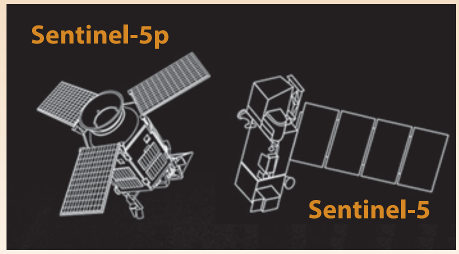
COMET plans to use Sentinel-1A data to monitor slow shifts in the ground that can precede quakes. Such information will help public officials ensure that building codes in earthquake-prone regions are up to date.

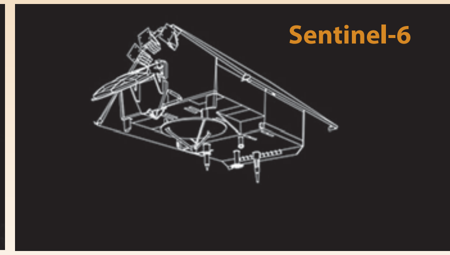
Such is the promise of Europe's Sentinel project: Erect a vast constellation of satellites that is always on, constantly collecting almost every kind of data imaginable about the Earth. European officials consider the Sentinels one of two flagship space programs managed by the European Commission, with the other being the Galileo global navigation satellite system. Both programs seek to assert European technology independence in space.

The challenge for Europe, says a veteran American space expert, will be to marshal the staying power to get all the Sentinels to orbit.

"I wish them well, as I know firsthand how difficult it is to sustain such efforts here in the U.S. across administration, congressional and NASA leadership changes," says Bill Townsend, who was acting associ-







Sentinel 4A, 4B
Spectrometer payloads for EUMETSAT geostationary weather satellites.
Purpose: Air quality monitoring and forecasting.
Launch Dates: **4A:** 2021
4B: TBD

Sentinel 5p, 5A, 5B, 5C
5p (precursor) is a low-Earth-orbit satellite. 5A, 5B and 5C are payloads on EUMETSAT polar-orbiting satellites.
Purpose: Atmospheric monitoring.
Launch Dates: **5p:** 2016
5A: 2021
5B: TBD
5C: TBD

Sentinel 6A, 6B
Satellites with radar altimeters to measure global sea-surface height.
Purpose: Operational oceanography and climate studies.
Launch Dates: **6A:** 2020
6B: 2025

ate administrator for earth science when NASA made a similar attempt in the 1990s.

New Copernican Revolution

Sentinel is part of the European Union's Copernicus program, which until December 2012 was known as GMES, for the Global Monitoring for Environment and Security system. The name Copernicus reflects the goal of revolutionizing the world's perceptions of Earth just as astronomer Nicolaus Copernicus improved the world's understanding of the cosmos by showing that Earth orbits the sun, not the other way around.

The European Commission, the EU's executive arm, oversees Copernicus. The European Space Agency manages the space segment and the European Environment Agency furnishes data from terrestrial sources, including ground-based weather stations and ocean buoys.

The space component includes 20 new spacecraft: 15 ESA satellites, plus five ESA payloads that will be hosted on satellites operated by the European Organisation for the Exploitation of Meteorological Satellites, or EUMETSAT. These spacecraft are to comprise six lines of Sentinel satellites, or "families" in Sentinel parlance, each with distinct missions ranging from tracking oil spills to monitoring air quality.

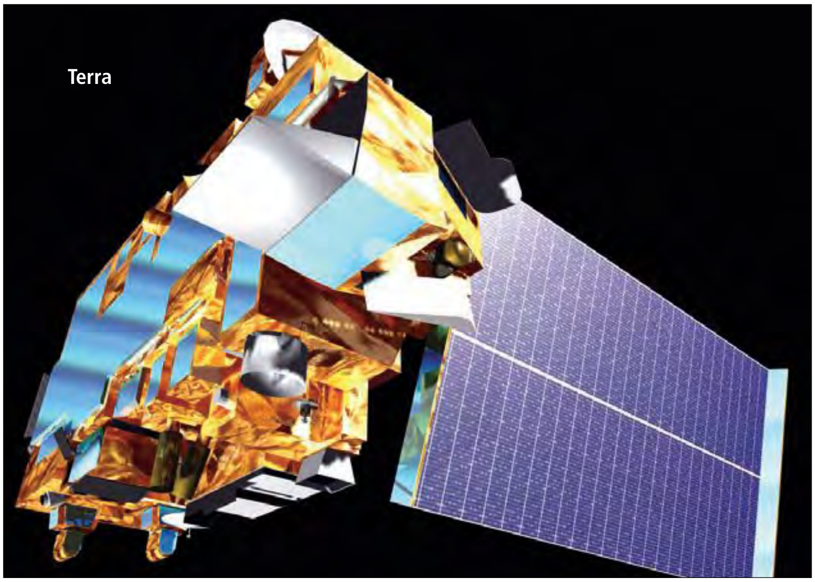
Some satellites will replace aging spacecraft, while others will perform missions that were previously unaddressed. Data from all of the satellites will be available free of charge and mostly online to policymakers, researchers and businesses.

The first satellite, Sentinel-1A, was launched by Arianespace in April on a Soyuz rocket from Europe's Spaceport in French Guiana. Thales Alenia Space designed and built the satellite and Airbus Defence and Space provided the radar, which can pierce clouds and darkness. Sentinel-1A ground images are at least four times finer in resolution than those of its predecessor satellite, Envisat.

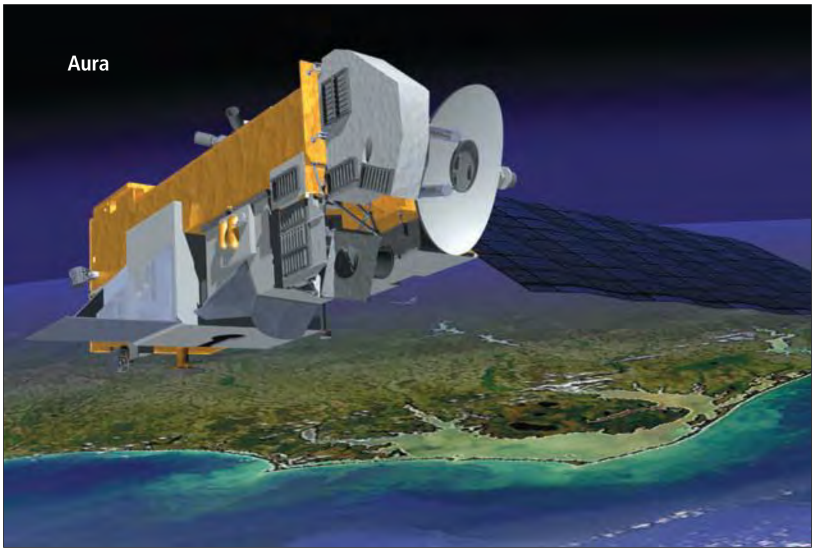
Besides earthquake mapping, Sentinel-1A is helping track landslides in Norway, river flooding in Namibia and ice cap motion in the Arctic Ocean. It will be joined by its identical twin, Sentinel-1B, in 2016. Having the pair in orbit at the same time will make it possible to revisit a particular spot on Earth every six days instead of 12.

Each family has a built-in retirement plan. When the initial satellite or satellites reach the end of their service lives, new ones will be launched. For instance, 1A and 1B, which are expected to last seven years each, are scheduled to be succeeded by 1C in 2021 and 1D in 2023.

ESA contends that Sentinel will be more comprehensive than the U.S. Earth-observation arsenal, which was assembled



NASA



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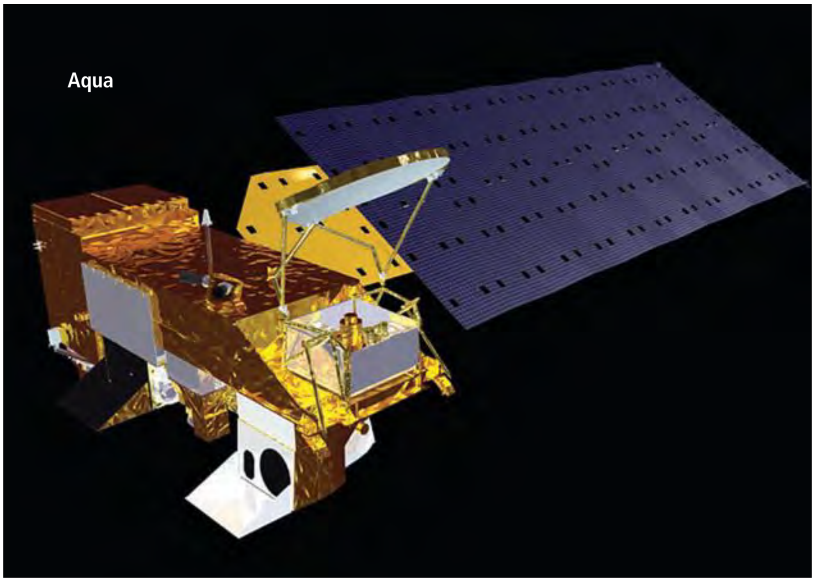

NASA

Due to budget constraints, NASA's Earth Observing System of the 1990s was scaled back to a single set of three main satellites — Terra, Aura and Aqua — which remain in service but are well beyond their design lives.

in piecemeal fashion. The United States has no civilian radar counterpart to Sentinel-1. As for Sentinel-2, the U.S. Landsat satellites are similar in that they collect imagery for agriculture and other uses, but the sensors aboard Sentinel-2 will cover wider areas than Landsat sensors.

"In the U.S., there is no Earth-observation program comparable to Copernicus, both in terms of objectives and size," says Guido Levrini, ESA program manager for the Copernicus space segment.

The United States does have a limited role in Sentinel, though. The U.S. government will participate in Sentinel-6, which will continue the Jason series of ocean-monitoring satellites that the United States and Europe have jointly fielded for over two decades.

The United States will provide three payload instruments and a still-to-be-determined launch vehicle for each of two Sentinel-6 satellites. Launch vehicle candidates are SpaceX's Falcon-9, Orbital Sciences Corp.'s Antares and United Launch Alliance's Atlas 5.

NOAA leads the U.S. contribution on Sentinel-6, with support from NASA's Jet Propulsion Laboratory and the Navy. Development of the first Sentinel-6 is to begin in 2015.

Townsend says that continuing this partnership is critical to improving the United States' understanding of climate change. The Sentinel-6 satellites will measure how the oceans redistribute energy that is pumped into them from sunlight and by greenhouse gases that trap heat in the atmosphere.

The United States has a smaller role in two other Sentinel families. These efforts include sharing data between Landsat 8 and Sentinel-2 satellites and between the U.S. Suomi weather satellite and the Sentinel-5P satellite.

Finding funding

Despite government budget constraints across Europe, Levrini says Copernicus has enough EU funding in place — the equivalent of \$4.1 billion U.S. — to sustain it through 2021. A majority of the Sentinels will have been launched by then. In addition, the allocated money covers the development of satellites launched after 2021.

"The successful deployment of Copernicus in the coming years and the achievement of the program objectives" will help reaffirm support among policymakers for continuing to finance satellite operations beyond 2021, says Levrini.

As envisioned in the 1990s, NASA's Earth Observing System was supposed to be a recurring series of satellites but ended up being scaled back to a single set of three main satellites — Terra, Aqua and Aura — due to budget constraints, Townsend says. Those three satellites remain in service but are well beyond their design lives, and no replacements are planned. Terra, which collects data about Earth's changing climate, is the oldest of the trio and turns 15 in December.

One factor that may help Europe complete the Sentinels is that its policymakers agree on the need to stem climate change. The United States lacks such consensus.

"Simply put, Democrats tend to believe that climate change is real and Republicans tend to question it," Townsend says. "Maybe after 20-plus years of continuing sea level rise, melting Arctic sea ice, extreme weather events, etc., [Europeans] are finally acknowledging the need to figure out better what the causes of global change really are and, therefore, help the policymakers make the best choices possible rather than shooting in the dark as has happened sometimes in the past."

Townsend says Europe and the United States would both benefit from a greater U.S. role in Sentinel. Europe would gain another funding source and the United States would gain more eyes in the sky. At the moment, the number of U.S. Earth-observing missions is projected to plummet from more than 20 in 2014 to six to 12 by 2020, according to a National Academy of Sciences report cited by Townsend.

"We ought to collaborate much more than what we are currently doing on the important global problem of climate change," he says. "That would help prevent unnecessary duplication of effort and help ensure the continuation of needed measurements for the future."

Leonard David contributed to this report.

25 Years Ago – November 1989

Nov. 18 For the last launch of NASA's Delta vehicle, the Cosmic Background Explorer (COBE) is orbited. Future launches are to be made with commercial or military rockets. COBE is designed to investigate background interstellar radiation left over from the "Big Bang" caused by the creation of the universe. By early May 1992, COBE detects temperature variations in the sky that are claimed as evidence of the Big Bang theory. This finding is considered a major milestone in astronomy. NASA, Astronautics and Aeronautics, 1986-90, pp. 237, 245-246; Flight International, May 6-12, 1992, p. 18.

