July-August 2014

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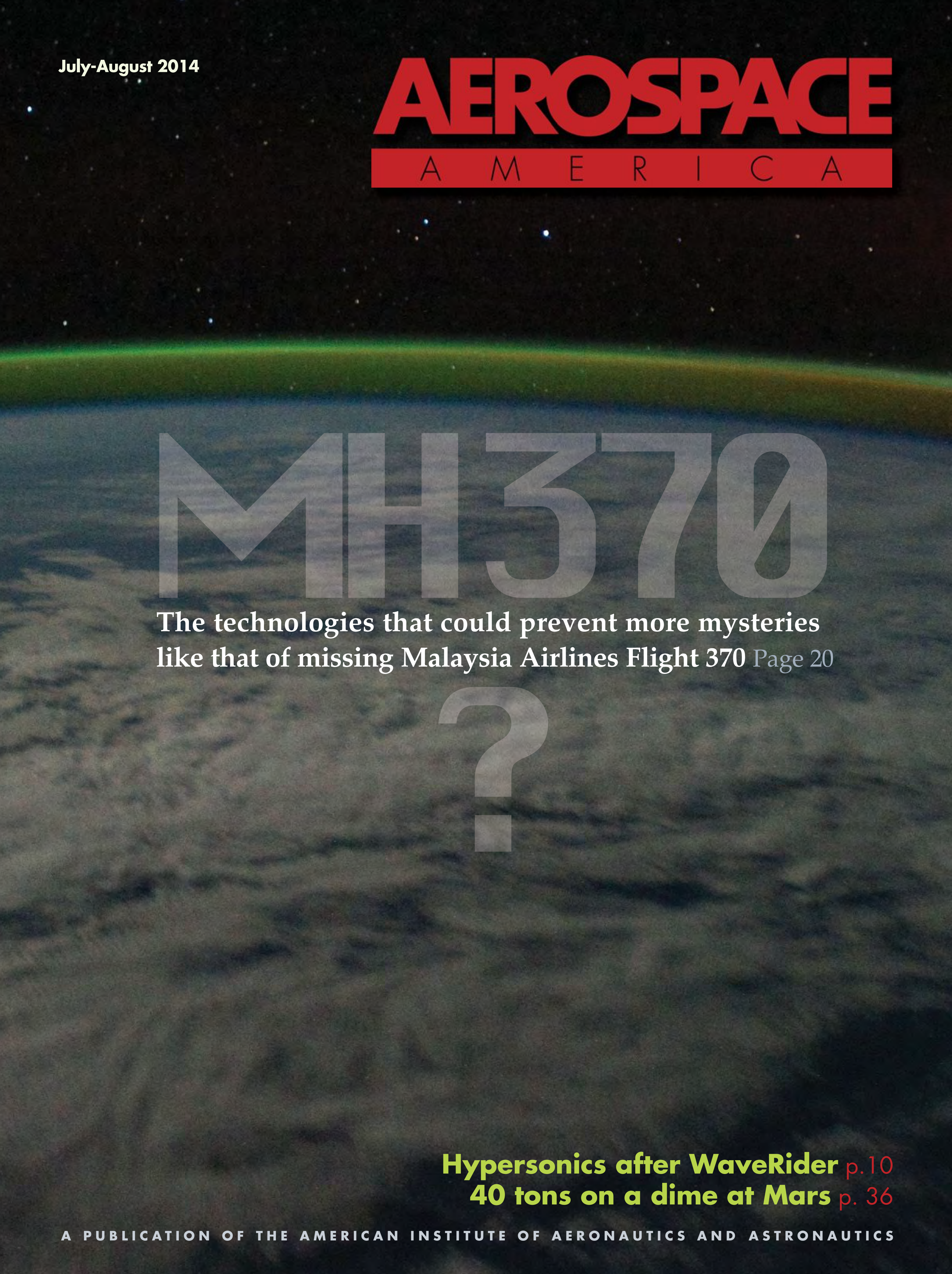

MH370

The technologies that could prevent more mysteries like that of missing Malaysia Airlines Flight 370 Page 20

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Hypersonics after WaveRider p. 10

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July-August 2014

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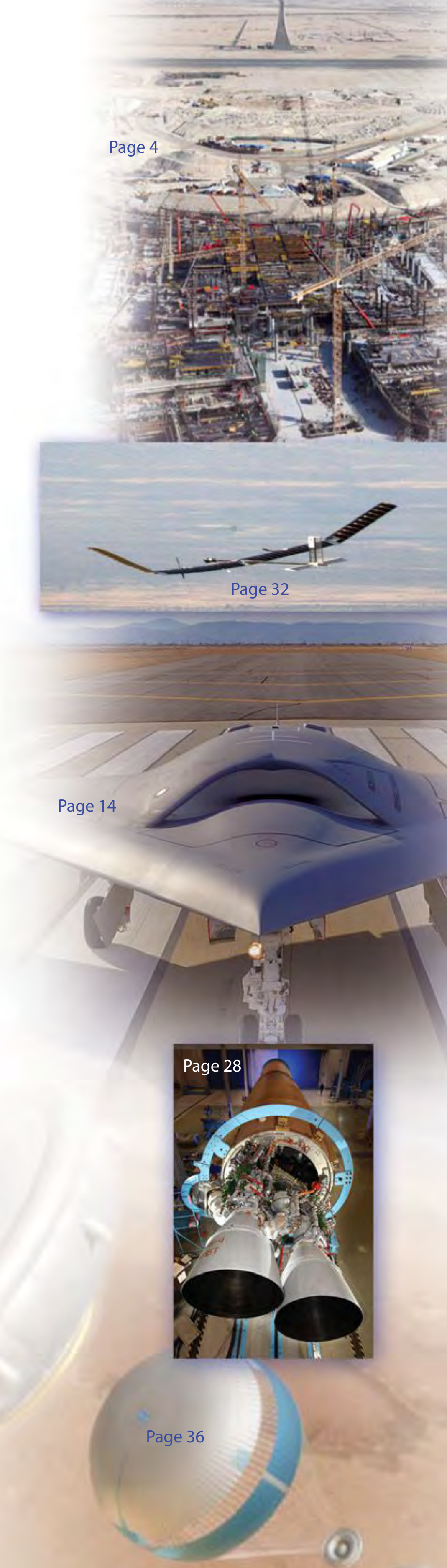

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Editor's Notebook

The value of being specific

In this edition of Aerospace America, we're inaugurating a new section we call Case Study. This is where aerospace engineers are invited to describe their work in their own words with advice and help from our editors.

My sense is there will be lots of demand to be featured as a Case Study, so I wanted to share some thoughts about the purpose and vision for these articles.

Our goal is to let readers hear directly from subject matter experts about the technologies and problem-solving techniques underlying specific projects. These articles will be valuable not just for the details they provide, but because they will be windows into entirely new or fast-changing markets and trends.

Our inaugural Case Study, "Shaping the things to come," [page 14] describes one company's additive manufacturing technique for parts on the U.S. Navy's X-47B unmanned planes. The article says a lot about the company's work, to be sure, but readers also get a sense of the cultural and technical challenges that advocates of additive manufacturing are facing. The aerospace industry is understandably cautious about new components and techniques, because innovation can't come at the expense of reliability or safety.

We also see another value in this Case Study section, and it's one that should not be underestimated. We make sure that the articles are written in a style that makes them understandable across aerospace domains and even outside the industry. This way, they can help inspire more innovation and contribute in some way to wise investment decisions by companies and agencies. They'll also help students and young professionals refine their career choices by giving them visibility into work outside their immediate areas of focus.

This is just one of many more improvements to come for Aerospace America and its readership.

Ben Iannotta
Editor-in-Chief

C-17s for firefighting

The article "Putting Out the Fires" [June, page 28] rekindled memories of design discussions from 2000. When C-17s are available as surplus, they can handle two [Modular Airborne Fire Fighting System 2] units side-by-side. That would be 6,000-8,000 gallons on target with true low-level maneuverability and short runway capability. That should be an operational match for any lumbering DC-10 and the venerable C-130. At the very least, it should be worth an updated design study and discussion.

Ed Zadorozny
Garden Grove, CA

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Ready or not: In the interview in the June 2014 Aerospace America, General Mark A. Welsh III says "we're not ready for unmanned aircraft carrying nuclear weapons."

The term for an unmanned aircraft carrying a nuclear weapon is "cruise missile." We've had them since 1954, when the (unmanned) B-61 Matador missiles were first deployed at Bitburg Air Base (Germany).

Geoffrey Landis
Berea, OH

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.

Events Calendar

July 13-17
International Conference on Environmental Systems, Tucson, Ariz.
Contact: Andrew Jackson, 806/742-2801 x 230; Andrew.jackson@ttu.edu; http://www.depts.ttu.edu/ceweb/ices/

July 15-18
ICNPAA 2014 – Mathematical Problems in Engineering, Aerospace and Sciences, Narvik, Norway.
Contact: Seenith Sivasundaram, 386/761-9829; seenithi@aol.com; www.icnpaa.com

July 28-30
AIAA Propulsion and Energy 2014, featuring: 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and 12th International Energy Conversion Engineering Conference. Cleveland, Ohio.
Contact: 703/264-7500

July 31-Aug. 1
Second AIAA Propulsion Aerodynamics Workshop; Hybrid Rocket Propulsion; Missile Propulsion Design, Technologies, and System Engineering, Application of Green Propulsion for Future Space. Cleveland, Ohio.
Contact: 703/264-7500

Aug. 3-4
Decision Analysis, San Diego, Calif.
Contact: 703/264-7500

Aug. 4-7
AIAA SPACE 2014, featuring: AIAA/AAS Astrodynamics Specialist Conference; AIAA Complex Aerospace Systems Exchange; 32nd AIAA International Communications Satellite Systems Conference; AIAA SPACE Conference. San Diego, Calif.
Contact: 703/264-7500

Abu Dhabi Airports

Mideast states nurture their aerospace

Work in progress: The Abu Dhabi airport complex will include manufacturing plants, maintenance facilities, and a pilot training school. Similar expansion projects are underway at several airports in the Middle East.

The next two years will see the construction of major aerospace manufacturing and support centers in Abu Dhabi, Dubai and Saudi Arabia, moves that appear to reflect strategic government plans to rival the aerospace hubs of Seattle and Toulouse.

In the emirate of Abu Dhabi, the first phase of the 25-square-kilometer Nibras Al Ain Aerospace Park is scheduled to be completed in 2015. The cluster of aerospace manufacturing plants, maintenance centers and pilot training schools is under development by Abu Dhabi's Mubadala Aerospace company and the Abu Dhabi Airport.

The work reflects a subtle shift of emphasis. The Arabian Peninsula's aerospace engineering interests have traditionally centered on supporting the vast numbers of civil and military aircraft ordered by the region's governments, rather than designing and producing aerospace structures. But a transition to include manufacturing is underway, driven in part by a demand for new commercial aircraft.

The region "represents a strong market for future aerospace and aviation growth, with passenger numbers at Middle Eastern airports increasing by nearly 8 percent last year alone. Significant investment in new airport infrastructure continues across the region, and it is expected that around 1,800 aircraft will be required within the next 20 years," says Paul Everitt, chief executive of U.K. aerospace trade organization ADS, short for aerospace, defense and security.

At the November 2013 Dubai Air Show, Mubadala announced manufacturing contracts worth over $11.8 billion with U.S. and European suppliers including Airbus, Boeing, General Electric and Rolls-Royce. Also at the show, AMMROC — the Advanced Military Maintenance, Repair and Overhauling Centre, a joint venture among Lockheed Martin, Sikorsky Corporation and Mubadala Aerospace — secured a $5.8-billion logistics support contract for the United Arab Emirates Armed Forces. AMMROC plans to open its new logistics center at Nibras Al Ain Aerospace Park in January 2016.

Huge maintenance, repair and overhaul centers are emerging from the desert sands. Saudia Aerospace Engineering Industries is building a maintenance center covering more than 100 square kilometers at Jeddah/King Abdulaziz International Airport — including 12 aircraft hangars and employing more than 7,500 staff — planned for completion by the end of 2015. Dubai World Central/Al Maktoum International Airport is developing a 6.7-square-kilometer maintenance facility at Aviation City, a cluster of aviation maintenance, academic and helicopter support organizations. It is the operational base for Dubai Aerospace Enterprise, a Dubai-owned maintenance company set up in 2006, which has since acquired Zurich-based SR Technics and Standard Aerospace, the Tempe, Ariz., civil and military support supplier.

These aviation support organizations are now being joined by manufacturers with niche capabilities. Mubadala has developed a specialist capability in carbon fiber structures assembly, following its 2009 agreement with Austria's Future Advanced Composite Components to build a joint manufacturing facility in Al Ain. At the start of January 2014, Abu Dhabi's Etihad Airways, the Takreer oil refining company and the Masdar Institute of Science and Technology announced a strategic agreement with Boeing to develop an aviation biofuel industry in the region. In the same month the consortium carried out a 45-minute demonstration flight in a Boeing 777 powered in part by locally produced sustainable aviation biofuel.