Nov. 22-27 The Space Shuttle Discovery conducts a five-day mission following its launch from the Kennedy Space Center. STS-33 carries a classified Defense Department satellite, which is placed in a geostationary orbit as part of the Strategic Defense Initiative. The crew consists of mission commander Col. Frederick Gregory, pilot Col. John Blaha, and mission specialists Navy Captain Manley L. Carter, Jr. F. Story Musgrave and Kathryn C. Thornton. Discovery lands at Edwards Air Force Base on Nov. 27. NASA, Astronautics and Aeronautics, 1986-90, p. 238.

50 Years Ago, November 1964

Nov. 2-4 The Relay 1 and Relay 2 communications satellites are used to broadcast election results in Europe, while the Syncom 2 geosynchronous communications satellite stationed over the Pacific relays nearly eight hours of U.S. presidential election results to the Far East, with the Voice of America transmitting the radio signals. These are perhaps the first times communications satellites are used to convey political news. NASA News Release 64-279.

Nov. 3 Perhaps for the first time, a university attempts to study the Earth's atmosphere and the composition of stars by means of a rocket payload, when a NASA Aerobee 150 sounding rocket carries a spectrograph payload prepared by Princeton University to an altitude of 78.8 miles in a launch from the White Sands Missile Range, N.M. The primary objective is to study ultraviolet radiation of three stars in the constellation Orion. The payload is successfully recovered by parachute and the film extracted and developed. New York Times, Nov. 17, 1964, p. 72.

Nov. 5 Mariner 3 (Mars 64) is launched from Cape Kennedy, Fla., by an Atlas-Agena D toward Mars but the space communications fail when a fairing does not jettison, preventing the deployment of the solar panel. In addition, the spacecraft does not align itself properly with the Sun, preventing the proper pointing of the communications antennas. Mariner is fitted with TV equipment for taking pictures of the Martian surface as well as instruments to study radiation, space dust and magnetic forces near Mars during this attempted swing-by mission. New York Times, Nov. 6, 1964, p. 16; Flight International, Nov. 12, 1964, p. 843.

Nov. 6 The 295-pound Explorer 23 (S-55c) meteoroid detection satellite is launched from NASA's Wallops Island Station, Va., by an all-solid propellant Scout vehicle. The equipment aboard records the rates and sizes of meteoroid penetration. This data is needed for the efficient design of spacecraft capable of operating for long periods in Earth orbit. Missiles and Rockets, Nov. 16, 1964, p. 33; Flight International, Nov. 26, 1964, p. 899.

Nov. 12 The first successful demonstration of internal thrust from a "scramjet" (supersonic combustion ramjet) engine is announced by the Air Force Systems Command. The test is one of a series to demonstrate that scramjet engines can be developed for very high-speed vehicles and is conducted with a 30-inch-long scramjet engine up to a simulated speed of about Mach 6. Scramjets differ from conventional engines in that they have no moving parts except for the fuel-feeding system that produces thrust by burning fuel in a supersonic airstream. Air Force Systems Command Release 49-40-141.

Nov. 17 The Ryan XV-5A lift-fan jet V/STOL makes its first transition flight at Edwards Air Force Base, Calif., successfully converting to conventional flight after a vertical takeoff. The XV-5A is more economical in fuel consumption than other vertical flight planes and the aircraft has no trouble operating from unprepared dirt surfaces, since the downward flow of air from the fans is relatively cool and gentle. New York Times, Nov. 18, 1964, p. 17.

Nov. 21 For the first time, NASA orbits dual spacecraft with a single booster when it launches Explorers 24 and 25 from Vandenberg Air Force Base, Calif., with a four-stage solid-propellant Scout rocket. The 19-pound Explorer 24 (Air Density Explorer, or Air Density Balloon) provides global comparative measurements of the reflection of sunlight and radio waves by means of a series of sensors on aluminum foil, while the 90-pound Explorer 25 (Injun 4) uses radiation sensors to measure protons and electrons in low-Earth orbits. NASA News Release 64-284; Flight International, Dec. 17, 1964, pp. 1059-1060.

Past

An Aerospace Chronology
by **Frank H. Winter**
and **Robert van der Linden**

Nov. 28 The Mariner 4 Mars probe is launched from Cape Kennedy, Fla., by an Atlas-Agena D and once it leaves Earth parking orbit into a Mars trajectory it locks on the star Canopus for stabilization, the first time a star is used for an attitude reference on a long space mission. Like Mariner 3, Mariner 4 carries TV cameras to televise the Martian surface and instruments to study radiation, space dust and magnetic forces near Earth, Mars and in deep space. Washington Post, Nov. 30, 1964; Flight International, Nov. 26, 1964, p. 900.

Nov. 30 The USSR launches the Zond 2 probe toward Mars. The electronic plasma ion engines are also successfully tested shortly after launch under real space environment conditions. But one of the two solar panels fails and only half the anticipated power is available to the spacecraft. Then, after a mid-course maneuver, communications with the spacecraft are lost in early May 1965. At its closest point, Zond passes within 1,000 miles of Mars on Aug. 6. Washington Post, Dec. 2, 1964; Aviation Week, Dec. 7, 1964, p. 26; Robert Zimmermann, The Chronological Encyclopedia of Discoveries in Space, p. 36.

75 Years Ago - November 1939

Nov. 4 The House of Representatives votes to lift an arms embargo on belligerents in the war, thereby allowing a cash and carry policy of delivering supplies, mostly military flying equipment, to the Allies. President Franklin Roosevelt signs the act the next day. German Field Marshal Hermann Goering responds that the American aviation industry is weak and that it would be extremely difficult to ship 8,000-10,000 airplanes across the Atlantic. Interavia, Nov. 10, 1939, pp. 1-4.

Nov. 17 Howard Hughes and the four men who accompanied him on his record-breaking around-the-world flight in July 1938 in a twin-engined Lockheed 14 are named the recipients of the 1938 Collier Trophy. Aircraft Year Book, 1940, p. 435.

Nov. 21 The Piaggio P.108B heavy bomber prototype makes its maiden flight. The P.108B will become Italy's only four-engined bomber in service during World War II. Jonathan Thompson, Italian Civil and Military Aircraft: 1930-1945, pp. 227-229.

Nov. 25 The Bell XP-39B fighter prototype makes its first flight. The plane is subsequently produced in large numbers and becomes known as the P-39 Airacobra. A unique feature is that its engine is mounted within the rear fuselage. A.J. Pelletier, Bell Aircraft Since 1935, pp. 25-39.

Nov. 30 The second annual Rotating Wing Aircraft Meeting is convened at the Franklin Institute. Igor Sikorsky, Alexander Klemin and George Lewis of the NACA are notable participants. Aviation, Nov. 1939, p. 67.

And During November 1939

— The Soviets announce a new USSR parachute record of 32,800 feet by the engineer Solodovnik, who made the jump in a special suit. The jump took 22 minutes, during which the parachutist drifted 9 miles. Interavia, Nov. 10, 1939, p. 17.

100 Years Ago, November 1914

Nov. 20 The dirigible L.7 (LZ-32) completes its first mission. A. van Hoorebeeck, La Conquete de L'Air, p. 110.

And During November 1914

— Princess Eugenie Mikhailovna Shakhovskaya becomes the first Russian woman to become a military pilot, and perhaps the first in the world. Francis K. Mason and Martin Windrow, Know Aviation, p. 17.

Career Opportunities

Georgia Institute of Technology
School of Aerospace Engineering

The Daniel Guggenheim School of Aerospace Engineering at the Georgia Institute of Technology in Atlanta, GA, invites nominations and applications for five tenure-track faculty positions. Applications are sought from candidates with expertise in the traditional aerospace disciplines, promising new research areas, and cross-cutting interdisciplinary fields. Areas of interest may include, but are not limited to, aerodynamics, design and manufacturing, structures and solid mechanics, and autonomy for aerospace systems. Preference is given for candidates seeking tenure-track Assistant Professor appointments, but exceptional candidates at all ranks will be considered.

Successful candidates will be expected to teach graduate and undergraduate courses; supervise graduate students; interact collaboratively with faculty in teaching, research, and service; and develop a strong, independent, externally funded research program. An earned doctorate in aerospace engineering or a related field is required at the time of hire, and successful candidates will have outstanding records of research accomplishments.

Applicants should submit a cover letter, curriculum vitae, statements of research and teaching interests, and contact information for four professional references to Prof. Mark Costello, Faculty Search Committee Chair, at ae-faculty-search@aerospace.gatech.edu.

The Aerospace Engineering program at Georgia Tech is the largest program of its kind in the US, having approximately 40 full-time faculty members, more than 800 undergraduate students, and over 500 graduate students. Its undergraduate and graduate programs are ranked among the top aerospace engineering programs in the nation. Information about the School can be found at www.ae.gatech.edu.

The Georgia Institute of Technology is an equal opportunity/affirmative action employer. The selection process will require passing a background check.

AUBURN UNIVERSITY
SAMUEL GINN
COLLEGE OF ENGINEERING
AEROSPACE

The Department of Aerospace Engineering at Auburn University invites applications for multiple tenure track positions at the assistant or associate professor rank. Candidates with exceptional background and experience may be considered at a higher rank. Areas of interest include air-breathing and rocket propulsion, aerospace structures and structural dynamics, aeroelasticity, computational fluid dynamics, and combustion. Other areas related to aerospace engineering may also be considered. Applicants must have an earned doctorate in aerospace engineering, mechanical engineering, or a closely related field.

Applicants are encouraged to apply as soon as possible by submitting a cover letter, current CV, research vision, teaching philosophy, and three references to the job posting at: http://aufacultypositions.peopleadmin.com/postings/711

Cover letters may be addressed to: Prof. Winfred A. (Butch) Foster, Faculty Search Committee Chair, 211 Davis Hall, Auburn, AL 36849. The review process will begin December 1, 2014, but applications will continue to be accepted until the position is filled. Additional information about the department may be found at: http://www.eng.auburn.edu/aero/

Auburn University is an EEO/Vet/Disability employer.

New Mexico State University

The College of Engineering at New Mexico State University (NMSU) invites applications for a 9-month tenure-track faculty position in the Mechanical and Aerospace Engineering Department starting Fall 2015. The successful candidate must have a doctoral degree in Aerospace Engineering, Mechanical Engineering or a closely related discipline. Particular expertise is sought in the areas of aircraft and/or spacecraft guidance, navigation and controls. Other areas of interest include nonlinear optimization, estimation and control, and cooperative control of teams of unmanned vehicles. Duties of the position include teaching at both the undergraduate and graduate levels in the discipline, developing a nationally-funded research program with peer-reviewed dissemination of results, and providing service to the university and the profession.

In addition to a competitive salary, NMSU also offers group medical and hospital insurance, group life insurance, long-term disability insurance, state educational retirement, workers' compensation, sick leave, annual leave and unemployment compensation, and opportunities for educational advancement. Nine month faculty- not eligible for annual and sick leave.

For a complete job description and to apply, visit http://jobs.nmsu.edu/postings/19996. **Please attach a cover letter and current vita (including a list of publications), a summary of teaching and research interests and names and contact information of at least three references. Deadline Date: January 09, 2015.**

NMSU IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER. All offers of employment, oral or written, are contingent on the University's verification credentials, of individual's eligibility for employment in the United States and other information required by federal law, state law, and NMSU policies/procedures, and may include the completion of a criminal history check.

AEROSPACE ENGINEERING AND MECHANICS
UNIVERSITY OF MINNESOTA

The Department of Aerospace Engineering and Mechanics seeks to fill faculty positions in aerospace systems. Applications are invited in all areas of aerospace systems, particularly in areas that complement current research activities in the department. These research activities include but are not limited to control system analysis and design, multi-sensor navigation and guidance algorithm design for the operation of aircraft, spacecraft and autonomous vehicles. The department has a large number of experimental and computational facilities. There are close ties with other departments and on-campus multidisciplinary centers. Information about the department is available at http://www.aem.umn.edu/

The successful candidate will participate in all aspects of the Department's mission, including teaching undergraduate and graduate courses in aerospace engineering mechanics and aerospace systems; supervision of undergraduate and graduate students; service responsibilities; and developing an independent, externally-funded research program.

Applicants must have an earned doctorate in a related field by the date of appointment. The intent is to hire at the assistant professor rank. However, exceptional applicants may be considered for appointment at the rank of associate professor with or without tenure. It is anticipated that the appointment will begin fall 2015.

To apply for this position, candidates must go to http://www1.umn.edu/ohr/employment/index.html and search for requisition no. 193904. Please attach your letter of application, detailed resume, names and contact information of three references, and a statement of teaching and research interests.

Application Deadline: The initial screening of applications will begin on December 1, 2014; applications will be accepted until the position is filled.

The University of Minnesota is an equal opportunity educator and employer.

Open Rank Faculty Position in Aerospace Engineering

The Department of Aerospace Engineering at The Pennsylvania State University invites nominations and applications for a full-time, tenure-track or tenured open-rank faculty position starting in Fall 2015. Expertise in one or more of the following areas is of particular interest: spacecraft–environment interactions; rarefied gas dynamics; chemical and electric spacecraft propulsion; reentry and rocket-nozzle and -plume flows; and space- and propulsion-related plasmas. Applicants must have an earned doctorate in aerospace engineering or a related field; at least one degree in aerospace engineering or related aerospace experience is preferred. Responses received before January 7, 2015, are assured full consideration, but the search will remain open until the position is filled. Applicants should submit electronically a single pdf file that contains a cover letter, a CV, a statement of research and teaching interests, and the names and contact information for at least three references at **apptrkr.com/530763** .

The Department of Aerospace Engineering enjoys an excellent international reputation in aeronautics and astronautics. The Department currently has 16 full-time faculty members, with more than 225 juniors and seniors and more than 120 graduate students. Annual research expenditures exceed $6 million.

Penn State at University Park is a land-grant institution located within the beautiful Appalachian mountains of central Pennsylvania. State College and nearby communities within Centre County are home to roughly 100,000 people, including over 40,000 students, and offer a rich variety of cultural, recreational, educational, and athletic activities. State College is a wonderful community in which to raise a family and has an excellent public school system.

CAMPUS SECURITY CRIME STATISTICS: For more about safety at Penn State, and to review the Annual Security Report which contains information about crime statistics and other safety and security matters, please go to http://www.police.psu.edu/clery/ , which will also provide you with detail on how to request a hard copy of the Annual Security Report.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, disabled individuals, and other protected groups.

Worcester Polytechnic Institute

Assistant or Associate Professor

Mechanical Engineering Department

Aerospace Engineering Program

Worcester Polytechnic Institute (WPI) invites applications for a faculty position in the Mechanical Engineering Department at assistant or associate rank, commensurate with qualifications. Required qualifications for the position include: an earned doctorate in Aerospace Engineering, Mechanical Engineering, or a closely related field; a strong commitment to teaching at the undergraduate and graduate levels; a demonstrated record of, or potential for scholarly research, and excellent communication skills. Candidates will be considered from the general area of synthesis, processing, testing, characterization, and modeling of Advanced Aerospace Materials. Emphasis is on application-driven materials, including structural, nonstructural, adaptive, smart, multifunctional, and environmentally friendly.

Successful candidates will be responsible for teaching courses and advising projects in the Aerospace Engineering Program. The candidates will be expected to develop and sustain an externally funded research program accompanied by strong scholarship.

The Aerospace Engineering Program offers undergraduate and graduate degrees to more than 250 students. Information about the Aerospace Engineering Program and faculty research areas can be found at http://www.wpi.edu/academics/aero. The Aerospace Engineering Program is part of the Mechanical Engineering Department which has 35 full-time faculty members and offer undergraduate degrees in mechanical engineering to about 750 students and graduate degrees in mechanical engineering, aerospace engineering, materials science and engineering, and manufacturing engineering to more than 250 graduate students.

WPI, founded in 1865 and located one hour west of Boston, is one of the nation's oldest technological universities. WPI is a highly selective private university with an undergraduate student body of over 4,000 and 1,900 full-time and part-time graduate students enrolled in more than 50 Bachelor's, Master's, and PhD programs. Its innovative project-enriched curriculum engages students and faculty in real-world problem solving, often at one of WPI's global project centers. U.S. News and World Report consistently ranks WPI among the top 100 national universities and College Factual – USA Today, lists WPI in the top 10 Best Engineering Schools in the U.S. (August 2014).

Applications should include detailed curriculum vitae, statements of teaching and research interests, and a list of five professional references at least one of which addresses teaching experience or potential, via **http://apptrkr.com/522850** . Applications from women and minority candidates are especially encouraged. This search will remain open until the position is filled. Questions can be addressed to the Chair of the Search Committee, Professor Nikolaos A. Gatsonis at gatsonis@wpi.edu.

To enrich education through diversity, WPI is an affirmative action, equal opportunity employer.

WPI

University of Colorado Boulder

Faculty Positions
Aerospace Engineering Sciences

The Department of Aerospace Engineering Sciences in the College of Engineering and Applied Science at the University of Colorado Boulder invites applications for **three tenure-track faculty positions** in the areas of **structures and materials, small satellites, and bioastronautics.** Applicants are especially sought with the following research interests:

- **Structures and Materials:** Design, modeling, fabrication, and characterization of structural and/or multi-functional materials and their integration into innovative aerospace systems; preference given to applicants with an experimental focus.
- **Small Satellites:** Advances in technology and application of small satellite systems; novel sensors, guidance and control, autonomy, propulsion, and communication subsystems; scientific application of small satellite systems; experience in mission design and systems integration.
- **Bioastronautics:** Human spaceflight including, but not limited to, human spacecraft design, test and analysis; life support systems and spacesuit technologies; space biotechnology and biomedical countermeasures for astronaut health concerns.

Although these positions are targeted at the assistant professor level, other levels will be considered for experienced candidates with outstanding credentials. Job duties include teaching, research, and service to the University and to professional communities. Applicants should show strong promise to develop a robust research program that complements the existing strengths of the department and also to excel at undergraduate and graduate teaching, and student mentoring. A Ph.D. degree in Aerospace Engineering or a related field is required.

Application materials are accepted electronically through Job Posting F01786 at **https://www.jobsatcu.com**. Please indicate in your cover letter which position you are interested in, and include a curriculum vitae, statements of research and teaching interests, and the names and contact information of four references. Address the cover letter to Search Committee Chair Prof. Jeffrey M. Forbes, Department of Aerospace Engineering Sciences, University of Colorado Boulder.

For information about the department, please visit **http://www.colorado.edu/aerospace.**

Review of applications will begin 1 December 2014 and continue until finalists are identified, no later than the end of January.

The University of Colorado Boulder is an Equal Opportunity/Affirmative Action Employer committed to building a diverse workforce. We encourage applications from women, racial and ethnic minorities, individuals with disabilities, and veterans. The University of Colorado Boulder conducts background checks for all final applicants.

College of Engineering: Open Rank Faculty

Department of Aerospace Engineering

College of Engineering

University of Illinois at Urbana-Champaign

The Department of Aerospace Engineering at the University of Illinois at Urbana-Champaign is seeking highly qualified candidates for multiple faculty positions with emphasis on the areas of space systems/propulsion, autonomous aerospace systems, multi-disciplinary design optimization, aeroelasticity, and aerospace materials and structures. Particular emphasis will be placed on qualified candidates who work in emerging areas of aerospace engineering and whose scholarly activities have high impact.

Please visit http://jobs.illinois.edu to view the complete position announcement and application instructions. Full consideration will be given to applications received by November 3, 2014. Applications received after that date will be considered until the positions are filled.

ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Illinois is an EEO Employer/Vet/Disabled - www.inclusiveillinois.illinois.edu and committed to a family-friendly environment (http://provost.illinois.edu/worklife/index.html).

The Department of Aerospace Engineering at **San Diego State University** invites applications for the position of Department Chair to begin in Fall of 2015.

Applicants must hold an earned PhD in Aerospace Engineering or closely related discipline. A record of leadership showing interpersonal skills and organizational ability, strong research background and funding records with recognized professional accomplishments in aerospace engineering, and a commitment to excellence in teaching at both undergraduate and graduate levels are required. Aerospace Engineering is one of four departments in the College of Engineering at San Diego State University with an ABET-accredited program and offers Bachelors, Masters and Doctoral degree programs. Southern California offers exceptional opportunities for industrial research partnerships with its extensive aerospace industry. Additional information about the university and department may be obtained at **http://www.sdsu.edu** and **http://aerospace.sdsu.edu**.

SDSU is a large, diverse, urban university and Hispanic-Serving Institution with a commitment to diversity, equity, and inclusive excellence. Our campus community is diverse in many ways, including race, religion, color, sex, age, disability, marital status, sexual orientation, gender identity and expression, national origin, pregnancy, medical condition, and covered veteran status. We strive to build and sustain a welcoming environment for all. SDSU is seeking applicants with demonstrated experience in and/or commitment to teaching and working effectively with individuals from diverse backgrounds and members of underrepresented groups.

Initial review of applications will begin on January 12, 2015 and will continue until the position is filled. Applicants should submit a curriculum vita, statement of vision for the department, statement of research interests, three representative publications and complete contact information for five references to Interfolio at: **http://apply.interfolio.com/26591**.

The person holding this position is considered a "mandated reporter" under the California Child Abuse and Neglect Reporting Act and is required to comply with the requirements set forth in CSU Executive Order 1083 as a condition of employment.

SDSU is a Title IX, equal opportunity employer and does not discriminate against persons on the basis of race, religion, national origin, sexual orientation, gender, gender identity and expression, marital status, age, disability, pregnancy, medical condition, or covered veteran status.

PRINCETON UNIVERSITY

Assistant Professor

The Department of Mechanical and Aerospace Engineering (MAE) at Princeton University is conducting a broad search for two (2) tenure-track assistant professors. We welcome applications from all areas in mechanical and aerospace engineering, including but not limited to the fields of robotics, lightweight structures, nonlinear mechanics, engineering systems, propulsion, and energy systems and efficiency. Applicants must hold a Ph.D. in Engineering, Materials Science, Physics, or a related subject, and have a demonstrated record of excellence in research with the potential to establish an independent research program. We seek faculty members who will create a climate that embraces excellence and diversity, with a strong commitment to teaching and mentoring.

Princeton's MAE department has a long history of leadership in its core areas of Applied Physics, Dynamics and Controls, Fluid Mechanics, Materials Science, and Propulsion and Energy Sciences, with additional strength in cross-disciplinary efforts impacting areas such as biology, the environment, security, and space. We seek creative and enthusiastic candidates with the background and skills to build upon and complement our existing departmental strengths and those who can lead the department into new and exciting research areas in the future.

To ensure full consideration, applications should be received by December 1, 2014. Applicants should submit a curriculum vitae, including a list of publications and presentations, a 3-5 page summary of research accomplishments and future plans, a 1-2 page teaching statement, and contact information for at least three references online at http://jobs.princeton.edu, requisition number 1400675. Personal statements that summarize leadership experience and contributions to diversity are encouraged.

Princeton University is an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability status, protected veteran status, or any other characteristic protected by law. We welcome applications from members of all underrepresented groups. This position is subject to the University's background check policy.

Massachusetts Institute of Technology

Come work with us!

Tenure-Track Faculty Position

Department of Aeronautics and Astronautics

The Department of Aeronautics and Astronautics at MIT invites applications for a tenure-track faculty position with a start date of September 1, 2015 or thereafter. The department is conducting a search for exceptional candidates with a strong background in any discipline related to Aerospace Engineering, broadly defined. We are seeking highly qualified candidates with a commitment to research and education. Faculty duties include teaching at the graduate and undergraduate levels, advising students, and conducting research.

Candidates should hold a doctoral degree in a field related to aerospace engineering by the beginning of employment. The search is for a candidate to be hired at the assistant professor level; however, under special circumstances, a senior faculty appointment is possible.

Applications must include a cover letter, curriculum vitae, 2-3 page statement of research and teaching interests and goals, and names and contact information of at least three individuals who will provide letters of recommendation. Applications must be submitted as a pdf at https://school-of-engineering-faculty-search.mit.edu/aeroastro/register.tcl. Letters of recommendation must be submitted directly by the recommenders at https://school-of-engineering-faculty-search.mit.edu/letters.

To ensure full consideration, complete applications should be received by December 1, 2014. Note: Applications will be considered complete only when both the applicant materials and at least three letters of recommendations are received.

MIT is building a culturally diverse faculty and strongly encourages applications from female and minority candidates.

For more information on the Department of Aeronautics & Astronautics at MIT, please visit http://aeroastro.mit.edu/

MIT is an Equal Opportunity/Affirmative Action employer. **http://web.mit.edu**

FACULTY POSITION
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AFB, DAYTON OH

The Department of Aeronautics and Astronautics seeks applicants for a tenure-track Aerospace Engineering faculty position (preferably at the assistant or associate professor level). The department's most urgent needs are in the following areas: spacecraft design, spacecraft systems, spacecraft attitude dynamics and control, space operations, astronautical engineering, and rocket propulsion. In addition to an earned Ph.D. in Aeronautical Engineering, Astronautical Engineering, Space Systems Engineering, Mechanical Engineering or a related field, the candidate should have a demonstrated or a potential ability in teaching at the graduate level and in conducting independent research for the Air Force and other government agencies. Good communication skills, both oral and written, are essential. Applicants **must** be U.S. citizens and **must** currently possess or be able to obtain/maintain a TOP SECRET clearance. If selected, applicants must produce proof of citizenship at time of appointment.

The Department offers both M.S. and Ph.D. degrees in Aeronautical Engineering, Astronautical Engineering, Space Systems and Materials Science. The Department has several state-of-the-art computer and experimental laboratories. Interested candidates should send a resume and the names of three references to:

Dr. Brad S. Liebst
Professor and Head
Department of Aeronautics and Astronautics
Air Force Institute of Technology
AFIT/ENY
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
Phone: (937) 255-3069
e-mail: Bradley.Liebst@afit.edu

The Air Force Institute of Technology is an Equal Opportunity/Affirmative Action employer.

AIAA Bulletin

Oregon State University's AIAA Student Branch kicked off the start of its third year as a club at an event that included a tour through the Evergreen Air and Space Museum in McMinville, OR. See more information about how students are preparing to participate in AIAA's Design/Build/Fly Competition and the Experimental Sounding Rocket Association's Intercollegiate Rocketry Engineering Competition on page **B11**.