The Arabian Peninsula region is leading the way, but not all of the development work in the Middle East is entirely homegrown or centered there. By the end of this year, Canada's Bombardier Aerospace plans to complete a $200-million manufacturing plant in Nouaceur, Morocco, making aircraft structural parts, as part of a long-term partnership with the Moroccan government. Bombardier figures to have a workforce of 850 recruited by the end of 2018.

It is still too early to forecast exactly how many new aerospace manufacturing companies based in the Middle East will emerge over the next few years and whether they will become serious competitors or partners to legacy suppliers in the West. But the recent growth of Gulf-based airlines, airports and aircraft maintenance companies have had a huge impact on the aviation industry worldwide, and it is likely that the region's manufacturing businesses, through either acquisition or growth, will seek a much larger share of the global aerospace marketplace.

Flying round the world on solar power

The designers of Solar Impulse 2 are beginning to publicize details about the innovations they hope will propel the craft around the globe without stopping next year.

The plane's improved performance over its predecessor Solar Impulse 1, which flew across the U.S. in several hops in 2010, results from combining many efficiency-increasing technologies, says André Borschberg, a founder of the company. He will be one of the two pilots who will be aboard the plane when it takes off in March 2015.

One of these is the aircraft's carbon fiber skin, which at 25 grams per square meter weighs only a third as much as printer paper. The plane has brushless motors — another improvement, because brushes add weight, wear out, cause sparking and are hard to cool. Solar Impulse 2's motors also are sensorless, making them simpler, more reliable, and less vulnerable to dirt and humidity.

Built into the wings are 17,248 solar cells that supply the plane's four electric motors with energy. Each cell is monocrystalline silicon — made from a single silicon crystal rather than many. The material costs more than polycrystalline silicon but is more efficient. According to information on the Solar Impulse website, the plane's propulsion system is 94% efficient — based on the percentage of electric energy converted into thrust.

During the day, the solar cells recharge lithium polymer batteries so that Solar Impulse 2's propellers can continue to turn at night. The batteries account for a quarter of the aircraft's weight.

The plane has a wingspan larger than a 747's but weighs just 2,300 kilograms. By comparison, the Rutan Voyager, which flew around the world in 1986 powered by two piston engines, had a gross weight of 4,397 kilograms, with the fuel weighing 3,000 kilograms.

Many of the plane's systems have been flown on unmanned high-altitude long-endurance aircraft. Solar Impulse 2's designers wanted to see whether some of these concepts could be transferred to a plane with a pilot on board. Demonstrating clean technologies is one of the project's primary goals, says the company's website.

Borschberg says the project will help advance several technology research programs that the industry partners will develop, in aerospace and other areas. Advances could include lighter materials, energy savings, better reliability and performance for electric motors, more efficient solar cells, and batteries that store more energy, he says. Some of the technologies on the aircraft could have promising applications in markets such as solar panel protection materials, computer and cellphone batteries, and materials for baggage compartments and other aircraft structures.

The Federation Aeronautique Internationale ratified eight world records set by the Solar Impulse 1 team, which includes recognition for the highest and longest flight by a solar-powered aircraft. But the biggest test of the team's ambition to fly around the world will be the five-day, five-night crossing of the Pacific Ocean. If that can be achieved, then Solar Impulse 2 could well be the trailblazer of a new era of solar-power global aviation.

Solar Impulse

Solar Impulse 2 on its June 2 inaugural flight from Switzerland. The aircraft's carbon fiber skin weighs less than printer paper.

Europe prepares for Clean Sky 2 research

At the start of July, the European Union plans to make its first call for companies and research agencies to compete for funding under the Clean Sky 2 Joint Technology Initiative, the next phase of Europe's multibillion-euro effort to reduce aviation pollution and noise.

Clean Sky 2's total budget of €3.95 billion ($5.3 billion) was approved in May by the European Union Council and is more than twice the budget of the first Clean Sky program. Some of the new funds are already pegged for specific companies and agencies, but companies and agencies will be applying for about €1 billion ($1.35 billion) in research funds.

Clean Sky

Snecma, part of the Safran group, has designed a new open-rotor jet engine for greater fuel efficiency. The first ground test is planned for 2015.

Organizers hope the additional funds will propel the industry to meet a set of ambitious goals laid out in 2001 by the Advisory Council for Aviation Research in Europe. By 2020, the council wants a 50 percent reduction in aircraft fuel consumption and carbon emissions; an 80 percent reduction in nitrogen oxide emissions; a 50 percent reduction in perceived aircraft noise; and substantial progress toward reducing the environmental impact of the manufacture, maintenance and disposal of aircraft and related products.

In Clean Sky 2, the near-term "star of the show," as Clean Sky Executive Director Eric Dautriat told an audience, will be Snecma's testing of an open-rotor jet engine, a design that engineers expect will be more fuel efficient. The first ground test is scheduled for 2015, Dautriat said.

Clean Sky 1 involved a host of research projects by 600 industrial and academic European bodies. An ATR-72 turboprop was equipped with a composite fuselage panel; new environmental control and icing protection systems were devised and flown on an A320 test plane; a new rotorcraft propeller design was developed for high-speed cruise.

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Division of labor

There are six main technology research areas within the Clean Sky research program. In Clean Sky 2, just as in Clean Sky 1, each sector will be managed by a European aerospace company.

- *Fast rotorcraft—Agusta Westland and Eurocopter*
- *Large passenger aircraft—Airbus*
- *Regional aircraft—Alenia Aermacchi*
- *Airframes—Dassault, Airbus Defence and Space, Saab*
- *Engines—Safran, Rolls-Royce and MTU*
- *Systems—Thales and Liebherr*

These sectors are clustered into two main areas—or "core building blocks"

- *Innovative Aircraft Demonstrator Platforms. Technologies to improve large passenger planes, regional planes and helicopters will be flown on test aircraft Integrated Technology Demonstrators. Entirely new airframes and engines will be flight tested.*
- *Analysis work on how different new technologies can be combined together.*

Parallel research is being undertaken to examine:

- *ECO-Design. This term refers to assessing environmental impacts by taking into account the entire aircraft life cycle, from design to operations and maintenance to withdrawal from the fleet.*
- *Small air transports. The goal is to reduce the environmental impacts of small general aviation and commuter aircraft.*

NASA hones its crowdsourcing

NASA is on a mission to make it even easier for John and Jane Q. Public to suggest solutions to some of the agency's most vexing technical problems, from figuring out how to fly unmanned aircraft safely in the national airspace to keeping astronauts healthy in space.

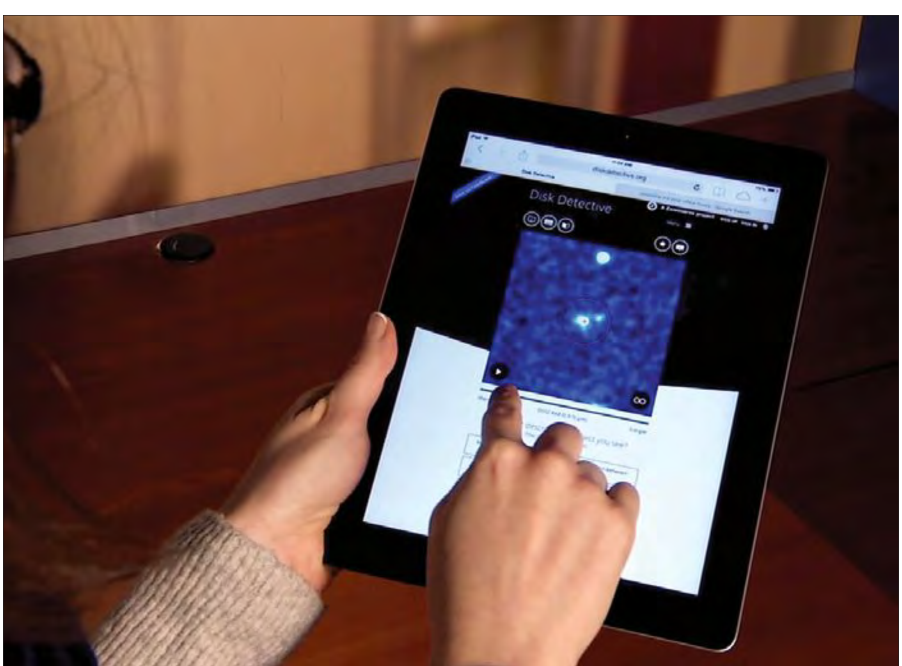
The agency is turning to private sector web experts to ensure it's being user friendly to those who want to participate in the series of technology challenges it has established to award cash prizes to problem solvers. The company InnoCentive, Inc., which describes itself as an "online platform for crowd sourcing your innovation problems," has run pilot projects with NASA to test the use of web portals in the challenge initiative. The agency has also tested a service called TopCoder, which runs challenges specifically geared toward solving computer coding problems.

By going online, people with good ideas "don't actually have to bring a physical prototype or a technology to a demonstration event," says Jenn Gustetic, challenges and prizes program executive in the Office of the Chief Technologist at NASA headquarters. "They can submit their code or their idea or their testing method through the web using on-line platforms like InnoCentive and TopCoder."

NASA is not new to crowdsourcing. It formed a partnership with Planetary Resources Inc. of Bellevue, Wash., to apply crowdsourcing to the development of algorithms for detecting near-Earth objects. The agency also crowdsourced solutions for optimizing the placement of the International Space Station's solar arrays.

Gustetic says "bringing a diverse group of perspectives to a problem" opens the door to considering "out-of-discipline perspectives — or you get different ways of approaching a problem that can really result in a breakthrough."

NASA



Citizen scientists: Volunteers in the Disk Detective project view space telescope images to help NASA classify celestial objects.

In another example of crowdsourcing, citizen-scientists have volunteered to help astronomers discover embryonic planetary systems hidden in infrared data from NASA's Wide-field Infrared Survey Explorer, a 40-centimeter space telescope launched in 2009. Participants in the Disk Detective project view images from WISE and other sky surveys and classify objects based on whether they are round or include multiple objects. Astronomers can then use human photo interpretation to zero in on sources that may contain planetary environments. One hundred thousand volunteers have identified 600,000 possible signs of planetary formation, Gustetic says.

Managers of the Fred Lawrence Whipple Observatory in Amado, Ariz., were "so impressed by the results they were getting that they awarded four nights of viewing time on their Tillinghast Telescope to do follow-up observations" on some of the high-interest planetary discs identified by the citizen-volunteers.

"My sense is that the role of the individual in helping solve tough problems — and co-delivering services and…products, and a whole host of co-creation activities — is only going to increase in the future," says Gustetic. "NASA has really embraced the idea that it's important to engage individuals in their space program, and also recognizes that there are unique skills, expertise and time that those individuals can potentially contribute." She says it's NASA's responsibility "to figure out how to best leverage that. We like to talk about the government and industry and academia being important partners of the innovative ecosystem in the U.S. We should also include individual members of the public in that equation."

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NRC examines autonomy

Boeing

The ScanEagle is one of only two unmanned planes to have received FAA certification to fly commercially without going through a long approval process.

In the future, many of the tasks currently performed by pilots, unmanned aircraft operators and air traffic controllers could be turned over to sophisticated systems designed to operate for extended periods of time without human supervision. Before that occurs, however, U.S. government agencies with the support of industry and academic groups will need to conduct a targeted, coordinated research campaign to address a series of technical, regulatory, social and legal issues related to the use of increasingly autonomous systems, according to a National Research Council report issued in June, "Autonomy Research for Civil Aviation: Toward a New Era of Flight."

The report describes barriers, including a lack of available bandwidth for wireless communications and the FAA's lengthy certification process for unmanned aircraft. It highlights priorities for research designed to pave the way for the gradual transition to a time when U.S. civil aviation is characterized by "the seamless operation of diverse categories of aircraft and systems, some crewed, some not crewed, and a little bit of everything in between," says John Lauber, a former Airbus chief product safety officer and co-chair of the Committee on Autonomy Research for Civil Aviation, the NRC panel that drafted the report. The ad-hoc committee was formed at NASA's request.

One of the primary challenges for the research community will be to find a way to characterize the behavior of systems that adapt and learn as they respond to environmental changes. "There will have to be some creative research done to characterize how these systems make judgment calls and how they make decisions," says John-Paul B. Clarke, NRC committee co-chair and associate professor of aerospace engineering at the Georgia Institute of Technology. "We will not be able to test every possible thing that the system could see, because that's too time consuming."

Researchers also will need to study how people interact with autonomous systems. "How do I make sure that when a human comes back into the loop after a long period, he or she is able to understand very quickly what is happening and decide whether to follow the recommendations of the autonomous system or override it?" Clarke asks. "That's one of the big questions."

Instead of simply focusing on those challenges, however, the report emphasizes the promise of increasingly autonomous systems to make civil aviation more economical and efficient without compromising safety. In general aviation, for example, autonomous systems could support pilots who are alone in the cockpit. "That's a case where we believe you could definitely increase safety," Clarke says. "In commercial aviation, you could reduce costs while maintaining or even improving safety."

Lauber agrees that safety is paramount. "It is quite clear that anything that comes along in terms of new technology must at the very least maintain the high levels of safety that we experience now, particularly in civil transport operations," Lauber says.

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Going hypersonic

The British company Reaction Engines Ltd. hopes to achieve what the U.S. couldn't under the National Aerospace Plane program: Build an engine capable of propelling a spaceplane to orbit in a single stage, albeit without people. The U.S. canceled NASP in 1993 in favor of a more tightly focused research agenda, a decision that eventually gave rise to the X-51A WaveRider program. With the WaveRider program now over, Erik Schechter compares its technologies to those in the engine that would power Skylon, the spaceplane that Reaction Engines hopes to convince major manufacturers to build and operate.

The X-51A mounted below the B-52 wing at Edwards Air Force Base. This was the second of the four expendable, unmanned WaveRiders.

Somewhere at the bottom of the Pacific Ocean lies the last in a series of X-51A WaveRider hypersonic test vehicles that the Air Force launched between 2010 and 2013. The vehicles were carried aloft on B-52s, dropped from their left wings, boosted to hypersonic speeds by conventional rockets, and then, after separation, accelerated to speeds up to Mach 5.1. They were propelled by experimental airbreathing engines that burned fuel with oxygen gleaned from the atmosphere.

With the conclusion of the WaveRider program, companies and countries are vying to continue progress toward the long-promised benefits of airbreathing hypersonic propulsion. Without the need to lug and shed disposable oxidizer tanks, such a craft would be completely reusable and could launch payloads again and again.

The 60-person company Reaction Engines Ltd. of Abingdon, in the U.K., is among those looking to take up the hypersonic mantle. With funds from the U.K. Space Agency, the company has ambitious plans to leapfrog beyond WaveRider's goal of proving the feasibility of accelerating a hypersonic vehicle. The company has designed a proposed spaceplane called Skylon that would take off from a runway, deliver cargo such as small satellites to orbit and fly home.

The Skylon spaceplane showing one of its two SABRE engines. The SABREs are airbreathing in the atmosphere and then switch to rocket mode.

European Space Agency

The Skylon spaceplane is currently in the proof-of-concept phase. If eventually built by a team of contractors, it would be about the size of big airliner – 85 meters long, 6.75 meters wide, with a wingspan of 25.4 meters — and could carry 12 tons of cargo into orbit.

Powering Skylon's flight from runway to space would be two hydrogen-fueled SABRE, or Synergistic Airbreathing Rocket Engines — synergistic because they're designed to operate in two modes. In the airbreathing mode, they would take in oxygen from the atmosphere to begin the first leg of the journey. At an altitude of 26-30 kilometers and a speed of Mach 5, the SABREs would switch over to rocket mode and use a tank of liquid oxygen to blast into orbit at a speed of Mach 25.

The U.K. Space Agency gave Reaction Engines £60 million ($100 million) in June 2013 to work on SABRE as the linchpin for a future spaceplane. "Skylon will be fully reusable, cheaper to operate" – about one-fiftieth the cost of conventional spacecraft – "more efficient to operate, with the intention of having more launches per year with a far lower failure rate," predicts Elizabeth Seaman of the U.K. Space

U.S. Air Force

Agency, the agency's lead for the SABRE project.

Promises like these have been heard for decades, and the challenges are daunting. Air would blow by a hypersonic vehicle at many times the speed of sound, and the craft's engine or engines would need to glean enough oxygen from it to maintain combustion. Propulsion engineer Anthony Haynes, the senior development engineer at Reaction Engines, says the company has figured out how to slow and cool the air enough for subsonic combustion without making the vehicle so heavy that it would undercut the value of airbreating propulsion. This approach is very different from that of the WaveRider. The Air Force-Boeing team let air race at supersonic speeds through the engine, called a supersonic combustion ramjet engine, or scramjet for short.

Final test: The fourth and last X-51A WaveRider, carried under the wing of a B-52H. The WaveRider attained a speed of Mach 5.1 on this flight.

U.S. Air Force

Keeping their cool

Because of friction, the air flowing over a hypersonic vehicle gets exceedingly hot, posing a thermal challenge for engine designers. Temperatures inside the WaveRider vehicles rose to as high as 1,870 degrees Celsius. To deal with this heat, the team built the engines from Inconel, a heat-tolerant nickel-chromium alloy. In addition, JP-7 fuel was pumped through channels in WaveRider engine walls to provide conduction cooling.

Using JP-7 as a conduction coolant had an additional benefit. "As that fuel travels through the walls of the engine, it becomes a supercritical gas. And therefore, when you take that fuel and collect it, [and] then you put it into the combustor and burn that fuel, the fuel is prepared better to burn," says Joseph Vogel, director of air launch space access at Boeing Phantom works.

Reaction Engines also employs Inconel but in a very different cooling system and for a very different reason. Slowing the air to subsonic speed creates even more friction and heat. The air is simply too hot to compress and feed into the combustion chamber, and so it must be cooled. This will be done inside a heat exchanger, or pre-cooler, comprised of 1-millimeter-wide tubes – thousands of them – coiled in layers. These tubes won't contain fuel, as was the case with WaveRider channels. Instead, they will use helium that has been cooled by the craft's liquid hydrogen fuel.

"The helium passes through the heat exchanger and is cooled down directly by the hydrogen at a single point in the system," Haynes explains, "and then after the helium emerges from the pre-cooler, it's heated up by the incoming airflow. So you end up with very hot helium" — and very cold air.

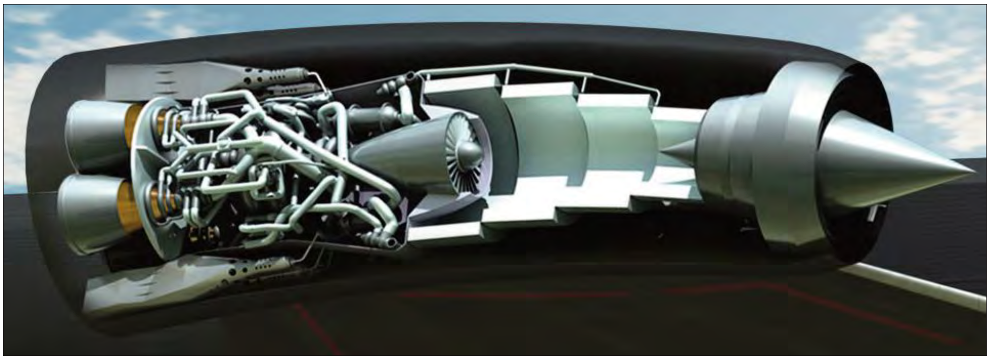
The process is quick and efficient, Haynes adds. At Mach 5, air sucked into the engine goes from 1,000 Celsius to -150 Celsius in one-hundredth of a second, and a frost control system keeps the moisture from turning into ice and clogging the heat exchanger. Then, as the chilled air moves onto the turbo-compressor, the now-hot helium helps drive that compressor before cycling back through the pre-cooler. And the process begins all over again.

The pre-cooler and frost control system are the revolutionary elements of SABRE, Haynes says. "Reaction Engines has been working on this technology for the last 10 to 20 years, basically figuring out a way of making a heat exchanger compact and light enough…to fly it on this sort of vehicle," he says.

In March 2012, engineers at Reaction tested a demonstration pre-cooler at the company's B9 test facility, near Abingdon. The test system used a Rolls-Royce Viper Mk 535 turbojet, helium loop system, and, to save money, liquid nitrogen instead of hydrogen. The next step will be to test the thermodynamic cycle of the system. Finalization of the engine design is scheduled to begin in November, and test flights are tentatively scheduled for 2019.

In terms of design, the WaveRider and Skylon blueprints are nothing alike. WaveRiders resembled cruise missiles with air inlets under their flat, tungsten-covered noses. The inlet fed an Aerojet Rocketdyne SJY61 scramjet engine – meaning a supersonic combusting ramjet in which the air flowed supersonically throughout the engine. As the vehicle traveled along at Mach 4.5 and above, air would hit the front of the vehicle, get compressed and enter the engine. Inside the scramjet, the oxygen mixed with propellant, was ignited and then expelled out the back of the engine with the exhaust. There were no moving parts.

Reaction Engines Ltd



Cutaway: The SABRE engine mounted on one of Skylon's two nacelles. The engine's revolutionary elements involve the cooling system, says the company.

One of the challenges was starting the engine. The WaveRider needed to be boosted to a speed of Mach 4.5 to start the engine, which is why booster rockets were needed. At that speed, ethylene was sprayed to heat the engine and initiate combustion. For fuel, the WaveRider's scramjet engine used JP-7 — the kind used by the SR-71 Blackbird — in both vapor and liquid form. "We transition to the JP-7 once it's hot enough, and we're off to the races." By contrast, SABRE is designed to operate from a standing start on the runway without special preparation or additives.

Sleek and balanced

Unlike the WaveRider, which looks sleek and straightforward, the Skylon mockup resembles a plane with no cockpit, with droopy nacalles, one on the tip of each wing. There is one SABRE per nacelle — though in rocket mode each SABRE effectively comprises two engines. The shape of Skylon reflects the lessons learned from a previous spaceplane program called HOTOL for Horizontal Take-Off and Landing. The U.K. cancelled that program in 1988.

The HOTOL engines were placed at the rear of the vehicle, a rocket-style arrangement that made the craft fairly unstable in ascent and re-entry, says Haynes. So for Skylon, the team moved the two SABRE engines forward to establish a center of gravity, and placed them at the tips of the wings so the spaceplane would stay clear of its own exhaust. As for the nacelles, they droop a bit so the intake cone can better take advantage of airflow during airbreathing mode.

"Essentially, the rocket engines are angled one way, to keep the direction of thrust pointed towards the center of gravity, and the airbreathing engines are pointed the opposite direction in order to capture as much air as possible during the ascent," Haynes explains.

In airbreathing mode, the cone intake is open, allowing air to rush in. Some of that flow passes through the center of the engine, where it is cooled, compressed and passed along to the injectors and, finally, expelled out the rocket nozzles as exhaust. Meanwhile, the rest of the air passes uncooled around the engine, going through a ring of bypass burners before exiting SABRE.

A single-stage-to-obit plane is a lofty goal, and that might not be the first application for airbreathing hypersonics. Strike weapons will probably come first, predicts aerospace engineer Charlie Brink, deputy director of the U.S. Air Force Research Laboratory's High Speed Systems Division. "That suite of propulsion technologies [as exemplified by the WaveRider] is, I would say, ready today or in the very near term to provide the capability, if our decision-makers so desire."

Erik Schechter
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Shaping the things to come

Near the forward avionics bays of the U.S. Navy's two X-47B experimental planes are titanium alloy components that were made by melting metal powder into a complex shape a layer at a time. The components were built by CalRAM, short for California Rapid Manufacturing, a 10-person company that got its start in 2005 partly through a congressional earmark. CalRAM co-founder Dave Ciscel gives a glimpse of how such additive processes could revolutionize aerospace manufacturing.

Typically, the ducts and flow tubes of an aircraft's warm air mixer are made by pouring metal into casts and welding the finished pieces together. CalRAM, the company I co-founded in Simi Valley, Calif., figured out how to build warm air mixers as a single piece (including complex inner structures) by using an electron beam to melt titanium powder a layer at a time. This is illustrative of our part count reduction ability; very significant for the aerospace world, where up until now each of the multiple pieces produced by conventional methods had to be designed, built, inspected, tracked, inventoried and then assembled. Furthermore, each joint becomes a potential failure mechanism. By eliminating these interfaces, part count is reduced, reliability is increased and delivery schedules are compressed.

The X-47B's warm air mixers are among the hundreds of devices CalRAM has made with the electron beam melting — EBM — technique since our founding in 2005. We believe the Navy's willingness to include them at the urging of Northrop Grumman shows that customers are beginning to embrace additive manufacturing and EBM in particular. In the months and years to come, we are confident that EBM will perform well compared to other additive techniques, such as a version of EBM called wire feed, where solid metal, not powder, is melted, and laser sintering, in which photons heat metal so it can be formed into shapes without melting it.

The X-47B warm air mixers were not considered flight-critical components, but we have no doubt that the military and FAA will one day allow EBM components to be used for such applications. The economics of additive manufacturing are just too compelling not to seize the opportunity. Our EBM process requires no custom tooling to recreate broken or worn parts that might no longer be in production. A component can be laser scanned and turned into a CAD file, and in about two weeks we can deliver a finished component. We calculate that with EBM, our customers in the aircraft maintenance, repair and overhaul market can cut 85 per-

Dave Ciscel is a retired Air Force lieutenant colonel and acquisition expert. He co-founded CalRAM in 2005 with materials engineer John Wooten.