NOVEMBER 2014

AIAA Directory

AIAA HEADQUARTERS
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www.aiaa.org

To join AIAA; to submit address changes, member inquiries, or renewals; to request journal fulfillment; or to register for an AIAA conference. **Customer Service: 800/639-AIAA**†

Other Important Numbers: ***Aerospace America*** / Greg Wilson, ext. **7596*** • ***AIAA Bulletin*** / Christine Williams, ext. **7500*** • **AIAA Foundation** / Karen Thomas, ext. **7520*** • **Book Sales** / **800.682.AIAA** or **703.661.1595**, Dept. 415 • **Corporate Members** / Merrie Scott, ext. **7530*** • **International Affairs** / Betty Guillie, ext. **7573***; Emily Springer, ext. **7533*** • **Editorial, Books and Journals** / Heather Brennan, ext. **7568*** • **Honors and Awards** / Carol Stewart, ext. **7623*** • **Journal Subscriptions, Member** / **800.639.AIAA** • **Exhibits / Journal Subscriptions, Institutional / Online Archive Subscriptions** / Michele Dominiak, ext. **7531*** • **Continuing Education** / Chris Brown, ext. **7504*** • **Public Policy** / Steve Howell, ext. **7625*** • **Section Activities** / Chris Jessee, ext. **3848*** • **Standards, Domestic** / Amy Barrett, ext. **7546*** • **Standards, International** / Nick Tongson, ext. **7515*** • **Student Programs** / Stephen Brock, ext. **7536*** • **Technical Committees** / Betty Guillie, ext. **7573***

* Also accessible via Internet. Use the formula first name last initial@aiaa.org. Example: megans@aiaa.org.
† U.S. only. International callers should use 703/264-7500.

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			
3–6 Nov†	28th Space Simulation Conference	Baltimore, MD (Contact: Andrew Webb, 443.778.5115, Andrew.webb@jhuapl.edu, http://spacesimcon.org/)	
12–14 Nov†	Aircraft Survivability Technical Forum 2014	Laurel, MD (Contact: Meredith Hawley, 703.247.9476, mhawley@ndia.org, www.ndia.org/meetings/5940)	
17–18 Nov†	Institution of Mechanical Engineers: Disruptive Green Propulsion Technologies – Beyond the Competitive Horizon	London, UK (Contact: Kelly Grant, k_grant@imeche.org; http://events.imeche.org//ViewEvent?EventID=2387)	
2015			
3–4 Jan	Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-On Training Using CIFER®	Kissimmee, FL	
3–4 Jan	Best Practices in Wind Tunnel Testing	Kissimmee, FL	
3–4 Jan	Third International Workshop on High-Order CFD Methods	Kissimmee, FL	
4 Jan	Introduction to Integrated Computational Materials Engineering	Kissimmee, FL	
5–9 Jan	AIAA SciTech 2015 (AIAA Science and Technology Forum and Exposition) Featuring: 23rd AIAA/ASME/AHS Adaptive Structures Conference 53rd AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference AIAA Infotech@Aerospace Conference 2nd AIAA Spacecraft Structures Conference AIAA Guidance, Navigation, and Control Conference AIAA Modeling and Simulation Technologies 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	2 Jun 14
8–9 Jan	Fundamentals and Applications of Modern Flow Control	Kissimmee, FL	
11–15 Jan†	25th AAS/AIAA Space Flight Mechanics Meeting	Williamsburg, VA (Contact: AAS—Roberto Furfaro, 520.312.7440; AIAA—Stefano Casotto, Stefano.casotto@unipd.it; http://space-flight.org/docs/2015_winter/2015_winter.html)	15 Sep 14
26–29 Jan†	61st Annual Reliability & Maintainability Symposium (RAMS 2015)	Palm Harbor, FL (Contact: Julio Pulido, 952 270 1630, julio.e.pulido@gmail.com, www.rams.org)	
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)	
10–12 Mar	AIAA DEFENSE 2015 (AIAA Defense and Security Forum) Featuring: AIAA Missile Sciences Conference AIAA National Forum on Weapon System Effectiveness AIAA Strategic and Tactical Missile Systems Conference	Laurel, MD	4 Nov 14
11 Mar	AIAA Congressional Visits Day	Washington, DC	
25–27 Mar†	3rd Int. Conference on Buckling and Postbuckling Behaviour of Composite Laminated Shell Structures with DESICOS Workshop	Braunschweig, Germany (Contact: Richard Degenhardt, +49 531 295 3059, Richard.degenhardt@dlr.de, www.desicos.eu	
30 Mar–2 Apr	23rd AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar	Daytona Beach, FL	30 Sep 14
13–15 Apr†	EuroGNC 2015, 3rd CEAS Specialist Conference on Guidance, Navigation and Control	Toulouse, France (Contact: Daniel Alazard, +33 (0)5 61 33 80 94, alazard@isae.fr, w3.onera.fr/eurognc2015)	
13–17 Apr†	2015 IAA Planetary Defense Conference	Frascati, Italy (Contact: William Ailor, 310.336.1135, william.h.ailor@aero.org, www.pdc2015.org)	
6 May	Aerospace Spotlight Awards Gala	Washington, DC	
25–27 May†	22nd St. Petersburg International Conference on Integrated Navigation Systems	St. Petersburg, Russia, (Contact: Prof. V. G. Peshekhonov, 7 812 238 8210, icins@eprib.ru, www. Elektropribor.spb.ru)	

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
4 Jun	**Aerospace Today ... and Tomorrow—An Executive Symposium**	Williamsburg, VA	
16–19 Jun†	**7th International Conference on Recent Advances in Space Technologies – RAST 2015**	Istanbul, Turkey (Contact: Capt. M. Serhan Yildiz, +90 212 6632490/4365, syildiz@hho.edu.tr or rast2015@rast.org.tr)	
22–26 Jun	**AIAA AVIATION 2015 (AIAA Aviation and Aeronautics Forum and Exposition)** **Featuring:** **21st AIAA/CEAS Aeroacoustics Conference** **31st AIAA Aerodynamic Measurement Technology and Ground Testing Conference** **33rd AIAA Applied Aerodynamics Conference** **AIAA Atmospheric Flight Mechanics Conference** **7th AIAA Atmospheric and Space Environments Conference** **15th AIAA Aviation Technology, Integration, and Operations Conference** **AIAA Balloon Systems Conference** **AIAA Complex Aerospace Systems Exchange** **22nd AIAA Computational Fluid Dynamics Conference** **AIAA Flight Testing Conference** **45th AIAA Fluid Dynamics Conference** **22nd AIAA Lighter-Than-Air Systems Technology Conference** **16th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference** **AIAA Modeling and Simulation Technologies Conference** **46th AIAA Plasmadynamics and Lasers Conference** **45th AIAA Thermophysics Conference**	Dallas, TX	**13 Nov 14**
28 Jun–2 Jul†	**International Forum on Aeroelasticity and Structural Dynamics (IFASD)**	Saint Petersburg, Russia (Contact: Dr. Svetlana Kuzmina, +7 495 556-4072, kuzmina@tsagi.ru, www.ifasd2015.com)	
6–9 Jul	**20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference**	Glasgow, Scotland	**8 Dec14**
12–16 Jul†	**International Conference on Environmental Systems**	Bellevue, WA (Contact: Andrew Jackson, 806.834.6575, Andrew.jackson@ttu.edu, www.depts.ttu.edu/ceweb/ices)	
27–29 Jul	**AIAA Propulsion and Energy 2015 (AIAA Propulsion and Energy Forum and Exposition)** **Featuring:** **51st AIAA/ASME/SAE/ASEE Joint Propulsion Conference** **13th International Energy Conversion Engineering Conference**	Orlando, FL	**7 Jan 15**
9–13 Aug†	**2015 AAS/AIAA Astrodynamics Specialist Conference**	Vail, CO (Contact: Dr. W. Todd Cerven, 571.304.7572, william.t.cerven@aero.org, www.space-flight.org/docs/2015_astro/2015_astro.html)	
31 Aug–2 Sep	**AIAA SPACE 2015 (AIAA Space and Astronautics Forum and Exposition)**	Pasadena, CA	**10 Feb 15**
2016			
4–8 Jan	**AIAA SciTech 2016 (AIAA Science and Technology Forum and Exposition)** **Featuring:** **24th AIAA/ASME/AHS Adaptive Structures Conference** **54th AIAA Aerospace Sciences Meeting** **AIAA Atmospheric Flight Mechanics Conference** **15th Dynamics Specialists Conference** **AIAA Guidance, Navigation, and Control Conference** **AIAA Infotech@Aerospace Conference** **AIAA Modeling and Simulation Technologies Conference** **18th AIAA Non-Deterministic Approaches Conference** **57th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **9th Symposium on Space Resource Utilization** **4th AIAA Spacecraft Structures Conference** **34th ASME Wind Energy Symposium**	San Diego, CA	

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

CHECKING IN ON THE FOUNDATION

Sandy H. Magnus, Executive Director

Exciting things are happening at the AIAA Foundation! As I had mentioned in my January 2014 column, we are restructuring and retooling the Foundation to support the Institute's K–12 outreach activities and this work is proceeding rapidly. An ad hoc K–12 STEM committee is well on the way to defining a charter and organizational structure for a committee to work under the auspices of the Foundation. Its goals will be to coordinate, propose, and implement STEM programming across the organization. We have so many great K–12 outreach activities occurring throughout the AIAA family that having a central point of communication will benefit everyone. Being able to coordinate activities across the various sections and the committees allows all to benefit as we can share best practices more efficiently, learn from each other's experiences, and propagate more widely those programs that work well. Working together we can make a big impact.

We are also in the process of restructuring the Foundation Board of Trustees (BOT). In the past the Board was comprised mainly of AIAA Past Presidents. Moving forward we are asking some of our corporate partners to join the BOT to help leverage our collective efforts. I am happy to announce that John Tracy, Senior Vice President of Engineering, Operations & Technology and Chief Technology Officer, The Boeing Company, and Ray Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation, have both agreed to serve. In addition, Ray not only volunteered his time, a precious commodity when we are all so busy, but you will recall that earlier this year, we announced that Lockheed Martin has made a transformative, multi-year corporate commitment to the Foundation to help us get our work started in earnest.

On another exciting note, Aurora Flight Sciences approached us with a proposal to embark on a joint project aimed at bringing programming and aerospace concepts to high school students. The program, called SkyRobotics, is based upon a simple UAV kit that Aurora is providing, and is designed around a game or mission the students need to program the UAV to conduct. The goal is to have a final "fly-off" competition during the school year—think of First Robotics in the air. Working with some educators, the program also has an accompanying curriculum designed to provide teachers with a methodology for introducing and teaching the concepts that accompany the program. We are excited about the possibilities and have agreed to a three-year evaluation with the goal of building it slowly into a national AIAA program. The opportunity to bring aerospace concepts to 9th and 10th graders and also give them exposure to technology fits right in with the vision and mission of the Foundation!

Also in the works is an effort to bring STEM outreach programming to AIAA forums. As you know, each of our forums brings together the best and brightest from industry, government, and academia to illustrate their work and discuss all of the exciting things happening in aerospace. This breadth and depth of experiences, stories, and highlights from across the community gathered in one place should not be passed up: it is an opportunity to reach out to local students to expose them to the aerospace profession and all the cool things we do! A small group is brainstorming what possible events or structure can be put in place for a STEM experience at the forums. In 2015, we are going to pilot this at SPACE and then work to expand the program to our other AIAA forums. It is exciting to think about how many students we will be able to reach this way.

I am thrilled by all of the activity on the horizon for the AIAA Foundation and STEM outreach! We know aerospace professionals do the coolest, most fun kind of engineering there is. We also know that our industry can have a powerful pull on young people. There is no reason why we should not be out in front, among the leaders, working to excite young people about going into engineering, science, math, and technology. I hope you will support our efforts as we move to reignite the AIAA Foundation and STEM programming. The future of our industry, and the workforce we will need to carry our success forward, is depending on us.

The AIAA Liquid Propulsion Technical Committee presented the Lifetime Achievement Award to **Robert Sackheim** in July of this year. The award was presented posthumously to Mr. Sackheim's wife, Babette, and his son, Andrew. Presenting the award for the committee is Kent Pugmire (left).

Mr. Sackheim worked and lived liquid propulsion for most of his career, primarily at TRW Corporation, followed by management responsibilities at NASA Marshall Space Flight Center. Mr. Sackheim was the recipient of many prestigious, well-deserved awards. The aerospace community will miss his valuable contributions and his fellow propulsion engineers will remember him with appreciation.

AIAA FOUNDATION PRESENTS GRADUATE AND UNDERGRADUATE AWARDS

The AIAA Foundation annually awards financial aid to graduate and undergraduate students in science or engineering programs related to aerospace. Its graduate scholarship program presents awards to graduate students doing excellent research in the air and space sciences. The Foundation also offers scholarships to college sophomores, juniors, and seniors each year, and recipients can apply to renew their scholarships annually until they graduate.

Graduate Awards for the 2014–2015 Academic Year

Each year the AIAA Foundation presents *Orville and Wilbur Wright Graduate Awards*. These $5,000 awards, given in memory of the Wright brothers' contributions to the evolution of flight, are presented to students pursuing master's degrees or doctoral thesis work. The 2014–2015 winners are:

- **Fanny Besem**, Duke University, Durham, NC
- **Guiseppe Cataldo**, MIT, Cambridge, MA

The AIAA Foundation also presented its *John Leland Atwood Graduate Award* to **Sydney Do,** MIT, Cambridge, MA. The Leland Award, sponsored by endowments from Rockwell and Boeing North America, Inc., and named in memory of John Leland "Lee" Atwood, former chief executive officer of Rockwell, North American, is presented to a student actively engaged in research in the areas covered by the technical committees of AIAA.