A Navy X-47B UCAS at Palmdale, Calif.

Northrop Grumman

cent to 90 percent off the cost of replacing titanium parts. For engineers who are working on entirely new airframes, CalRAM can deliver a prototype part within about two weeks of receiving a CAD file. Further iterations can follow the same manufacturing path, significantly reducing a client's time to market.

Our process takes place inside an EBM machine provided by the Swedish company Arcam AB, whom we've been working with since our founding. Current is run through a filament to produce an electron beam. A series of magnetic coils focuses this beam into an enclosed build tank that receives titanium alloy powder from two hoppers, one on either side. A small rake — the only moving part in the machine — spreads the powder across the component a layer at a time. The beam is steered across the powder by varying the magnetic field. It sinters and then melts the powder on the build platform precisely as planned in the CAD file. We use Ti-64 powder, an alloy of titanium with 6 percent vanadium and 4 percent aluminum.

Our engineers have solved many challenges to bring EBM manufacturing to today's high level of reliability. Using proprietary software we digitally slice existing 3-D design models into a series of separate layers, much as a modern CAT scan machine does. With this software ready to direct the melting, powder can then be spread on the start plate by the rake in the build chamber. Layers are typically btween 0.000050 meters and 0.000070 meters thick. The first layer is sintered to the plate by heat from the electron beam, and then melted by a second higher energy pass. Each successive layer is sintered to the previous layer to ensure a conductive path for the electrons. The second pass consolidates the material into shape. We repeat this process layer-by-layer, until the entire part is complete. Since parts are formed directly in the powder bed, EBM is fast, with maximum build times that are normally less than 60 hours. We calculate that because of the higher energy of the electron beam compared to lasers (3 kilowatts vs. 700 watts), we can produce material up to five times faster than laser methods. Additionally the EBM process creates a cleaner material than the laser process due to the vacuum environment in which EBM works.

A challenge we faced was to prevent sagging and swelling during the build. We solved this by learning to add small, temporary titanium struts to physically support the part, if necessary, as it takes shape. The supports also act as thermal and electrical shunts from the melt pool, so that each layer cools at a precise rate, which is a key to preventing swelling of the material as it solidifies.

The machine also must operate within a precise temperature window — about 700 C for Ti-64. If the powder is not hot enough, it won't sinter to the preceding layer and electrical charge will build up. If that happens, the powder will repel itself and go airborne as a fine dust resembling smoke that can block the electron beam gun. But if the operating temperature is too hot, the material will swell. Staying in the precise temperature window between smoke and swelling was an early issue that's been resolved with the advent of more reliable EBM machines.

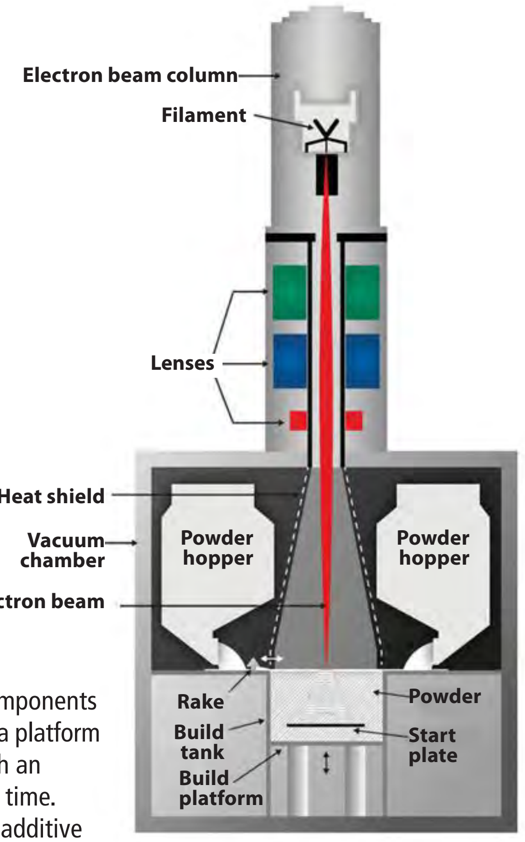
A goal in any additive process is to avoid oxygen contamination of the titanium melt. EBM minimizes contamination by operating in a vacuum instead of an inert gas environment, as in laser sintering. This leads to improved microstructure with excellent mechanical and physical properties. The high temperatures used during EBM (700 C for titanium and up to 1,000 C for nickel-based superalloys and other materials) leave parts stress-free after cooling, eliminating the need for separate post-build thermal treatments to develop full titanium mechanical properties.

As good as EBM has become, there remains room for innovation. The size of parts we can make is limited by the size of the build chambers in the EBM machines. Arcam and others are working on larger machines. Also, there is currently no database that designers can consult to learn about the properties of EBM-built parts. That is slowing adoption of the technology. Also, the surfaces of finished components are somewhat rough. This is because particles adjacent to the melt pool are melted a little bit as each layer is added. For many components, the roughness is not an issue. But for some parts, cleanup work is required. This can be done by filing the part, blowing air over it or loading it in a chuck and machining it. Those finishing processes add cost and are an area ripe for innovation.

Overall, however, EBM is giving designers new options for incorporating Ti-64 into their plans. Engineers love titanium because of its strength at high temperatures, but those on the business sides of their companies or agencies have often been deterred by its high cost and design challenges. Our EBM process is beginning to shift that calculus. Engineers might soon be able to choose titanium where they are today using aluminum or steel — in short, all over the aircraft.

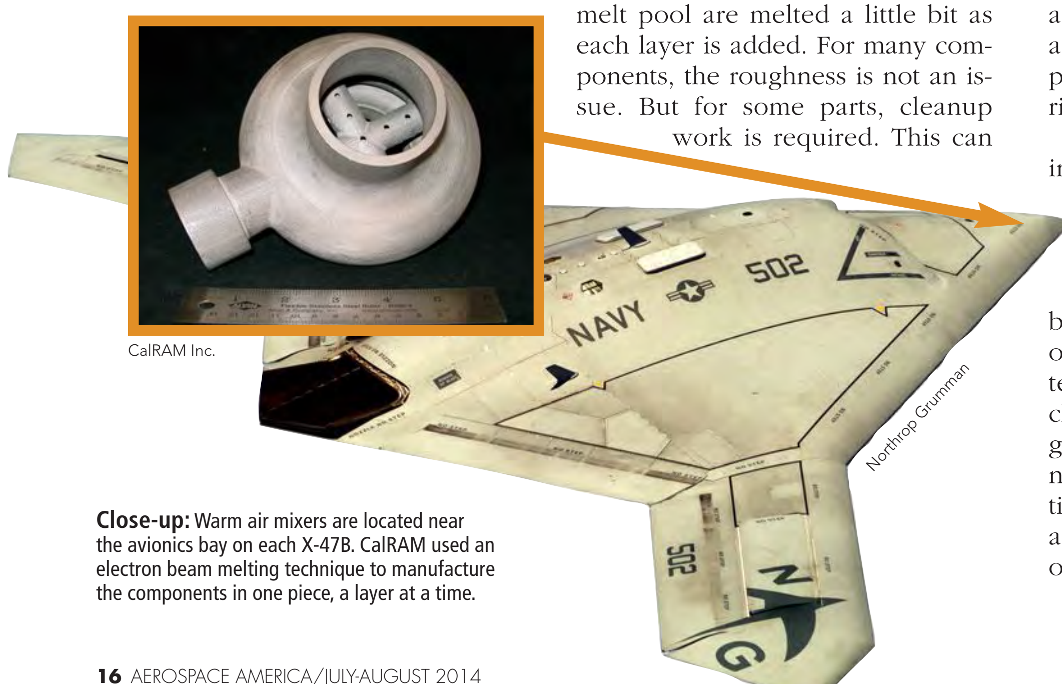
Dave Ciscel
Dave.Ciscel@calraminc.com

Inside the beam machine



CalRAM makes aerospace components by raking metal powder onto a platform and melting it into shape with an electron beam, one layer at a time. The process is an example of additive manufacturing.

Source: CalRAM Inc.



CalRAM Inc.

Northrop Grumman

Close-up: Warm air mixers are located near the avionics bay on each X-47B. CalRAM used an electron beam melting technique to manufacture the components in one piece, a layer at a time.

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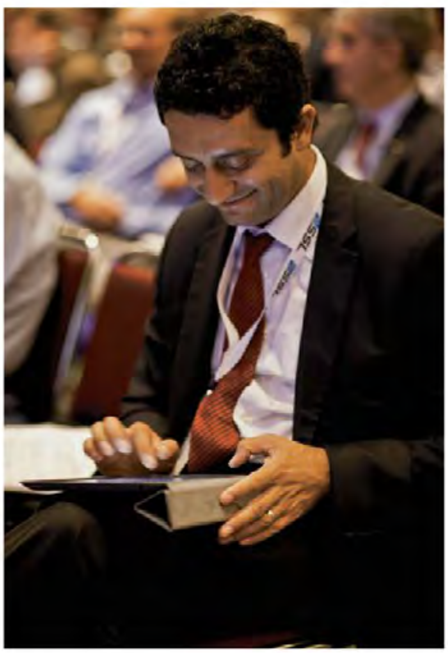

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31 July–1 August 2014 Cleveland, Ohio

Hybrid Rocket Propulsion
Instructor: Joe Majdalani

Summary: The purpose of this course is to present and discuss fundamental theory alongside research findings with emphasis on unsolved problems, open questions, and benchmark tests.

Missile Propulsion Design, Technologies, and System Engineering
Instructor: Eugene Fleeman

Summary: Attendees will gain an understanding of missile propulsion design, missile propulsion technologies, launch platform integration, missile propulsion system measures of merit, and missile propulsion system development process.

The Application of Green Propulsion for Future Space
Instructors: Alan Frankel, Ivett Leyva, and Patrick Alliot

Summary: Topics include a brief history of hypergols; what is considered green and what is driving the green propulsion movement; figures of merit and lessons learned in the development of green propellants; flight experience and applications for the various classes of satellites; and challenges for current and future green thrusters and systems.

2nd AIAA Propulsion Aerodynamics Workshop

Summary: The focus of the workshop will be on assessing the accuracy of CFD in obtaining multi-stream air breathing jet performance and flow structure to include nozzle force, vector and moment; nozzle thrust (Cv) and discharge (Cd) coefficients; and surface pressure prediction accuracy.

SPACE 2014

3–4 August 2014 San Diego, California

Decision Analysis
Instructor: John Hsu

Summary: Different decision analysis methods will be introduced starting from the traditional trade study methods; then continue to trade space for Cost as Independent Variable (CAIV), Analytic Hierarchy Process (AHV) which is part of the Analytic Network Process (ANP), Weighted Sum Model (WSM), Potentially All Pairwise Rankings of All Possible Alternatives (PAPRIKA), and Decision Analysis with Uncertain information/data.

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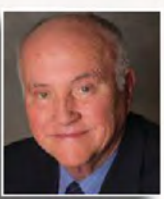

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AIAA
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Learning fast from MH370

The international aviation community wants to put an airliner-tracking system in place to prevent more mysteries like that of Malaysia Airlines Flight 370. And it wants to do so quickly. Natalia Mironova and Philip Butterworth-Hayes examine the options.

The International Civil Aviation Organization reacted to the disappearance of Malaysia Airlines Flight 370 by calling experts from more than 30 countries to a meeting in Montreal in May. As things stand, the world's airlines and air traffic controllers have no system in place to track planes as they cross the world's vast ocean and desert regions. For the normally restrained ICAO, the meeting's official announcement amounted to a bureaucratic scream about the need to fix that problem. ICAO said the goal was "to try and increase current momentum on deliberations over the specific aircraft and satellite-based capabilities needed to permit global implementation of worldwide flight tracking."

Photo by Laurent Errera

Pundits and airline passengers were shocked in March to learn that a Boeing 777 like Flight MH370 could simply disappear into the black of night in this age of satellite phones, in-flight Wi-Fi and remotely piloted aircraft. But those who gathered in Montreal were probably not surprised. Today, the passengers and crews of airliners are virtually on their own once they move beyond the approximately 290-statute-mile range of shore radars and radio towers. Before

MH370 vanished, the desire for better surveillance had been driven mostly by the allure of cutting fuel costs by allowing planes to fly closer together and spend less time in holding patterns.

The world is about to learn whether the mystery of Flight 370 will be enough to prompt the airlines and the world's air navigation service providers — meaning the FAA and equivalent organizations around the globe — to finally resolve the technical, financial and policy challenges posed by global airliner tracking. Whatever technology is chosen, the goal would be to plug the radar "dead zones" that could, in theory, put other jets at risk.