The Guidance, Navigation, and Control (GNC) Technical Committee's *Guidance, Navigation, and Control Award* was presented to **James Paulos**, University of Pennsylvania, Philadelphia, PA. The GNC Award is presented to a student engaged in work relating to the committee's subject area.

"The AIAA Foundation congratulates the recipients of our Graduate Awards," said AIAA Foundation Chairman Mike Griffin. "We are happy to be able to provide some assistance to these worthy individuals as they continue their graduate studies. We are confident that these winners will help our community continue its unparalleled record of technical achievement for some time to come, actively shaping the future of aerospace."

Undergraduate Scholarships for the 2014–2015 Academic Year

The AIAA Foundation has awarded nine AIAA Foundation undergraduate scholarships:

- *George and Vicki Muellner Scholarship for Aerospace Engineering*, named for and endowed by former AIAA President Lt. Gen. George Muellner, U.S. Air Force (retired) and president of advanced systems for Boeing Integrated Defense Systems (retired), and his wife, was presented to **Braden Hancock**, Brigham Young University, Provo, UT.
- *David and Catherine Thompson Space Technology Scholarship*, named for and endowed by former AIAA President David Thompson, chairman, chief executive officer, and president of Orbital Sciences Corporation, Dulles, VA, and his wife Catherine, was presented to **Bryan Sonneveldt**, Arizona State University, Tempe, AZ.
- *Leatrice Gregory Pendray Scholarship*, awarded to the Foundation's top female scholarship applicant, was presented to **Abigail Spohn**, The University of Dayton, OH.

Six AIAA Foundation undergraduate scholarships were presented by AIAA Technical Committees (TC) to students performing research in the TC's area:

The *Liquid Propulsion TC* presented a scholarship:
- **Pavan Chinta**, Embry-Riddle Aeronautical University, Daytona Beach, FL

The *Space Transportation TC* presented a scholarship:
- **Christopher Nie**, University of Colorado at Boulder

The *Digital Avionics TC* presented four scholarships:

- The *Dr. James Rankin Digital Avionics Scholarship* was presented to **Ashwin Krishnan**, Georgia Institute of Technology, Atlanta, GA
- The *Dr. Amy R. Pritchett Digital Avionics Scholarship* was presented to **Nicolas Spoentgen**, Purdue University, West Lafayette, IN
- The *Ellis F. Hitt Digital Avionics Scholarship* was presented to **Jackson Morris**, University of Alabama, Tuscaloosa, AL
- The *Cary Spitzer Digital Avionics Scholarship* was presented to **Arjun Krishnan**, Georgia Institute of Technology, Atlanta, GA

"The AIAA Foundation congratulates our Undergraduate Scholarship winners," said AIAA Foundation Chairman Mike Griffin. "Today's climbing tuition prices often force students to abandon their educations, threatening our nation's future prosperity, security, and technical achievements. These scholarships will defray some of the costs of the pursuit of their education, assisting them on their path to becoming the creators of the future of aerospace."

For more information on the AIAA Foundation Scholarships and Awards Program, please contact Rachel Andino at 703.264.7577 or rachela@aiaa.org.

The AIAA Scholarships and Graduate Awards site is now open to accept applications for the 2015–2016 academic year.
The application deadline is **31 January 2015**.
For more information visit us online: **http://www.aiaa.org/Scholarships**.

AIAA SSTC ESSAY CONTEST ATTRACTS WIDER SECTION PARTICIPATION IN STEM

Since 2011, the Space Systems Technical Committee (SSTC) has run a middle school essay contest to meet the TC's commitment to directly inspire students and local sections. The members have been working with their local sections to start parallel contests to feed into selection of a national winner awarded by the SSTC. In 2012, San Francisco and Los Angeles sections both participated, and in 2013, AIAA Hampton Roads and Palm Beach sections joined for a total of four sections participating in, "How Can Humans and Robots Work Together to Explore Mars?" Northrop Grumman sponsored the 2013 awards.

In 2014, nine sections participated, of which five had official entries to the SSTC contest: Los Angeles/Las Vegas, New Orleans, Northwest Florida, Hampton Roads, and a school in the Netherlands. A 7th and 8th grade overall winner was selected to receive $100, plus $250 for their classroom toward STEM materials or activities. The *Michigan Space Grant* and *Analytical Mechanics Associates, Inc.* sponsored the awards. The 2014 topic was "Describe an Experiment You Would Like to Do on the International Space Station. What Would You Learn from it?"

The 2014 7th grade winner is 7th grader **Dentin Bottino** and his teacher, Ms. Brenda Zins, at Meigs Middle School in Shalimar, FL. Ms. Zins will use the award to purchase consumable science supplies. The 8th grade winner is **Emily Wright** and her teacher, Mrs. Julie Slocum, at North Gulfport Middle School, North Gulfport, MS. Mrs. Slocum is using the money to buy different lab activities for her classroom, such as creating simple and parallel circuits.

The SSTC essay contest has lacked a consistent corporate sponsor. If your corporation is interested in sponsoring this program annually, or for 2015, please contact the SSTC officers. The topic for 2015 is "As a Future Space Tourist, Where Would You Go, and What Would You Do?"

To read the winning essays, go to **www.aerospaceamerica.org**, and click on Bonus Content.

Emily Wright (overall 8th grade winner), Mrs. Julie Slocum (teacher), and Merlynn Hines (local 7th grade winner).

Overal 7th grade winner, Dentin Bottino (right).

LONG ISLAND SECTION PARTICIPATES IN CAREER FAIR

The AIAA Long Island Section set up a booth at the 5th Biennial Aerospace Education Corporation's Aviation and Aerospace Career Fair at Republic Airport on 1–2 October. AIAA was the only engineering professional society represented, and four Section members, Ed Deutsch, Ron McCaffrey, Dr. Tyrone Bennett, and Dave Paris manned the booth and spoke with more than 220 students. A questionnaire is given to all students, which they fill in by seeking answers at the exhibitors' booths. Questions that our section included were:

- What courses should I take in high school to prepare for a college program in aerospace engineering?
- What do aerospace engineers do?
- Can you name three things designed by aerospace engineers?

We discovered that very few students have any idea of what engineers do. Most think that engineers repair things. Many think that engineers are pilots. They seemed surprised at our answers about what engineers really do. The questionnaires in many cases, having led the students to our booths, provided a starting point for our conversations. We handed out many AIAA Careers in Aerospace booklets, and also a lot of mini-Frisbees, pencils, and gliders, all supplied by AIAA Headquarters. We were encouraged to find that a few students were already interested in studying aerospace engineering and that a few others expressed interest in careers as pilots, A&P mechanics, air traffic controllers, airport managers, astrophysicists, and astronomers. We hope that we inspired at least a few of the students who said they enjoyed math or science to pursue engineering careers.

Dr. Tyrone Bennett talking with a student.

SECTION OFFICERS 2014–2015

AIAA has 60 sections throughout the United States and overseas organized into seven AIAA Regions. Each section offers technical programs, public policy events, STEM outreach, networking opportunities and many other activities tailored to local aerospace professionals, students, and educators. The officers of each section are all volunteers who work hard to develop and execute these activities on behalf of their local colleagues. The officers for 2014–2015 are listed below.

Region I - North East

Ferdinand Grosveld	Director
Raymond Sedwick	Deputy Director, Education
Paresh Parikh	Deputy Director, Honors & Awards
Justin Likar	Deputy Director, Membership
Timothy Dominick	Deputy Director, Public Policy
Carolyn Slivinski	Deputy Director, STEM K-12
Benjamin Jimenez	Deputy Director, Student Affairs
Stephen Rizzi	Deputy Director, Technical
Vignesh Ramachandran	Deputy Director, Young Professionals

Central Pennsylvania

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Michael Micci	Audit Committee Chair
Robert Melton	Membership Officer
Jack Langelaan	Public Policy Officer
Jack Langelaan	Secretary
David Spencer	Treasurer
Joseph Horn	Vice Chair

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Timothy Wagner	Newsletter Editor
Stephen Rocketto	STEM K-12 Officer
Wesley Lord	Treasurer

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William Donaldson	Education Officer
Joshua Higginson	Honors & Awards Chair
Timothy Dominick	Public Policy Officer
Douglas Burg	Secretary
Elishabet Lato	STEM K-12 Officer
Robert Bonifant	Technical Officer
Erika Conly	Treasurer
Eric Spero	Vice Chair
Daniel Sutton	Website Editor
Daniel Nice	Young Professional Officer

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Nicholas Altobelli	Communications Officer
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Ian Bournelis	Membership Officer
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Michael Brychcy	Technical Officer
Steven Matthews	Treasurer
Ardita Kola	Vice Chair

Hampton Roads

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Mayuresh Patil	Chapter Representative
Steven Bauer	Council Member
Karen Berger	Council Member
Robert Calloway	Council Member
Laurence Leavitt	Council Member
Michael Madden	Council Member
James Pittman	Council Member
David Throckmorton	Council Member
James Van Laak	Council Member
Dan Vicroy	Council Member
Richard Wahls	Council Member
William Tomek	Council Member; Technical Officer
Jacob Bean	Technical Officer
Karen Berger	Education Officer
Shann Rufer	Education Officer
Colin Britcher	History Officer
Eugene White	Honors & Awards Chair
Marlyn Andino	Membership Officer
Sally Viken	Programs Officer
Melissa Carter	Public Policy Officer
Eric Walker	RAC Representative
Jeffrey Flamm	Scholarship Officer
Gregory Buck	Secretary
Karen Berger	STEM K-12 Officer
Shann Rufer	STEM K-12 Officer
Patrick Clark	Student Liaison
Justin Green	Student Liaison
J. Philip Drummond	Technical Officer
Alaa Elmiligui	Treasurer
Dale Arney	University Liaison Officer
Colin Britcher	University Liaison Officer
Christopher Rumsey	Website Editor
John Wells	Young Professional Officer
Kenneth B. Walkley	Corporate Liaison
Rebecca Stavely	Young Professional Officer
Steven Dunn	Public Policy Officer
John Lin	Newsletter Editor

Long Island

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Nicholas DiZinno	Council Member
Joseph Fragola	Council Member
Muhammad Hayan	Council Member
Frank Hayes	Council Member
Jason Herman	Council Member
Peter Kontogiannis	Council Member
John Leylegian	Council Member
Emil Schoonejans	Council Member
Jason Tyll	Council Member
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David Paris	Newsletter Editor
John Leylegian	Newsletter Publisher
Joseph Fragola	Programs Officer
Frank Hayes	Public Policy Officer
Wilfred Mackey	RAC Representative
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Wilfred Mackey	Treasurer
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Ronald McCandless	Public Policy Officer
Scott Fry	Secretary
Brendan McAndrew	Secretary
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Vignesh Ramachandran	Vice Chair
Tom Milnes	Website Editor
Robin Vaughan	Website Editor
Scott Fry	Young Professional Officer

National Capital

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Norman Wereley	Honors & Awards Chair
Reginald Smith	Embassy Event Liaison
Stephanie Bednarek	Public Policy Officer
M. Bruce Milam	RAC Representative
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Tucker Hamilton	STEM K-12 Officer
Chandrakanth Venigalla	Student Liaison
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David Brandt	Vice-Chair, Programs
Bruce Cranford	Website Editor
Christopher Kilzer	Website Editor
Michele McMurrer	Website Editor
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Katherine Stambaugh	Young Professional Officer

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Jon Morse	Public Policy Officer
John Blandino	Secretary
Xinyun Guo	Treasurer
David Padgett	Vice Chair

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Wendy Zhao	Student Liaison
Andrew Garrell	Treasurer
John Crassidis	Vice Chair

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Howard Brilliant	Membership Officer
Todd Wetzel	Treasurer
Xiaoqing Zheng	Website Editor

Northern New Jersey

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Abe Bernstein	Programs Officer
Fred Swern	Treasurer

Southern New Jersey

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Catherine Jaggard	Education Officer
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Richar Russell	Deputy Director, Finance
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John Fay	Deputy Director, STEM K-12
Thomas Mensah	Deputy Director, Technical
Tracie Prater	Deputy Director, Young Professionals

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Neil Hall	Treasurer
Robert Justice	Section Officer Specialized
Corey Spiegel	Section Officer Specialized

Cape Canaveral

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Bruce Vu	Education Officer
Anthony Mansk	Membership Officer
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Luke Roberson	RAC Representative
Hunt Culver	Secretary
Peter Warren	STEM K-12 Officer
Amanda Gillespie	Technical Officer
William Macdonald	Treasurer
David Fleming	Vice Chair
Taylor Dacko	Young Professional Officer

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Theodoros Spanos	Education Officer
Madeline Augustin	Membership Officer
John Paul Shebalin	North Carolina Liaison
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Jonathan Maddux	Treasurer
Nhatanh Ha	Website Editor

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Yunjun Xu	Education Officer
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Christopher Parks	Student Liaison
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Seetha Raghavan	University Liaison Officer
Yunjun Xu	University Liaison Officer
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Isadora Prata Thisted	Career and Workforce Development Officer
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Adam Hart	Newsletter Editor
Abass Jamal Eddine	Officer Specialized
Christopher Kabureck	Officer Specialized
Donald Kaderbek	Officer Specialized
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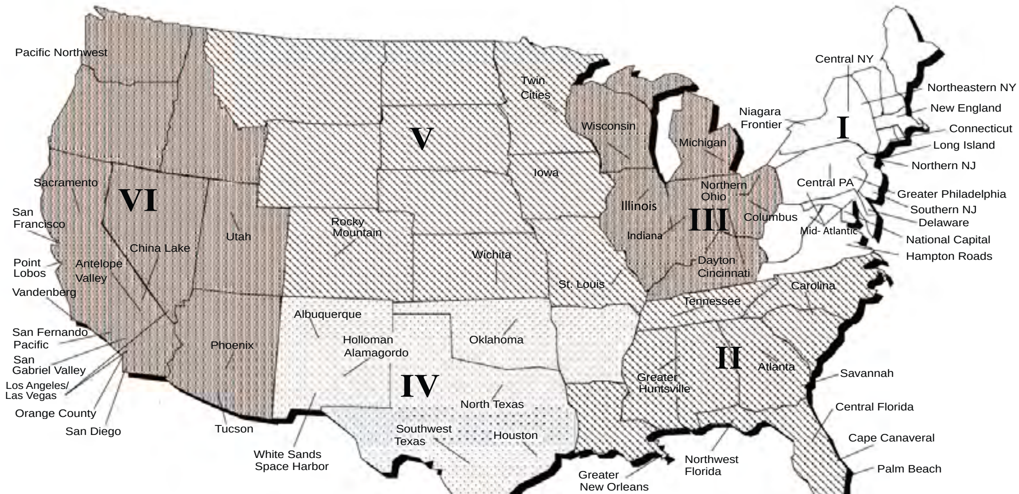

AIAA Regions I–VI. Region VII territory is everything outside the U.S.

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Namrata Dhingreja	Scholarship Officer
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Jason Riopelle	STEM K-12 Officer
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Jonathan Hughes	Young Professional Officer
Ryan Vas	Young Professional Officer

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Sivaram Gogineni	Deputy Director, Honors & Awards
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John Sordyl	Deputy Director, Public Policy
Jamey Condevaux	Deputy Director, STEM K-12
Robert Bruckner	Deputy Director, Technical
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Leo Burkardt	Officer Specialized
Cynthia Obringer	Officer Specialized
Richard Wills	Officer Specialized
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Carl Tilmann	STEM K-12 Officer
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Edgar Bering	Deputy Director, STEM K-12
Sarah Shull	Deputy Director, Technical
P. Cox	Deputy Director, Finance
Thomas Moore	Deputy Director, Public Policy

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Robert Malseed	Treasurer
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Millay Morgan	Vice Chair
Ryan Weisman	Young Professional Officer

Holloman/Alamogordo

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Samuel Schauer	Treasurer
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Victoria Wills	Young Professional Officer

Houston

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Edward Kenny	History Officer
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Eetion Narcisse	Membership Officer
Douglas Yazell	Newsletter Editor
Irene Chan	Officer Specialized
Robert Plunkett	Officer Specialized
Sarah Shull	Officer Specialized
Wayne Rast	Public Policy Officer
Rafael Munoz	Scholarship Officer
Zach Tejral	Secretary
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Charles Stangle	Vice Chair and Vice Chair, Technical

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Andrew Arena	Secretary
Frank Chambers	Treasurer
Richard Gaeta	Vice Chair

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James Crean	Public Policy Officer
Thomas Moore	Secretary
George Hindman	Technical Officer
Pablo Bueno	Treasurer
Aubrey Mason	Vice Chair
Elliott Bryner	Website Editor

White Sands Space Harbor

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Robert Cort	Honors & Awards Chair
Stephen McDougle	Treasurer
Joseph San Filippo	Vice Chair
Stephen McDougle	Website Editor

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Barrett McCann	Deputy Director, Education
Larry Frutiger	Deputy Director, Finance
Andrew Carlson	Deputy Director, Honors & Awards
Brandon Wegge	Deputy Director, Honors & Awards
Gary White	Deputy Director, Membership
Chris Tavares	Deputy Director, STEM K-12
David Barnhart	Deputy Director, STEM K-12
James Casler	Deputy Director, Technical
Matthew Cannella	Deputy Director, Young Professionals

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Travis Sippel	Programs Officer
Sridher Kaminani	Secretary
Michael Gries	Treasurer
Nithin Kolencherry	Vice Chair

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Pamela Burke	Council Member
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Orval Powell	Honors & Awards Chair
John Reed	Membership Officer
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Anuradha Bahl	Programs Officer
Lisa Holowinski	Programs Officer
Heather McKay	Programs Officer
Arthur Hingerty	Public Policy Officer
Jason Kuchera	Public Policy Officer
Susan Janssen	Secretary
Brendan Coyne	STEM K-12 Officer
Nicholas Zinner	STEM K-12 Officer
Farzad Taghaddosi	Technical Officer
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Donna Gerren	Vice Chair
Taylor Lilly	Vice Chair
Michael Stoellinger	Vice Chair - Wyoming
John Grace	Website Editor
Brian Gulliver	Website Editor
Taylor Lilly	Website Editor
John Niehues	Young Professional Officer

St. Louis

William Alban	Chair
Karen Copper	Communications Officer
Brandon Wegge	Education Officer
Trent Duff	History Officer
Darin Haudrich	Membership Officer

AIAA 2014–2015 Section Officers, continued

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Lawrence Brase	Officer Specialized
Trent Duff	Officer Specialized
John Mohr	Officer Specialized
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Bradley Sexton	Programs Officer
Karen Copper	Publicity Officer
Frank Youkhana	RAC Representative
Darin Haudrich	Secretary
Jeffrey Geear	Technical Officer
Chris Tavares	Treasurer
John Donigan	Website Editor
Joseph Henits	Young Professional Officer

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Christopher Sanden	Membership Officer
James Casler	Officer Specialized
Anand Vyas	Officer Specialized
Weston Kirch	Programs Officer
Akshit Reddy Bussanagari	Secretary
Joshua Kohn	STEM K-12 Officer
Frank Hoffmann	Treasurer
Christopher Sanden	Vice Chair
Andrew Carlson	Website Editor

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Z Charlie Zheng	Education Officer
Jacob Lynn	Membership Officer
Dustin Tireman	Membership Officer
Vicki Johnson	Newsletter Editor
Jacob Lynn	Programs Officer
Robert Stuever	Public Policy Officer
Jacob Lynn	Secretary
Thomas Atambo	STEM K-12 Officer
Jonathan Latall	Treasurer
Vicki Johnson	Website Editor

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Ranney Adams	Deputy Director, Honors & Awards
Matthew Angiulo	Deputy Director, Membership
John Rose	Deputy Director, Public Policy
Shelly Corbets	Deputy Director, STEM K-12
Jeffrey Laube	Deputy Director, Technical
Jeffrey Jepson	Deputy Director, Young Professionals

Antelope Valley

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Brendan McCracken	Education Officer
Jason Lechniak	Education Officer
Michael Bociaga	Programs Officer
Nichole Moore	Programs Officer
Jacob Downey	Public Policy Officer
Sarah Arnac	Secretary
Clifton Davies	Treasurer
Erik Larson	Vice Chair

China Lake

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Steven Goad	Public Policy Officer
Steven Goad	RAC Representative
Edward Jeter	Secretary
William Sturgeon	Treasurer
Jeffrey Scott	Vice Chair
Edward Jeter	Website Editor
Jeffrey Scott	Website Editor
Randall Drobny	Young Professional Officer

Los Angeles-Las Vegas

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Veena Peddu	Chapter Officer
Sofia Russi	Chapter Officer
Dennis Wonica	Chapter Officer
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Jeffery Puschell	Council Member
Brian Franz	Education Officer
Robert Friend	Honors & Awards Chair
Jeff Guild	Honors & Awards Chair
Seymour Ferdman	Membership Officer
Rick Garcia	Membership Officer
Richard Van Allen	Reinventing Space Conference
Greg Larson	Programs Officer
Christianna Taylor	Programs Officer
Charles Kilmer	Public Policy Officer
Jeffery Puschell	Public Policy Officer
Michael Todaro	Public Policy Officer
Manasa Tavarageri	Secretary
Dan Mikkelsen	STEM K-12 Officer
David Fyda	Student Liaison
Gary Moir	Technical Officer
Marsha Weiskopf	Treasurer
Jeffery Puschell	Vice Chair
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Ian Kunze	Young Professional Officer
Manasa Tavarageri	Young Professional Officer
Norris Tie	Young Professional Officer

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Joseph Justin	Chairman Emeritus
Janet Koepke	Council Member
John Rose	Council Member
Omid Gohardani	Director-At-Large
Robert Koepke	Director-At-Large
Janet Koepke	Education Officer
H. Welge	Membership Officer
James Martin	Programs Officer
Kamal Shweyk	Public Policy Officer
H. Welge	RAC Representative
Ronald Freeman	Secretary
John Rose	Technical Officer
Philip Ridout	Treasurer
Jonathan Hart	Website Editor
Philip Schulze	Young Professional Officer

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Tamaira Ross	Council Member
Betty Smith	Council Member
William VanValkenberg	Council Member
Erika Wagner	Council Member
Ryan Crompton	Education Officer
Emmanuel Domingo	Honors & Awards Chair
Paul Vijgen	Honors & Awards Chair
Karl Rein-Weston	Liaison
Christopher Roberdeau	Liaison
Stanley Ferguson	Membership Officer
Priscilla Martinez	Newsletter Editor
Inanc Senocak	Idaho State Representative
Roberto Albertani	Oregon State Representative
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Patrick Remy	Technical Symposium Chair
Ryan Crompton	Treasurer
Ryan Crompton	University Liaison Officer
Elana Slagle	Vice Chair
Patrick Remy	Website Editor
Hanna Calvert	Young Professional Officer
Alex Kreul	Young Professional Officer

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Rob Trepa	Chairman Emeritus
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Joshua Loughman	Council Member; Public Policy Officer
Garrick Williams	Council Member
Richard Kale	RAC Representative; Secretary
Michael Mackowski	STEM K-12 Officer
Mathew Allyn	Student Liaison
Breana Merriweather	Treasurer
George Somi	Vice Chair
Michael Mackowski	Website Editor
Joshua Loughman	Young Professional Officer

Point Lobos

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Andy Newton	STEM K-12 Officer
Daniel Bursch	Treasurer
Lara Magallanes	Vice Chair
Jae-Jun Kim	Website Editor

Sacramento

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Kevin Noonan	Newsletter Editor
Brian Pomeroy	Vice Chair; Programs Officer
Susana Munoz	Treasurer
Ryan Sebastian	Website Editor
Nathaniel Blaesser	Young Professional Officer
Andre White	Young Professional Officer

San Diego

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Sean Davis	Education Officer
Cesar Martin	History Officer
Keith Glassman	Honors & Awards Chair
Jennifer Rhymer	Membership Officer
Tatiana Roy	Membership Officer
Jennifer Rhymer	Public Policy Officer
Jennifer Rhymer	RAC Representative
Greg Marien	Scholarship Officer
Martin Miller	Secretary
Philip Smith	STEM K-12 Officer
Ramon Guerra	Student Liaison
Steven Jacobson	Student Liaison
Joel Perez	Treasurer
Mark Anderson	University Liaison Officer
Nagy Nosseir	University Liaison Officer
Katherine Kucharski	Vice-Chair, Long-range Planning
Jonathan Blackler	Vice-chair, Programs
Steven Jacobson	Website Editor
Ioana Broome	Young Professional Officer

San Fernando Pacific

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Robert Tarn	Secretary
Christine Hansen	Hawaii State Representative
Carl Ehrlich	Technical Officer; Treasurer
Corinne Cho	Website Editor

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Steven Cerri	Career and Workforce Development Officer
Hubert Wong	Education Officer
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Lauren Marie Taylor	Other
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AIAA FOUNDATION ANNOUNCES WINNERS OF ITS 2013–2014 AIRCRAFT DESIGN COMPETITIONS

The AIAA Foundation is pleased to announce the winners of its Aircraft Design Competitions in the Individual Undergraduate, Individual Team, and Graduate Team categories. The ***Individual Undergraduate*** entrants were required to submit a design for an advanced pilot training aircraft. The winners are:

- First prize: **Sebastiaan van Schie**, Delft Technical University, Delft, The Netherlands, for his design "Delft Advanced Transonic Trainer." Roelof Vos, faculty advisor. van Schie will receive an award of $1,000 from the AIAA Foundation.
- Second prize: **Alejandra Stefania Escalera Mendoza**, University of Kansas, Lawrence, KS, for her design "SPICA NOX JET." Ron Barrett, faculty advisor. Escalera Mendoza will receive an award of $500 from the AIAA Foundation.
- Third prize: **Eleazar Lachino**, University of Kansas, Lawrence, KS, for his design "Pegasus Jet Trainer." Ron Barrett, faculty advisor. Lachino will receive an award of $300 from the AIAA Foundation.