What's clear is that the aviation industry has a fresh determination: "I hope we learn more from Flight 370 than let's have longer-life batteries," says Allan McArtor, chairman and CEO of Airbus Group, formerly EADS North America, referring to calls for longer lasting black boxes.

Time is of the essence. Coming out of the May meeting, ICAO set up a new Aircraft Tracking Task Force to identify and assess the options. An ambitious deadline of October 14 was set for a final report.

The choice

One camp would like to adapt the existing Aircraft Communications Addressing and Reporting System to relay position data over geosynchronous satellites and ground gateways. Airlines use ACARS mainly to receive intermittent performance reports from planes in flight so maintenance work on engines or electrical systems can be done once the planes land. It is used less often to relay navigation data. The maintenance data arrives at airline operations centers via radio links when the planes are over land or via Iridium and Inmarsat satellites when they are over the oceans. As the world now knows, the satellite carrying ACARS data kept shaking hands hourly with MH370 via an Inmarsat geosynchronous satellite, although no data was sent.

There is another camp, and this camp would like to take advantage of the fact that airliners are starting to be equipped to

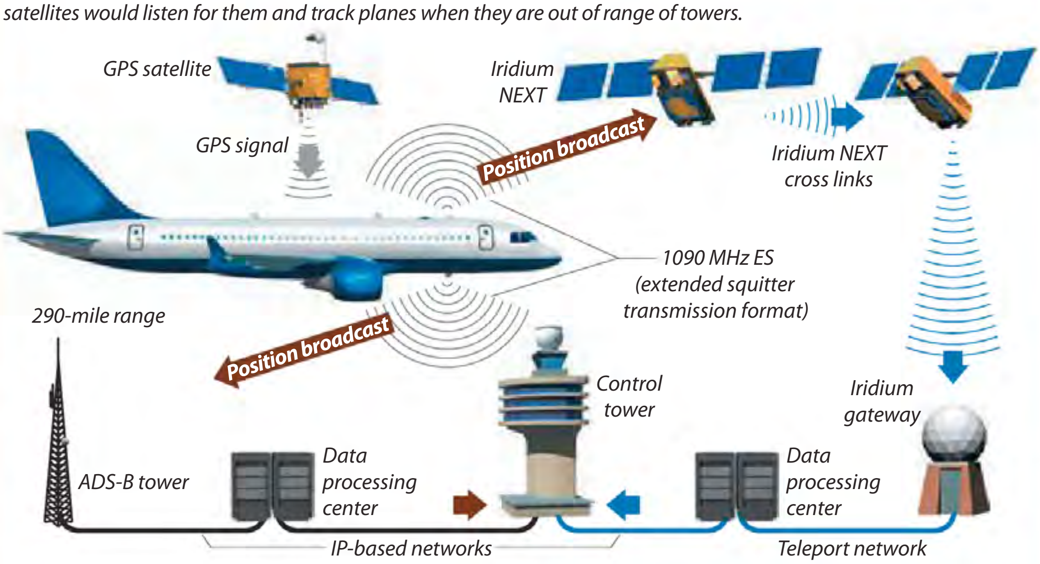
Boeing

Tamper proof? Fire concerns are making authorities hesitant to deny the crew the ability to turn off GPS broadcasts. Shown here is an artist's rendering of the cockpit of Boeing's new 737 MAX family of aircraft.

by Natalia Mironova and Philip Butterworth-Hayes

EXPANDED SURVEILLANCE

Airlines are equipping planes to broadcast GPS locations to controllers via automatic dependent surveillance-broadcast, ADS-B, services. These signals are meant for ground towers, but they also radiate to space, where new Iridium satellites would listen for them and track planes when they are out of range of towers.



Sources: FAA, Iridium, Exelis

Illustrations by John Bretschneider

broadcast GPS coordinates via new automatic dependent surveillance-broadcast, or ADS-B, transponders, as required by the FAA under its NextGen air traffic control modernization initiative. These transponders broadcast GPS signals through antennas positioned on the roofs and bellies of planes so the plane doesn't lose connectivity with receiving towers when it banks. The signals are meant for those ground towers, but they also radiate into space. That's where satellite operator Iridium and the multinational venture called Aireon come in. Even before MH370 disappeared, Aireon executives were laying plans to listen in on ADS-B signals with antennas aboard Iridium's forthcoming next-generation low-Earth-orbit satellites.

The task force is saying only that it wants to examine timely solutions. "The [task force] is focused on identifying near-term options for global tracking of aircraft. One of the primary activities of [the task force] will be to assess the products and services that exist today to see how they may be used to implement global flight tracking. Because the industry has committed to an extremely aggressive timeline to develop recommendations, it is imperative to limit the scope of the assessment," says Perry Flint, spokesman for the Americas for IATA, the International Air Transportation Association, which represents the interests of the world's airlines and leads the new task force.

Which options or option would constitute near-term solutions? That's unclear at this point. Flint says it will be up to the task force to identify those options.

Going global

The main alternative to the ACARS-Inmarsat proposal comes from Aireon, the joint venture between Iridium Communications, Inc., and Nav Canada, the not-for-profit company that owns and operates Canada's air navigation system. Aireon payloads will be installed on 66 Iridium NEXT satellites, which Iridium plans to begin launching next year, with the tracking service expected to start in 2017. Aireon is banking that its timetable will mesh well with installation of the ADS-B technology on airliners. Each aircraft's avionics compartment (usually located below the pilots) must be fitted with a transponder box the size of a microwave oven that sends out the plane's GPS location data every 10 to 15 seconds to a ground-based data center, which processes the information and distributes it to the airlines and air traffic control. The FAA is already rolling out ADS-B in U.S. airspace as part of the NextGen initiative, and it will be mandatory for all aircraft flying into the U.S. by 2020.

If ADS-B is going to be turned into a tracking solution, it "needs a global rollout...not just in the U.S.," cautions McArtor of Airbus.

Aireon hopes to make ADS-B a global system by fixing its one disadvantage: The stations and towers that receive ADS-B broadcasts and relay them to controllers are all on land, which limits coverage to when planes are over land or within a few hundred miles.

ADS-B has not been fully rolled out aboard planes, but advocates note that the towers and networking equipment are in place and that aviation authorities beyond the FAA are beginning to mandate it — although not yet the satellite version. "Europe has a similar thing in place. And more and more countries are moving to that model," says Ed Sayadian, vice president of air traffic management at Exelis, which built and is maintaining the ground system for the FAA's portion of ADS-B and will also build and maintain the data management and distribution system for Aireon. According to Sayadian, the transition to satellite-based ADS-B would be seamless for aircraft already equipped with ADS-B transmitters because of the omni-directional nature of the antennas.

Even so, the FAA hasn't signed on to be part of Aireon just yet. Onboard so far are Nav Canada, the Irish Aviation Authority, the Italian Company for Air Navigation Services — known by the Italian acronym ENAV — and Naviair, which provides aviation infrastructure in Denmark, Greenland and the Faroe Islands.

Wayne Plucker, an aviation industry expert with global consulting firm Frost & Sullivan, says the "heavyweights" like the FAA and Eurocontrol will have to adopt Aireon for it to become a global standard for flight tracking, and he says he is not convinced everyone is onboard yet. "There is still a lot of talking going on about data-sharing," he says. "No one wants a terrorist to use tracking information for ill use," he adds.

On top of that, making sure smaller and less financially stable nations can afford to participate will be key to making Aireon truly global. Aireon President and CEO Don Thoma tells Aerospace America that's an issue Aireon's partners have already thought through: "To take advantage of Aireon's service there are no additional service charges that they already incur from ANSPs (air navigation service providers) and we expect those additional fees will be based on a net savings to the airlines, as the cost of the Aireon service will be less than the value of fuel saved," he explains by email.

The case for existing technology

The ACARS proponents say they have an edge, because while ADS-B transponders are being installed in some planes, ACARS is already aboard many more. ACARS data link service providers SITA of Geneva and ARINC of Annapolis, Md., have been using Inmarsat and Iridium satellites to complement the VHF and HF radio communications used over land.

The primary role of ACARS has been maintenance messages, but even now airlines sometimes use it to transmit position information. In this model known as ADS-C (the C standing for contract), the airplane's position message is automatically broadcast to a requesting air navigation service provider as part of an international initiative called FANS for Future Air Navigation System, using ACARS as the communications medium. A plane entering an authority's airspace establishes a real-time communications "contract" after it's requested by air traffic control. The contract spells out how often position information will be transmitted. This is different from ADS-B, in which airliner positions are broadcast almost continuously for anyone with the right equipment to receive them.

Inmarsat wants the airlines to make greater use of ADS-C, and following the loss of MH370, the company has offered to provide this position reporting data for free. As Inmarsat aviation vice president David Coiley explains: "What we're trying to do is stimulate the routine use of that capability globally other than the way that it's currently used for flight-tracking. What we would like to see is more ANSPs take this up."

Inmarsat-compatible communications antennas are already on 90 percent of the world's widebody, long-haul airliners, Coiley says. "There is no additional expenditure required or hardware, and the solution facility and the flight-tracking capability already exist on the aircraft. So it's an immediate hit, an immediate improvement we are trying to stimulate to encourage the broader adoption of ADS-C positional reporting," he adds.

SITA, the ACARS communication provider, has an idea for how to expand ADS-C smoothly. Prompted by the Montreal meeting, the company announced in June that it will offer what it called an enhanced data sharing capability to complement Inmarsat's proposal. The SITA AIRCOM Server Flight Tracker service would allow an airline's flight dispatchers to access ADS-C data currently only available to air navigation service providers.

But ACARs has its own limitations as a flight tracking service. The service relies on geosynchronous satellites whose positions over the equator limit how far north or south they can reach, and so some regions are uncovered. There is the problem of reliability and security — a new back-up and system monitoring network will be needed to ensure the space-based and ground-based systems are operating to the required standards.

Airliner surveillance: Iridium's Aireon venture plans to use the forthcoming Iridium NEXT satellites to gather up position broadcasts.

Aireon

Tamper proof?

Besides the logistics of data sharing and affordability issues, one topic keeps coming up in discussions about onboard tracking devices — all of them can be turned off by the pilot. The Flight 370 mystery has been punctuated by speculation that someone — the flight crew or perhaps terrorists — intentionally switched off or disabled the communications equipment that would transmit position data.

So far, no one has proposed a device that would be locked away in a tamper-proof box with its own wiring and power source, similar to the way airliner black boxes operate. The main reason for that is the pilot's need to be able to turn off avionics or anything else electrical in case of fire, be it with an off switch or a circuit breaker. It's a safety issue, according to the pilots. The International Federation of Air Line Pilots' Associations "supports the concept of global tracking of aircraft; however, as with any issue related to aviation, there needs to be a safety and cost benefit analysis for procedures and/or equipage proposals," says Valerie McLeod, a spokeswoman for the federation. "IFALPA is not in favor of simply making aircraft communications equipment 'tamper proof' — the ability to turn off electrical equipment in the aircraft in the event of a malfunction or electrical fire is essential."

One solution could be to place the flight tracking device in a part of the aircraft that cannot be accessed by the flight crew — such as in the tail behind the rear pressure bulkhead. "But then you would need to re-consider aircraft certification issues," says David Gleave, an aviation accident investigator based in the U.K. Today, long-haul aircraft must be ready to fly on battery power alone for 30 minutes. Adding a flight tracking device would increase the load on the batteries, and this could mean that many aircraft would not be able to operate for the required 30 minutes.

Inmarsat is exploring a potential solution to the "off switch problem" independently of the free flight-tracking service the company is offering. The one piece of equipment that stays on even if the avionics are turned off is the aircraft's antenna, which sends hourly signals to the satellite with the airplane's unique code to ensure continuous connectivity. This is known as "handshaking." It provided the only clues about MH370's possible flight path after other communications were lost.

Handshaking, however, is not a great tool for flight tracking — the updates happen only once an hour and the signal doesn't include any position data, so the direction of flight had to be calculated from the angle between the aircraft and the satellite. Coiley says Inmarsat is working to fix that. "What Inmarsat is evaluating at the moment is enhancing the handshake capability — the signaling capability in our network to actually include positional report data. It is currently possible for us to enhance the handshake to include position data," he says.

Policy questions

Whether the international community will embrace Aireon or sign on to Inmarsat's proposal depends on how a host of institutional challenges are resolved. Agreement would be needed about which class of aircraft must be covered. Should the smallest type of aircraft be required to engage in the global flight tracking service? If an airline's aircraft is never out of radar range, is it really necessary to re-equip with a satcom transmission system? Where does the information go? Directly to the nearest air navigation service provider, or to a ground station that would automatically distribute the information to the relevant en-route, approach or airport centers? Who would be responsible for tracking the aircraft's location against the flight plan, and alerting first the crew then the appropriate security and safety organizations in case the aircraft did not return to its agreed flight plan? How fast should the data update rate be? What sort of timescale should be considered for implementation?

This is the work that ICAO is currently undertaking after Montreal, separately from the airliner tracking task force. The data-sharing is likely to be based on the current system, in which the communications service providers (ARINC and SITA) distribute aeronautical telecommunications data to different clients, but use the same core system.

Not all governments are waiting for those questions to be sorted. In early May India's civil aviation regulator instructed Indian airlines to track all aircraft in real time using onboard ACARS or ADS-B. It ordered flight crews to report aircraft coordinates, speed and altitude every 15 minutes while flying over areas not covered by radar.

One thing experts agree on is that making airliner tracking global will require innovation and compromise. As Frost & Sullivan's Plucker says, "It's a study in international conundrums. There is not a good answer at this point." Or at least not an easy one.

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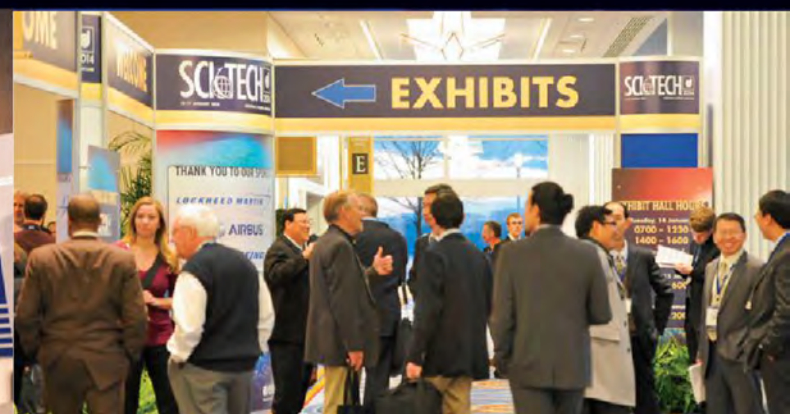

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RD-180: Learning to let go

Growing concerns over U.S. dependence on Russia's RD-180 engine for launching Atlas 5 rockets led to the recently released "Mitchell Report," named for the chairman of the panel that studied the issue. Marc Selinger explains the report's recommendations and looks behind the scenes at the long-simmering controversy.

by Marc Selinger

When the U.S. signed an agreement in 1994 to import RD-180 rocket engines built by Russia's NPO Energomash, many defense officials figured the U.S. would one day get around to doing what a panel of experts chaired by retired Air Force Maj. Gen. H.J. "Mitch" Mitchell now recommends it should do: figure out how to propel the first stage of the Atlas 5 without relying cooperation with Russia. Specifically, the Mitchell report recommends a domestically produced engine.

No one through the years was clairvoyant enough to predict that a Russian deputy prime minister would tweet a threat to cut off the supply of RD-180s because of tensions over Ukraine. But U.S. defense and intelligence officials were not unaware of the risk they were taking. Some inside the Pentagon argued that Boeing-built Delta 4 rockets could back up the Atlas 5 rockets if the inventory of RD-180s at a United Launch Alliance manufacturing plant in Decatur, Ill., ran out. Mitchell recommends making sure payloads are also compatible with Delta 4s, but cautions there is no option that would fully replace the RD-180s through fiscal 2017.

Most recently, in 2007, then-Pentagon acquisition chief John Young penned an "acquisition decision memorandum" — or ADM — directing the Air Force to develop an equivalent to the RD-180 on its own or become a co-producer of the engine, meaning a second nation to build RD-180s — not that it would build them jointly with Russia.

"I am deeply troubled by dependence on Russian-produced RD-180s for its space lift," Young wrote in cursive at the bottom of the one-page document. "I want to see a robust, aggressive, fully funded plan to develop a new engine, co-produce RD-180s, or both!"

Young tells Aerospace America that in light of the "long history of roller-coaster relations" between the United States and Russia, it was too risky to rely on Russian engines for vital space launches. That concern is reflected in his memorandum, which tells the Air Force to "maintain a sufficient RD-180 inventory to ensure access to space in the event of a disruption in the supply of Russian engines. This inventory is intended to allow for the smooth transition to a new engine for Atlas 5 or for the orderly transfer of payloads to the Delta 4 system."

As a Georgia Tech-educated aerospace engineer, Young also strongly believed that the U.S. military could — and should — use American-made engines.

"I saw it as a matter of national pride," recalls Young. "In a nation that created the

Source of controversy: The two thrust chambers on the RD-180 engine on an Atlas 5 rocket. The U.S. depends on the Russian-built engine to power the rocket's first stage.

NASA

aerospace industry — or the vast majority of it — we were using Russian engines. That was never a satisfying condition for me."

Despite Young's effort, Air Force funding for a new or co-produced engine never materialized, and Young says the issue fell by the wayside when he left office in 2009.

"It just got buried in the Pentagon budget process," Young says.

The Air Force, in a prepared statement, said it "did continue R&D efforts to 'improve understanding' [of the RD-180] as directed by the ADM. Those efforts continue to inform the ongoing review of the issue and any decisions that may be made."

U.S. lawmakers are also concerned about continued reliance on Russian engines. The House Appropriations Committee has proposed spending $220 million in fiscal year 2015 to begin developing a new U.S.-made engine.

Starting anew?

The Mitchell panel estimates it would take six years to develop a new engine, which is typical, even aggressive, for a new rocket engine program, industry officials say. The program would begin with two years of technical risk-reduction efforts, followed by four years of full-scale development.

The risk reduction phase would cover standard issues for a new engine, including pre-burner and main-chamber combustion stability, the injector and turbo-pump designs, and metallurgy technology.

U.S. rocket experts say developing a new engine would be preferable to learning to make the RD-180 in the U.S. Domestic production of the RD-180 would save little time or money and would use a 40-year-old design, these industry officials say. One problem is that Russian engineers protect metals parts inside the RD-180s by applying coatings. The U.S., by contrast, would prefer the newer approach of utilizing alloys that can withstand an oxygen-rich combustion environment like that inside the RD-180 — an environment that can burn parts absent the right engineering solution.

"There are not many things you would start with 40-year-old technology, and rocket engines are no exception," one industry official says.

Also, an agreement allowing the U.S. to co-produce the RD-180 expires in 2022, and there is no guarantee Russia would approve renewing that agreement, especially with U.S.-Russian relations tense over Ukraine.

On the other hand, developing a new engine would create its own set of challenges.

The 46 Atlas 5 launches powered by the RD-180 have gone well. "If we do a new engine, there will be no track record," Young says. "We're going to have to start over and we're going to be taking some risk. But I believe…the U.S. should have the capability and the national will to have a rocket engine industrial base that can launch any payload we need to launch."

Standby: A Boeing Delta 4 lifts off. Some in the Pentagon have argued that if the RD-180 engine became unavailable, this heavy-lift rocket could fill in for the Atlas 5.

Boeing

United Launch Alliance

Blasting off: An Atlas 5 launch at Vandenberg Air Force Base. An angry tweet by a Russian official during the Ukraine crisis threatened to cut off the supply of RD-180 engines that power the rocket's first stage.

Atmos

The desire by Google and Facebook to make broadband access truly ubiquitous is breathing new life into work on atmospheric satellites – aircraft or aerostats that would fly for months at time. Debra Werner examines the technology.

by Debra Werner

The financial world was abuzz earlier this year with rumors that Facebook was about to pay $60 million to buy Titan Aerospace. Out of nowhere came Google, with a plan to buy the 14-person unmanned plane maker for an undisclosed sum.

Why would two online giants be locked in a tug-of-war over a small company specializing in solar-powered drones? Businesses like Facebook and Google know that two-thirds of the world's people don't have Internet connections of any kind, and they see long-duration aircraft as a potentially cost-effective way to soar beyond an obvious roadblock to their long-term growth.

Facebook and Google, which completed the Titan acquisition in April, are not alone in sensing the potential of long-duration aircraft. For more than two decades, government agencies and aerospace heavyweights have dabbled in attempts to build airplanes and aerostats that would spend months or years in the stratosphere, relaying communications, providing surveillance and serving as stand-ins for satellites. Some refer to their proposed craft as atmospheric satellites, and their key advantage over the orbiting kind would be their relatively low cost and ease of launch. So far, the technical challenges have been too much for these craft to pose competition to satellites, which need occasional station keeping boosts but don't have to be constantly moving to stay aloft. Engineers have yet to prove that batteries or fuel cells can function reliably on a solar-powered plane for months at a time. Aerostats have the advantage that they can be reeled down to change their batteries. But if too much maintenance is required or their lightweight materials can't withstand the elements, then their economic advantages disappear quickly.

Enter the impressive financial resources of Google and Facebook. Observers are beginning to wonder aloud whether the private sector's research dollars can be combined with the research to date to make this the age of the atmospheric satellite.

pheric satellites

"In the last 5 years, the aeronautical technology needed, the actual structural aspects as well as solar panels have become more efficient and the storage mechanism for the electrical energy have become much better. We are now finding a situation where it is possible to build a solar powered plane we were originally looking at over a decade ago," says David Grace, head of the communications and signal processing research group at England's University of York.

Why it's hard

Virtually limitless flight would require getting to the stratosphere in a light airframe that would have to handle the journey upward through wind and weather to calmer skies above 18 kilometers.

Some atmospheric satellites have achieved impressive results. Zephyr, an unmanned aircraft built by Qinetiq, a defense technology company based in Farnborough, England, set an endurance record in 2010 when its 50-kilogram plane with a 22.5-meter wingspan remained airborne for 14 days. Earlier this year, a high-

Qinetiq

Zephyr, developed by U.K.-based Qinetiq. The unmanned solar aircraft set an endurance record in 2010, remaining airborne for 14 days.

Titan Aerospace

Artist's rendering of Solara 50, designed to stay airborne for five years. The plane is under development by Titan Aerospace, the New Mexico company purchased by Google in April.

altitude balloon built by Raven Aerostar, an aerospace company with headquarters in Sioux Falls, S.D., demonstrated its ability to keep a high-altitude balloon aloft for 77 days. [See "Flying around the world on solar power," Page 5.]

Many more projects have failed because of the enormous financial investments required and the significant technical challenges. The challenges posed by long-endurance aircraft are very different from those of a "conventional airliner, which after a mission duration of a few hours, can be brought down and repaired," Grace says.

He knows the problem well. A decade ago, he served as principal scientific officer for Capanina, a European Union project that tested the ability of high-altitude craft, including balloons, airships and unmanned solar-powered planes, to relay wireless and optical communications. When Capanina funding ran out in 2008, aeronautical technology simply was not ready for long-duration airship or unmanned aircraft missions.

Since then, solar panels, batteries, fuel cells and composite structures have improved. "We are now finding a situation where it is possible to build a solar-powered plane we were originally looking at over a decade ago," Grace says.

Google's Titan Aerospace agrees. Company officials declined to say what performance they have achieved to date with Solara 50, a 15.5-meter-long solar plane with a wingspan of 50 meters, but they've advertised a goal of keeping it aloft for five years. "It's very early days for Titan Aerospace, but they have designed, built and tested early prototypes and components as a proof of concept," says a Google spokesman. "We aren't providing details about these tests — except to say they have shown that atmospheric satellites have the potential to solve problems that Google has long been interested in, such as Internet access and disaster relief."

Power progress

No aircraft has come close to the five-year mark. In 2010, the Defense Advanced Research Projects Agency awarded Boeing an $89-million contract to develop an unmanned solar-powered plane capable of lifting 450 kilograms above 18 kilometers and keeping it there for five years. Within two years, DARPA scaled back the effort to focus on the project's major obstacles: solar and fuel cell technology.

Extremely efficient solar panels can provide aircraft, aerostats and their onboard electronics with enough power for daytime operations. To keep electronics humming through the night requires some way to turn the solar energy into electricity and store it. That means batteries or fuel cells, which have not yet been able to demonstrate the energy density needed for long-term unmanned aircraft flights.

AeroVironment's Helios prototype used battery power and solar cells. It was the precursor to Global Observer.

NASA

Companies have made incremental progress. "People who have been able to demonstrate high energy density in the lab have not been able to turn that into a practical battery that can have useful life in the field," says John Langford, chairman and chief executive of Aurora Flight Sciences, an unmanned aircraft developer in Manassas, Va. "The batteries begin to fall apart after 30 to 50 charge cycles, and that is not enough."

AeroVironment, a technology company focused on unmanned aircraft, energy and electric vehicles in Monrovia, Calif., experimented with batteries and regenerative fuel cells when it built the Helios Prototype, an unmanned flying wing with a 61-meter wingspan that set an altitude record in 2001, reaching 29.5 kilometers during a flight that lasted nearly 17 hours. That flight relied on batteries. In testing on the ground, AeroVironment engineers proved they also could use solar panels to electrolyze water into hydrogen and oxygen during the day and reverse the flow at night to produce electricity. "It worked, but it ended up being a complex system; and not inexpensive," says Steve Gitlin, AeroVironment vice president for marketing strategy and communications.