The competition "gives the students an excellent chance to put their education and skills to the test," said Danielle Soban, lecturer in aerospace engineering, Queen's University, Belfast, Northern Ireland, the competition's head judge. "They ... gain experience in critical skills such as teamwork, time management, requirements allocation, and technical writing. Working in a competitive environment tends to motivate them to do their best work. One of the benefits of doing well in the competition is the opportunity to present their work at an international aerospace conference." Soban concluded: "The ability to present their work gives them experience in technical presentations, allows them to receive critical feedback, and provides them an occasion to begin their professional networking. The quality of the submissions continues to improve each year, and the entries are always truly excellent."

The ***Undergraduate Team*** entrants were required to design an advanced, turbo-prop powered passenger aircraft. The winners are:

- First place: **"Team University of Kansas,"** Lawrence, KS, for their design "Jayhawk Economic Turboprop Transport (J.E.T.T)." Team members: Brandon Basgall, Katie Constant, Alejandra Escalera, Eleazar Lachino, Adrian Lee and Emily Thompson. Ron Barrett, faculty adviser.
- Second place: **"Team Efficient Regional Aircraft,"** California Polytechnic State University, San Luis Obispo, CA, for their design "The Aeolus." Team members: May Chauvin, Michael Duffield, Michael Labdon, Cameron Law, Juan Lazarin, Kyle Rom and Connor Sousa. Nicholas Brake and Bruce Wright, faculty advisers.
- Third place (tie): **"Team University of Kansas,"** Lawrence, KS, for their design "Dragonfly." Team members: Ryan Evans, Luiz Toledo, Nathan Smith, Ryan Su and Yinglong Xu. Ron Barrett, faculty adviser.
- Third Place (tie): **"Team Eta Aviation,"** California Polytechnic State University, San Luis Obispo, CA, for their design "Aria." Team members: Victor Hernandez, William Hilgenberg, Doug Howe, David Kuratomi, Tyler Swope and Robert Weinberg. Nicholas Brake and Bruce Wright, faculty advisers.

The competition exposes students "to the challenges inherent in aircraft design," said Hernando Jimenez, a member of the research faculty at the Georgia Institute of Technology, Atlanta, Georgia, and chair of AIAA's Aircraft Design Technical Committee. "... Students also sharpen many non-technical skills like teamwork, decision making and negotiation of design solutions, effective written and oral communication, and time management among others. I believe this is an important contribution to the formation of well-rounded and highly capable professionals that will help shape and lead the aerospace domain in the future."

The ***Graduate Team*** entrants were required to design a supersonic multi-utility technology test bed. The winners are:

- First prize: **Delft University of Technology**, Delft, The Netherlands, for their design "SMART: SupersonicMulti-utility Aeroelastic Reconfigurable Test-bed." Team members: Malcom Brown, Koen van de Kerkhof, Raphael Klein, Martijn Roelofs, Niels Singh and Daan Westerveld. Ron Barrett and Roelof Vos, faculty advisors. The team will receive an award of $500 from the AIAA Foundation.
- Second prize: **University of Kansas**, Lawrence, KS, for their design "Delta Spike." Team members: Richard Bramlette, Katie Constant, Adam D'Silva, Julian McCafferty and James Sellers. Ron Barrett, faculty advisor. The team will receive an award of $250 from the AIAA Foundation.
- Third prize: **"Team Petrodyne Aerospace," The Georgia Institute of Technology**, Atlanta, GA, for their design "Modular Aircraft for Supersonic Technology Research (MASTER)." Team members: Giada Abate, Mathilde Deveraux, Brett Hiller, Emmanuel Lacouture, Tejas Puranik and Christopher Sandwich. Dimitri Mavris, faculty advisor and Daniel Cooksey, project advisor. The team will receive an award of $125 from the AIAA Foundation.

Mike Griffin, AIAA Foundation chairman, said that the "designs demonstrate the creativity, ingenuity and commitment to excellence that are a hallmark of our community. We are confident that the experiences each of you have had in this competition, with its emphasis on teamwork, collaboration, and hard work have well prepared you to make important contributions to the future aerospace workforce. I look forward to see how each of you shapes the future of aerospace."

For information on the AIAA Foundation Aircraft Design Competitions, go to **www.aiaa.org/DesignCompetitions** or contact Rachel Andino at 703.264.7577 or rachela@aiaa.org.

OSU AIAA GEARS UP FOR A NEW YEAR!

Oregon State University's (OSU) AIAA Student Branch kicked off the start of its third year as a club on 23 August. The event attendees included OSU Seniors looking to be a part of an OSU AIAA design team to fulfill their graduation Capstone Requirements. Participation by capstone students has been crucial for the success of these teams in the past. The teams include a team for AIAA's Design/Build/Fly (DBF) competition and the Experimental Sounding Rocket Association's (ESRA) Intercollegiate Rocketry Engineering Competition (IREC). This will be OSU's third participation in the AIAA DBF competition and second in IREC.

Presentations on the year's proposed design process were followed by a tour through the Evergreen Air and Space museum in McMinville, OR—home of the Spruce Goose (http://evergreenmuseum.org). Students from both teams participated in build days on 6 September. The AIAA DBF competition team discussed the rules for the upcoming AIAA DBF competition and made gliders. The ESRA competition team began level 1 and 2 high power rocketry builds for their TRA certifications.

Members of the AIAA-DBF competition team will start flying trainer planes and members of the ESRA team will be attending the OROC public launch at Sheridan, OR on 27 September to launch their certifying flights.

2014 BEST PAPERS

During 2014, the following papers were recognized as a "Best Paper." Authors were presented with a certificate of merit at a technical conference. Congratulations to each author for achieving technical and scientific excellence!

AIAA Aeroacoustics Best Student Paper
"Flow Dynamics and Aeroacoustics of Heated Coaxial Jets at Subsonic Mach Numbers," AIAA 2014-2759, Michael Gloor, Stefan Buehler, and Leonhard Kleiser, Swiss Federal Institute of Technology.

AIAA Aerodynamic Measurement Testing Best Paper
"Dual-Pump CARS Of Air In A Heated Pressure Vessel Up To 55 Bar and 1300 K," AIAA 2014-1098, Luca Cantu, Emanuela Gallo, and Andrew Cutler, George Washington University; and Paul Danehy, NASA Langley Research Center.

AIAA Aerospace Power Systems Best Paper
"Performance Measurement of Advanced Stirling Convertors (ASC-E3)," AIAA 2013-3813, Salvatore Oriti, NASA Glenn Research Center.

AIAA Aerospace Power Systems Best Student Paper
"A Review of Models for Appendix Gap Losses in Stirling Cycle Machines," AIAA 2013-3613, Jens Pfeiffer and Hans-Detlev Kuehl, Technische Universität Dortmund.

AIAA Air Breathing Propulsion Systems Integration Best Paper
"Optimal Inlet Shape Design of N2B Hybrid Wing Body Configuration," AIAA 2013-3917, Hyoung Jin Kim, SAIC and Meng-Sing Liou, NASA Glenn Research Center.

AIAA Applied Aerodynamics Best Paper
"Over Wing Nacelle Installations for Improved Energy Efficiency," AIAA 2013-2920, John Hooker and Andrew Wick, Lockheed Martin Aeronautics Company; Cale Zeune, Air Force Research Laboratory, Wright-Patterson AFB; and Anthony Agelastos, Sandia National Laboratories.

AIAA Atmospheric Flight Mechanics Best Papers
"Virtual Deformation Control of the X-56A Model with Simulated Fiber Optic Sensors," AIAA Paper 2013-4844, Peter Suh and Dimitri Mavris, George Institute of Technology; and Alexander Chin, NASA Dryden Flight Research Center.

"Flight Testing of a Subscale Aeroservoelastic Aircraft," AIAA Paper 2014-0032, Jeffrey Ouellette, Mayuresh Patil, and Craig Woolsey, Virginia Polytechnic Institute and State University.

AIAA Atmospheric Flight Mechanics Best Student Paper
"Extension of the Allen-Eggers Analytic Solution for Ballistic Entry Trajectories with Application to Drag-Modulation Trajectory Control," AIAA 2014-2381, Zachary R. Putnam and Robert D. Braun, Georgia Institute of Technology.

AIAA/AAS Astrodynamics Specialist Best Paper
"Enhanced Visualization and Autonomous Extraction Of Poincare Map Topology," AAS 13-903, Wayne R. Schlei, Kathleen C. Howell, and Xavier M. Tricoche, Purdue University; and Christoph Garth, University of Kaiserslautern.

AIAA Computational Fluid Dynamics Best Student Paper
"Multidimensional Active Flux Schemes," AIAA 2013-2940, Timothy Eymann, CREATE-AV/Kestrel and Phillip Roe, University of Michigan.

AIAA David Weaver Best Student Paper
"Adjoint-Based Aerothermodynamic Shape Design of Hypersonic Vehicles in Non-Equilibrium Flows," AIAA 2014-0513, Sean R. Copeland, Francisco Palacios, and Juan J. Alonso, Stanford University.

AIAA Electric Propulsion Best Paper
"Conducting Wall Hall Thrusters," AIAA 2013-4117, Daniel Goebel, Richard Hofer, Ioannis Mikellides, Ira Katz, James Polk, and Brandon Dotson, NASA Jet Propulsion Laboratory.

AIAA Fluid Dynamics Best Paper
"Direct Numerical Simulation Of The Aeroelastic Response Of A Panel Under High Speed Turbulent Boundary Layers," AIAA 2013-3200, Christopher Ostoich, Daniel Bodony, and Philippe Geubelle, University of Illinois at Urbana-Champaign.

AIAA Gossamer Systems Best Paper
"Deployable Helical Antennas for CubeSats," AIAA 2013-1671, Gina Olson, Sergio Pellegrino, and Joseph Costantine, California Institute of Technology; and Jeremy Banik, Air Force Research Laboratory, Kirtland AFB.

AIAA Ground Testing Best Paper
"Deployment of Particle Image Velocimetry into the Lockheed Martin High Speed Wind Tunnel," AIAA 2014-1238, Steven Beresh, Justin Wagner, Brian Pruett, and Russell Spillers, Sandia National Laboratories; Michael McWithey and Jeffrey Gary, Lockheed Martin Missiles and Fire Control; and Kurt Chankaya, Lockheed Martin Space Systems.

AIAA Guidance, Navigation and Control Best Paper
"Experimental Validation of Pulse Phase Tracking for X-ray Pulsar Based Spacecraft Navigation," AIAA 2013-5202, Kevin D. Anderson and Darryll Pines, University of Maryland.

AIAA Guidance, Navigation and Control Best Student Paper
"Derivation and Comparison between Numerical Based and Novel Analytical Compromise Solutions to the Multi-Objective Control Allocation Problem," AIAA 2014-0780, Francis R. Salama and Ali Savvaris, Cranfield University.

AIAA High Speed Air Breathing Propulsion Best Paper
"Unsteady Three-Dimensional Phenomena in Mode-Transition Simulations of the HIFiRE-2 Scramjet Flowpath," AIAA 2013-3753, Robert Yentsch and Datta Gaitonde, Ohio State University.

AIAA Hybrid Rockets Best Paper
"Development and Flight Testing of a Hybrid Rocket Booster for UAV Assisted Take Off," AIAA 2013-4140, Alberto Bettella, Federico Moretto, Enrico Geremia, Nicolas Bellomo, Daniele Pavarin, and Dino Petronio, University of Padua.

AIAA Hybrid Rockets Best Student Paper
"Mass Flow Rate and Isolation Characteristics of Injectors for Use with Self-Pressurizing Oxidizers in Hybrid Rockets," AIAA 2013-3636, Benjamin S. Waxman, Brian J. Cantwell and Jonah E. Zimmerman, Stanford University; and Greg Zilliac, NASA Ames Research Center.

AIAA Hypersonic Systems and Technologies Best Paper
"Design of an Airframe Integrated 3-D Scramjet and Experimental Results at a Mach 10 Flight Condition," AIAA 2012-5910, Luke J. Doherty, Michael K. Smart, and David J. Mee, The University of Queensland.

AIAA Liquid Propulsion Best Paper
"Passive Phase Separation in Cryogenic Upper Stage Tanks," AIAA 2013-3905, Philipp Behruzi, Jorg Klatte, and Gaston Netter, Astrium Space Transportation.

AIAA Modeling and Simulation Best Papers
"Modeling Wake Vortex Roll-Up and Vortex-Induced Forces

and Moments for Tight Formation Flight," AIAA 2013-5076, André Kaden and Robert Luckner, Technical University of Berlin.

"Propeller Slipstream Model for Small Unmanned Aerial Vehicles," AIAA 2013-4907, Waqas Khan, Ryan Caverly, and Meyer Nahon, McGill University.

AIAA Multidisciplinary Design Optimization Best Paper
"Multi-Point, Multi-Mission, High-Fidelity Aerostructural Optimization Of A Long-Range Aircraft Configuration," AIAA 2012-5706, Rhea Liem, University of Toronto; and Gaetan Kenway and Joaquim Martins, University of Michigan-Ann Arbor.

AIAA Multidisciplinary Design Optimization Best Student Paper
"Decoupled UMDO Formulation For Interdisciplinary Coupling Satisfaction Under Uncertainty," AIAA 2014-3014, Loïc Brevault, Mathieu Balesdent, and Nicolas Berend, ONERA; and Rodolphe Le Riche, National Center for Scientific Research (CNRS).