After Helios, AeroVironment executives decided their best bet for achieving persistent high-altitude operations with existing technology was to ditch solar power altogether. "We spent millions of dollars and concluded if you're interested in providing seamless coverage over the tropics, there's probably enough solar energy year-round," Gitlin says. "To operate in other areas, you need some other solution."

For AeroVironment, the solution is hydrogen power. With funding from the U.S. Defense Department and the U.S. Department of Homeland Security, the company developed Global Observer, a hydrogen-powered plane with a 53-meter wingspan that can fly at an altitude of 17 to 20 kilometers for five to seven days. By swapping aircraft weekly, Global Observer can provide persistent coverage, Gitlin says.

AeroVironment conducted test flights of its first Global Observer prototype from 2007 until 2011, when it crashed after spending 18 hours airborne. The firm is nearly finished building a second Global Observer and looking for customers to fund additional demonstration flights, Gitlin says.

Companies that continue to pursue solar-powered flight say materials technology is another piece of the puzzle that must be found. Much of the weight of a solar-powered plane is reserved for energy storage, so the aircraft body is made of lightweight carbon fiber composites that can be vulnerable to atmospheric turbulence. "There are questions about how well the aircraft will hold up in the high-altitude environment, but we've done reasonable amounts of testing, and I think that's a very manageable engineering problem," Langford says. "In our analysis we're pretty convinced we can build a solar-powered airplane where the structure will not be the limited life item.

AeroVironment, Inc.

AeroVironment's Global Observer is hydrogen powered. The first prototype crashed in 2011 after spending 18 hours airborne; a second plane is nearly finished.

Balloon science

For high-altitude balloons, materials are everything. "Nobody has been able to figure out how to get a lightweight, low-cost, clear, very reliable material into the stratosphere, where the temperature swings 40, 50 or 60 degrees in a day-night cycle, and keep it there," says Lon Stroschein, vice president and general manager for Raven Aerostar. "It's harder than rocket science."

Raven Aerostar has been developing high-altitude balloons for 50 years. The work gained momentum in 2013 when Google began supporting Raven Aerostar's work through Project Loon, the search giant's effort to use a group of high-altitude balloons to establish aerial wireless networks to provide communication links for rural and remote populations.

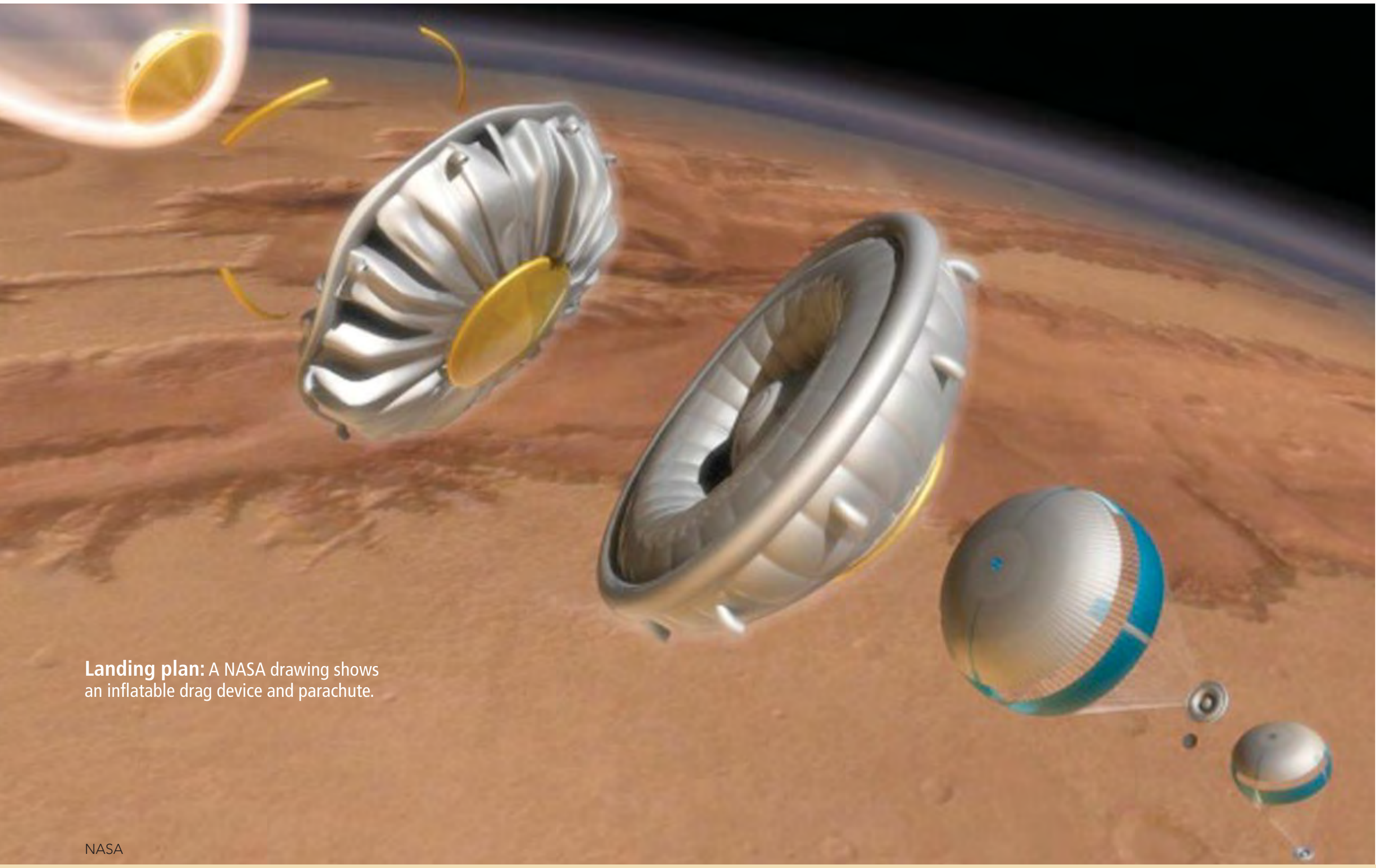
The super pressure helium balloons that Raven Aerostar builds for Project Loon stand 12 meters high and have a diameter of 15 meters when inflated. They are made of translucent polyethylene plastic that is about as thick as a Ziploc sandwich bag. The material's clarity helps to minimize the impact of ultraviolet rays and lets sunlight pass through the balloon to the solar panels that hang below.

As the balloons are carried by stratospheric winds in a circle around the globe, they must withstand enormous pressure. At the hottest time of the day, the balloon's polyethylene plastic, which is buttressed by 2-centimeter-thick tendons that run from top to bottom, must withstand 30,000 pounds of

(Continued on page 41)

WAN

MARS BRAKING TECH



Landing plan: A NASA drawing shows an inflatable drag device and parachute.

NASA

NTED

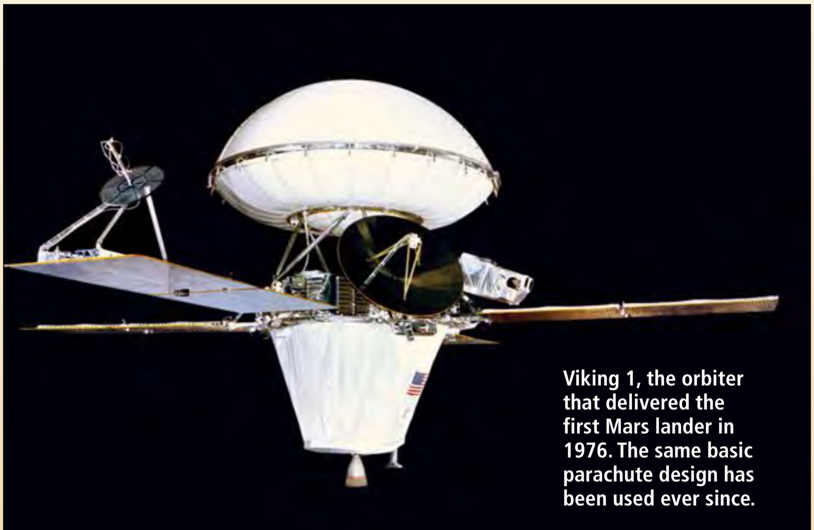
NASA has entered the test phase of an ambitious program to develop inflatable drag devices and mammoth parachutes for landing heavier things on Mars, including the many tons of life-support equipment human explorers would require. Leonard David examines NASA's efforts.

By Leonard David

One of NASA's greatest triumphs of innovation came when the Curiosity rover dangled to the surface of Mars from its Sky Crane module. As impressive as those moments were, other parts of the descent could have been mistaken for the Viking spacecraft landings of 1976.

Curiosity used a Viking-era parachute design. That was fine for the one-ton rover. NASA knows that stronger atmospheric braking technology will be required to land heavier robots and hardware to sustain human explorers on Mars. An inflatable drag vessel will surely have to be added to the entry vehicle, and a larger parachute — perhaps several — will be required.

With that on their minds, engineers at NASA's Jet Propulsion Laboratory in Pasadena are coming to the crucial flight test phase of a five-year, $200 million plan to develop and evaluate new braking technologies. The initiative is called the Low Density Supersonic Decelerator project, with low density referring to the challenge of slowing down a heavy object in the thin Martian atmosphere. At stake is whether



Viking 1, the orbiter that delivered the first Mars lander in 1976. The same basic parachute design has been used ever since.

NASA

Clean room: At the Jet Propulsion Laboratory, NASA workers prepare the saucer-shaped low-density supersonic decelerator for shipment to Hawaii, where it will be launched into near-space for testing. NASA JPL

NASA will be able to check a key box on the list of breakthroughs that might convince skeptics about the feasibility of sending people to the red planet. To be sure, there are questions about the design of the rocket to get there and the ability of humans to survive the radiation environment on Mars. Those questions are moot if the agency can't land heavier things.

The Viking landers were launched four decades ago, and "Since that time we have not done any tests of supersonic flight of these things, and we just relied on test data," says Mark Adler, project manager for the braking technology work at JPL.

"With Curiosity we landed a ton on Mars. To land humans it's something like in the 40-ton range. You can't go from one to 40 tons in one fell swoop. You have to take some steps in-between," says Adler. "So we're taking the first steps along that path, also increasing the Mach number."

Creating drag

Adler's team began the project in 2010, and so far it has devised a 30.5 meter-diameter parachute – almost twice the width of the 16-meter chute that slowed Curiosity — and two different versions of inflatable drag devices, known as SIADs, short for Supersonic Inflatable Aerodynamic Decelerators, or SIADs. A SIAD would be inflated around the periphery of the entry vehicle to slow it to less than Mach 2 from speeds greater than Mach 3.5 The giant parachute or parachutes would be unfurled after the SIAD does its job of slowing the capsule enough that the chute wouldn't be ripped apart.

The engineers are glad to be ending the long test hiatus after the Viking missions. "We have been standing on the shoulders of those tests for all of our Mars parachutes used since. What makes this [test program] much more challenging than those early tests is the larger size and mass of the systems we are testing," says Rob Manning, chief engineer for the low-density braking project.

So far, NASA has tested the big parachute and a SIAD at the Navy's China Lake, Calif., range using a rocket sled designed to roar across the desert floor. To test the parachute, a rope was run through a ground pulley and attached to the sled. The parachute was released and once fully opened, the sled's rockets were fired. As the sled raced ahead it pulled the parachute toward the ground and imparted the desired loads — some 90,000 pounds of force. More parachute and SIAD tests at China Lake are planned for later this year.

JPL engineer Mike Meacham says that the quest for much larger supersonic parachutes has, in the past, relied on wind tunnel data. However, the parachutes were getting so large that they no longer could fit into wind tunnels.

"We needed a way to apply this same type of wind in a controlled way and we had to get outside the building," Meacham says. "You want to go to Mars. You want to go big…then you've got to test big here on Earth," he says, so "You got to be a little crazy sometimes if you want to do crazy things."

The engineers set out to make a larger chute with a new shape, called a supersonic disk sail parachute. Proving the capability of such a large diameter parachute is not to be underestimated. Supersonic parachutes are "fickle devices," says Ian Clark, the principal investigator for the Low Density Supersonic Decelerator work at JPL.

"When we have to use them like we do at Mars, it's behind a very large, blunt vehicle. That vehicle is screaming through the atmosphere. It's punching a hole in the atmosphere. All the air is rushing in behind it to fill the vacuum that it's creating," he says. "That creates a very turbulent, very unsteady environment for the parachute to live in. You need a particular kind of parachute."