AIAA Nuclear and Future Flight Propulsion Best Paper
"A One-year Round Trip Crewed Mission to Mars using Bimodal Nuclear Thermal and Electric Propulsion (BNTEP)," AIAA 2013-4076, Laura Burke and Stanley Borowski, NASA Glenn Research Center; and David McCurdy and Thomas Packard, Vantage Partners LLC.

AIAA Plasmadynamics and Lasers Best Paper
"Experimental And Numerical Study Of Fast Gas Heating And O Atom Production In A Capillary Nanosecond Discharge," AIAA 2014-1030, Andrei Klochko, Arthur Salmon, Joseph Lemainque, Jean-Paul Booth, and Svetlana Starikovskaya, Ecole Polytechnique; Nikolay Popov, Moscow State University; and Mark Kushner and Zhongmin Ziong, University of Michigan.

AIAA Plasmadynamics and Lasers Best Student Paper
"Simulation of Reacting Flows in Magnetic Fields with Preconditioning," AIAA 2013-2754, Amrita Lonkar, Francisco Palacios, and Juan J. Alonso, Stanford University.

AIAA Propellants and Combustion Best Paper
"Thermo-Acoustic Coupling in Swirl-Stabilized Flames with Helical Vortices," AIAA 2013-3650, Vincent Caux-Brisebois and Adam Steinberg, University of Toronto; and Christoph Arndt and Wolfgang Meier, DLR.

AIAA Shahyar Pirzadeh Memorial Award for Outstanding Paper in Meshing Visualization & Computational Environments
"Visualization and Analysis of Vortex Features in Helicopter Rotor Wakes," AIAA 2013-1162, David Kao, Jasim Ahmad, Terry Holst, and Brian Allan, NASA Langley Research Center.

AIAA Solid Rockets Best Paper
"Electric Solid Propellants: A Safe, Micro to Macro Propulsion Technology," AIAA 2013-4168, Wayne Sawka and Michael McPherson, Digital Solid State Propulsion.

American Society for Composites Student Paper in Composites Award
"Adaptive Multistable Flexible Composite Surfaces," AIAA 2014-0671, Yuefeng Cui and Matthew J. Santer, Imperial College.

ASME/Boeing Best Paper
"Dynamic Aeroservoelastic Response with Nonlinear Structural Elements," AIAA 2013-1702, Mordechay Karpel, Technion-Israel Institute of Technology, Alexander Shousterman, Israeli Computational Fluid Dynamics Center; and Carlos Maderuelo and Hector Climent, Airbus Military.

ASME Propulsion Best Paper
"Model-Based Control of a Nonlinear Aircraft Engine Simulation using an Optimal Tuner Kalman Filter Approach," AIAA Paper 2013-4002, Joseph W. Connolly and Jeffrey T. Csank, NASA Glenn Research Center; Amy Chicatelli, Vantage Partners LLC; and Jacob Kilver, Ohio State University.

Collier Research HyperSizer/AIAA Structures Best Paper
"Structural Assessment of Advanced Composite Tow-Steered Shells," AIAA 2013-1769, K. Chauncey Wu, Bret Stanford, Glenn Hrinda, Zhuosong Wang, and Robert A. Martin, NASA Langley Research Center; and H. Alicia Kim, University of Bath.

Jefferson Goblet Student Paper
"Substructuring with Nonlinear Reduced Order Models and Interface Reduction with Characteristic Constraint Modes," AIAA 2014-1518, Robert J. Kuether and Matthew S. Allen, University of Wisconsin, Madison.

Lockheed Martin Student Paper in Structures
"Analysis of Space Structures Subjected to Hypervelocity Impact," AIAA 2014-0156, Andrew Thurber and Javid Bayandor, Virginia Polytechnic Institute and State University.

Harry H. and Lois G. Hilton Student Paper in Structures
"Local Buckling of Blade Stiffened Variable Angle Tow Panels," AIAA 2014-0167, Broderick H. Coburn, Zhangming Wu, and Paul Weaver, University of Bristol.

OBITUARY

AIAA Associate Fellow Garcia Died in September

Ephrahim Garcia, professor in the Department of Mechanical and Aerospace Engineering at Cornell University, died on 10 September. He was 51 years old.

Dr. Garcia received his B.S. in 1985, Master's in 1988, and his Ph.D. in 1990, all from the State University of New York at Buffalo. He specialized in electro-mechanical engineering based on smart materials.

During the 1990s, Dr. Garcia was an assistant professor at Vanderbilt University and owned and operated the technology company now known as Dynamic Structures and Materials. He was named a National Science Foundation Presidential Faculty Fellow in 1993 by President Bill Clinton.

He also worked at DARPA as a program manager, where he kicked off the CHAPS program, infusing funding into the community and pushing technology forward. He turned his attention to the smart wing program and created MAS (Morphing Aircraft Structures), resulting in a great deal of excitement, the creation of a new company and a host of fantastic research results.

After becoming a professor at Cornell, Dr. Garcia also became editor of the *Smart Materials and Structures* journal, where he re-structured the review process, breathed new life into it. He was the author of many papers, and among the awards that he received were the AIAA Abe M. Zarem Advisor Award in Aeronautics, 2010 & 2011; Merrill Presidential Scholar Advisor Recognition, 2010; and Dennis G. Sheppard Teaching Award (Sibley School of Mechanical and Aerospace Engineering), 2006. Dr. Garcia served as AIAA Deputy Director of Education for Region I from 2012–2013.

Cornell University College of Engineering Dean Lance Collins wrote, "[Garcia] advised three project teams, had many undergrads and mechanical engineering students in his lab, taught a popular Mechatronics class and had many Ph.D. students in his lab. ... He will be sorely missed."

CALL FOR 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 highly urged to carefully read award guidelines to view nominee eligibility, page limits, letters of endorsement, etc.

AIAA members may submit nominations online after logging into **www.aiaa.org** with their user name and password. You will be guided step-by-step through the nomination entry. If preferred, a nominator may submit a nomination by completing the AIAA nomination form, which can be downloaded from www.aiaa.org.

Aerospace Power Systems Award
This 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
This 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.

Daniel Guggenheim Medal
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 Award
This award 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
This 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. The award is presented for a timely outstanding contribution to the field of space transportation. (Presented even years)

Haley Space Flight Award
This award recognizes outstanding contributions by an astronaut or flight test personnel to the advancement of the art, science, or technology of astronautics. It honors Andrew G. Haley, who has been described as the world's first practitioner of space law and an expert on rocket propulsion. (Presented even years)

J. Leland Atwood Award
Established in 1985, this annual award is given to an aerospace engineering educator to recognize outstanding contributions to the profession. AIAA and ASEE sponsor the award. Note: Nominations should be submitted to ASEE (**www.asee.org**) no later than **15 January**.

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

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

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

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

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

Space Operations and Support Award
This 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
This 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
This award recognizes outstanding achievements in the architecture, analysis, design, and implementation of space systems.

von Braun Award for Excellence in Space Program Management
This award gives recognition to an individual(s) for outstanding contributions in the management of a significant space or space-related program or project.

William Littlewood Memorial Lecture
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.

Nominations should be submitted by **1 February** to SAE at **http://www.sae.org/news/awards/list/littlewood/**.

Wright Brothers Lectureship in Aeronautics
The Wright Brothers Lectureship in Aeronautics commemorates the first powered flights made by Orville and Wilbur Wright at Kitty Hawk in 1903. The lectureship emphasizes significant advances in aeronautics by recognizing major leaders and contributors. (Presented odd years)

Wyld Propulsion Award
This 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.

Upcoming AIAA Continuing Education Courses

**AIAA now offers live and on-demand Continuing Education webinars.
Viewers can enjoy excellent tutorials at home or in the office.
For more information please visit www.aiaa.org/webinars.**

Workshop and Courses at AIAA Science and Technology Forum and Exposition 2015 (AIAA SciTech 2015)
www.aiaa-scitech.org/ContinuingEd

3–4 January 2015

Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-On Training Using CIFER®

Instructor: Dr. Mark B. Tischler

The objectives of this two-day short course is to 1) review the fundamental methods of aircraft and rotorcraft system identification and illustrate the benefits of their broad application throughout the flight vehicle development process; and 2) provide the attendees with an intensive hands-on training of the CIFER® system identification, using flight test data and 10 extensive lab exercises. Students work on comprehensive laboratory assignments using student version of software provided to course participants (requires student to bring NT laptop). The many examples from recent aircraft programs illustrate the effectiveness of this technology for rapidly solving difficult integration problems. The course will review key methods and computational tools, but will not be overly mathematical in content. The course is highly recommended for graduate students, practicing engineers, and managers.

Key Topics

- Overview of system identification methods and applications
- Flight testing and instrumentation for handling-qualities and manned/unmanned control system development
- Simulation model fidelity analysis and design model extraction from prototype flight testing
- Flight test validation and optimization of aircraft dynamics and control
- Hands-on training in system identification training using CIFER®
- Students work on 10 comprehensive labs on model identification and verification using flight test data

Who Should Attend

The course is intended for practicing engineers and graduate students interested in learning the principles and applications of system identification for aircraft and rotorcraft. The course assumes some basic knowledge of the concepts of: dynamics, frequency-responses, transfer functions, and state-space representations. The course is not highly mathematical and no experience with other tools is a prerequisite.

3–4 January 2015

Best Practices in Wind Tunnel Testing

Instructors: David Cahill, Mark Melanson, and Allen Arrington

This course provides an overview of important concepts that are used in many wind tunnel test projects. The course is based largely on AIAA standards documents that focus on ground testing concepts. In particular, the course will address project management aspects of executing a testing project, the use and calibration of strain gage balances, the use of measurement uncertainty in ground testing, and the calibration of wind tunnels.

Key Topics

- Wind tunnel test processes
- Measurement uncertainty analysis for wind tunnel testing
- Internal strain gage balances for wind tunnel testing
- Aero-thermal calibration of wind tunnels

Who Should Attend

The course is designed for engineers who are involved with ground testing, particularly wind tunnel testing. The course will be beneficial to all levels of ground test engineers; it could be a primer for engineers new to testing but also will be of value to senior engineers as it will include lessons learned that can be directly applied by test project leaders.

3–4 January 2015

Third International Workshop on High-Order CFD Methods

Workshop Co-Chairs: H. T. Huynh and Norbert Kroll

High-order numerical methods for unstructured meshes offer a promising route to solving complex industrial fluid flow problems by combining superior accuracy with geometric flexibility. The 3rd International Workshop on High-Order CFD Methods is being organized by a committee of 21 international members co-chaired by H. T. Huynh of NASA Glenn Research Center and Norbert Kroll of DLR.

Workshop Objectives

- To provide an open and impartial forum for evaluating the status of high-order methods (order of accuracy > 2) in solving a wide range of flow problems

• To assess the performance of high-order methods through comparison to production 2nd order CFD codes widely used in the aerospace industry with well-defined metrics
• To identify pacing items in high-order methods needing additional research and development in order to proliferate in the CFD community

The workshop is open to participants all over the world. To be considered as speakers, participants need to complete at least one sub-case.

A number of fellowships will be provided by Army Research Office (ARO) and NASA to pay registration fees for undergraduate and graduate students to attend the workshop and present their work. If you are interested in applying for this registration waiver, please contact H. T. Huynh at huynh@grc.nasa.gov. For more information, please visit the https://www.grc.nasa.gov/hiocfd/.

4 January 2015

Introduction to Integrated Computational Materials Engineering (ICME)

Instructor: Dr. Vasisht Venkatesh

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. The important aspects of linking materials models with process models and subsequently to component design and behavior analysis models will be reviewed.

Key Topics

- Obtain awareness of ICME as an emerging technology area
- Understand general models and simulation methods involved in ICME
- Articulate critical issues/challenges with ICME
- Build awareness of materials and process modeling capabilities and limitations
- Understand important aspects of linking material models with process models and their integration into component design and behavior analysis.

Who Should Attend

This course is aimed at materials, mechanical design, and manufacturing engineers; program managers; and engineering management looking to introduce or apply ICME methods in the future. This course will not provide hands-on training, but rather will provide an appreciation for the types of models available, their benefits, and how various model outputs should be interpreted.

8–9 January 2015

Fundamentals and Applications of Modern Flow Control

Instructors: Daniel Miller, Louis N. Cattafesta III, and Tony Washburn

Modern passive and active flowfield control is a rapidly emerging field of significant technological importance to the design and capability of a new generation of forthcoming air-vehicle systems, spawning major research initiatives in government, industry, and academic sectors of aeronautics. This completely revised two-day short course will address introductory fundamentals as well as several emerging air-vehicle applications of modern aerodynamic flowfield control techniques. The first day will cover a brief overview of the fundamentals of flow control, including basic concepts, terminology, history, strategies/techniques, actuators, sensors, modeling/simulation, and closed-loop control. The second day will cover applications of flow control to current and next-generation air vehicle systems, including vehicle propulsion integration, airfoil control, noise suppression, wake control, and some forthcoming non-aeronautical applications. A multi-institutional team of eight researchers from government, industry, and academia will cooperatively teach this course.

Key Topics

- Concepts, terminology, and history of flow control
- Flow control strategies
- Actuators and sensors
- Modeling and simulation techniques
- Closed-loop flow control
- Air vehicle applications: propulsion, airfoil, dynamic flowfield, non-aero apps