Simulating a Mars descent

The sled tests were a good start, but the team needed a way to more realistically simulate the forces that the parachute and SIAD would encounter during the descent to the surface of Mars. The engineers decided to attach cameras to a test article of the size and shape of an entry vehicle and send it up to the stratosphere. A plan was drawn up to slowly loft the vehicle to an altitude of 120,000 feet using a 34-million cubic foot research balloon to be released from a tower at the Navy's Pacific Missile Test Range on the island of Kauai. At that altitude, pyrotechnics will release the vehicle and a split second later, four solid rocket motors are to stabilize the capsule's attitude. This ensures it is pointed correctly when an ATK Star-48 solid motor kicks on to blast the vehicle up to the top of the stratosphere — 160,000 to 180,000 feet — and a velocity of Mach 4. At that point, the vehicle should be positioned approximately horizontally.

"Then the vehicle is ready to conduct the technology experiments at the proper Mars-flight-like conditions," Adler says.

As the vehicle plunges back toward the ocean the SIAD inflates at Mach 3.8 to decelerate it to Mach 2.7, at which point a small chute called a ballute pulls out the 30.5-meter parachute. The craft splashes down about 40 minutes after it was released from the balloon and is recovered.

The need to accelerate the vehicle created an engineering challenge. "The Star 48 motor plume will be releasing a huge amount of radiative heat, so we have lots and lots of blankets to protect the vehicle," Adler says.

"With Curiosity we landed a ton on Mars. To land humans it's something like in the 40-ton range. You can't go from one to 40 tons in one fell swoop. You have to take some steps in between, so we're taking the first steps along that path, also increasing the Mach number."

— Mark Adler, NASA JPL

"It's much, much more complicated than the steel structure we put on the rocket sled," he adds. "But what we did learn is how to integrate SIAD onto the vehicle and make sure we knew how to interface it with the inflation devices. We showed that it deployed properly."

Last month, the team was waiting for the winds to ease enough at Kauai to conduct the first of three planned stratospheric tests — one this year and two in 2015. The team expects a rich bonanza of information once the vehicle is recovered. How did the SIAD survive the event? Did it start to rip and is there thermal damage?

NASA

Rocket power: A deceleration device on a rocket sled test fixture at China Lake, Calif. NASA wants to go to the stratosphere next.

How did the parachute fare?

Adler will consider the first flight a success if the test vehicle is launched to the proper speed and altitude. He describes it as a "shakeout flight" to see how the test approach works. Any information about the SIAD and parachute he considers a "bonus." Lessons will be applied to the flights next year.

One version of the inflatable device is called SIAD-R, with R short for robotic. This version is six meters across and is the version that Adler was trying to test from Kauai in June. It is meant to be paired with the next version of the Curiosity rover, which would be a bit larger than a ton. It would be inflated with pressurized hot gas. The second version is called SIAD-E, with E short for exploration. It's for payloads in the 3-ton, 5-ton or 10-ton class. Scoops on its side would pull air in at 2,000 miles per hour, inflating the SIAD to the proper shape.

"They are somewhat competitive, but it is the 6-meter that will be brought to Technical Readiness Level (TRL-6)" — meaning a prototype or representational model — "and ready for use in a project," Adler says.

The exploration version is more experimental and is planned to be brought to TRL-5, meaning a less-refined breadboard technology.

"They have similar mass, so the 8-meter would be more efficient," Adler explains.

Good to be testing again

The flight tests will mark the first time since the 1970's that NASA has tested large deceleration devices at supersonic speeds.

The tests from Kauai would be the most ambitious steps yet to go beyond that technology.

"It's been quite a while getting to this point," Adler says, comparing the work to "a spacecraft development."

An optimistic Adler says the technologies tested now might be used as early as NASA's proposed 2020 Mars rover mission, which is now being scoped out.

But his team has even greater ambitions. One idea that's blossoming would be to use a cluster of three to five of the 30.5 meter diameter parachutes to place perhaps 15 tons on Mars.

"Getting the humans down on Mars doesn't require that much mass. But it's not going to do them much good to land…and not have a place to live," Adler notes.

Satellites

(Continued from page 35)

force. "Making sure all those pressures are balanced and the balloon does not meet its ultimate demise in a burst takes a lot of solid engineering," Stroschein says.

Earlier this year, a Loon balloon spent 77 days in the stratosphere as it circumnavigated the southern hemisphere. Raven Aerostar will continue to push for longer duration and to address other vexing issues like station-keeping. While no one expects balloons to remain in place, operators do need to have some control over their location. Raven Aerostar gains that control by using a ballonet to make the balloon ascend or descend to the appropriate level in the stratosphere where it can catch a ride on winds that will move it in the proper direction.

Since 2012, Grace and his European Union colleagues have set aside plans for high-altitude aircraft and worked on developing low-altitude tethered aerostats to restore communications in the wake of earthquakes, hurricanes or other disasters. "This is a very tried and trusted technology that gives you the benefit of the aerial perspective," says Grace, lead investigator for Project ABSOLUTE — Aerial Base Stations with Opportunistic Links for Unexpected and Temporary Events. "You get the coverage you want with quick deployments."

Still, Grace has not given up on untethered missions. "High-altitude platforms, in general, need investments which Facebook and Google would be able to provide," he says.

Pushing back

Not to be outdone by Google, in March Facebook founder Mark Zuckerberg announced Facebook's purchase of Ascenta, an aerospace company based in the U.K. whose founders helped to build early versions of the record-setting Zephyr. Ascenta employees will work with a team of experts in aerospace and communications technology in Facebook's Connectivity Lab, the organization responsible for spreading Internet access, which Zuckerberg calls, "a human right." Internet.org did not respond to requests for comment on its atmospheric satellite projects.

Although atmospheric satellites have not proven their ability to establish communication networks, Facebook and Google must believe it's possible or they would not invest in the technology, says Michael Blades, Frost & Sullivan Aerospace and Defense senior industry analyst. Even if unmanned aircraft can spend only six months aloft instead of five years, Google and Facebook could reap enormous savings by using aircraft rather than satellites to establish communication networks, because high-altitude solar aircraft would cost a fraction of the price of a single satellite. And at the end of a flight when the aircraft lands, Google and Facebook can upgrade the onboard sensors or communication equipment, Blades says.

Titan Aerospace and Ascenta are two of many firms recently gobbled up by Google and Facebook. In late 2013 and early 2014 alone, Google purchased seven robotics companies. Google and Facebook companies are willing to spend money on interesting technologies in the hope that some of them will pay off down the road, says Rich Kapusta, marketing vice president for Alta Devices, a Sunnyvale, Calif., manufacturer of thin, flexible solar power films. The company, according to Kevin Jones, research associate professor at the Naval Postgraduate School in Monterey, Calif., is becoming the DARPA of the commercial world.

Raven Aerostar

A Raven Aerostar high-altitude balloon. The craft is part of Project Loon, Google's effort to create a network of balloons to provide wireless communications to remote populations.

25 Years Ago, July 1989

July 24 The European Space Agency launches two communications satellites — one French and one German — on an Ariane rocket. NASA, Astronautics and Aeronautics, 1986-1990, Page 273.

Fifty Years Ago, July 1964

July 5 About 30 light aircraft representing France, Switzerland and Austria fly en masse across the English Channel to commemorate Louis Blériot's historic first flight over the same course, made nearly 55 years earlier on July 25, 1909. Flight International, July 9, 1964, Page 41.

July 5 The Library of Congress distributes Braille translations of books on space exploration to 30 large city and state libraries, it is announced. The library publishes these works under a NASA grant. Las Cruces Sun-News, July 5, 1964.

July 5 The European Space Research Organization launches its first solid-propellant British Skylark sounding rocket to an altitude of 125 miles at the Salto di Quirra range on the island of Sardinia, Italy. The rocket carries two chemical cloud experiments for investigating photo-ionization and diffusion of gases in the upper atmosphere. The launch marks the start of a planned eight-year launch program. New York Times, July 11, 1964, Page 5; Aviation Week, July 13, 1964, Page 26; Flight International, July 16, 1964, Page 117.

July 6 An Atlas-Agena D rocket launches Elint, a U.S. electronic intelligence-gathering satellite, as a "piggyback" payload with a KH-7 high-resolution reconnaissance satellite, at Vandenberg Air Force Base, Calif. D. Baker, Spaceflight and Rocketry, Page 168.

July 7 In a statement broadcast on Moscow radio, Gen. Yevgeni Loginov, director general of Aeroflot, says the Soviet airline is now ready to open direct, non-stop air service between the USSR and the U.S. It will be another four years, however, before the service begins: The Moscow-New York route opens in 1968, 10 years after negotiations for the service started. Flight International, July 16, 1964, Page 86.

July 11 The USSR orbits a pair of scientific satellites, Elektron 3 and Elektron 4, on a single rocket. Both satellites are to study and make simultaneous measurements of the Earth's magnetic field, cosmic radiation, and radiation belts. Washington Evening Star, July 11, 1964; Aviation Week, July 20, 1964, Page 23.

July 11 Japan launches its most advanced research rocket, the three-stage Lambda 3, from the Kagoshima Space Center, up to an altitude of 600 miles, to gather data on the upper atmosphere. Washington Post, July 12, 1964.

July 16 Boeing announces plans to build the Boeing 737 short- to medium-range twinjet narrow-body airliner. The 737 series enters production in 1967 and becomes the best-selling jet airliner in the history of aviation, with more than 7,500 aircraft delivered and the plane still in production 50 years later. Flight International, July 23, 1964, Page 127; Boeing 737 file, National Air and Space Museum.

July 16 The joint Ryan-General Electric XV-5A, an experimental lift-fan jet-powered very short takeoff and landing aircraft developed for the Army, makes its first flight at Edwards Air Force Base, Calif. Flight International, July 23, 1964, Page 123.

July 20 Space Electric Rocket Test 1 is launched by a solid-propellant Scout booster from Wallops Island, Va. The 375-pound spacecraft confirms that electrostatic, or ion, engines can produce thrust in space. Even though their levels of thrust are minuscule, these engines have very high exhaust velocities and theoretically could propel vehicles into deep space for long-duration missions. Scout carries two engines, one built by the NASA Lewis Research Center and the other by Hughes Aircraft. They use mercury and cesium propellants, produce 0.0637 and 0.001 pounds of thrust, respectively, and are mounted on opposite sides of the craft. American rocket pioneer Robert H. Goddard first thought of electric propulsion for spacecraft as early as 1906. Flight International, July 30, 1964, Page 196.

July 27 Rocket pioneer Robert H. Goddard is posthumously named the winner of the 1964 Daniel Guggenheim Medal. Goddard created the first liquid-powered rocket, one of his many achievements cited in the award. Washington Evening Star, July 27, 1964.

Past

An Aerospace Chronology
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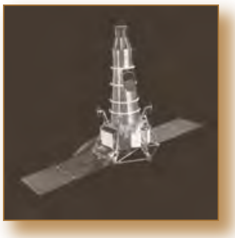


July 28 The 806-pound Ranger 7 space probe departs Cape Kennedy, Fla., for the moon. Launched on an Atlas-Agena rocket, the probe carries six TV vidicon cameras to take and relay close-up views of the lunar surface 17-18 minutes before impacting. Ranger 7 follows the failed attempts of its six predecessors and becomes the first U.S. space probe to transmit close images of the lunar surface back to Earth. New York Times, July 29, 1964; D. Baker, Spaceflight and Rocketry, Page 169; Aviation Week, Aug. 3, 1964, Pages 18-19.

July 29 West Germany's two-jet VJ101 vertical takeoff aircraft, developed by Boelkow, Heinkel, and Messerschmitt, exceeds the speed of sound in a test flight. Washington Post, July 31, 1964.

And During July 1964

Pan American Airways announces it will adopt inertial navigation for its 48 Boeing 707s and the seven more it has ordered. It is the largest electronic equipment purchase ever made by an airline. The system chosen is the new Sperry New York SGN-10. Flight International, July 30, 1964, Page 171.

75 Years Ago, July 1939

July 8 German aircraft designer Adolf Rohrbach dies at age 55 in Berlin. One of his most remarkable craft was the Staaken E.4/20 of 1919 which was made of duraluminum, had a wingspan of 101 feet, could seat 12-18 passengers, had a toilet and separate luggage space, and flew at approximately 140 mph. Passengers entered the plane from the nose. The aircraft was scrapped, however, by the Inter-Allied Control Commission because it believed the plane had military potential and would therefore violate Treaty of Versailles stipulations. Flight, July 13, 1939, Page 41; Interavia, July 14, 1939, Page 9.

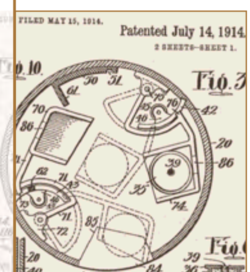
July 17 The prototype of the Bristol Type 156 aircraft, later known as the Beaufighter, makes its inaugural flight. C. Barnes, Bristol Aircraft Since 1910, Page 292.

July 25 The Avro Type 679 twin-engined heavy bomber, later known as the Manchester, makes its first flight. The Rolls-Royce Vulture engines are underdeveloped, but replacing these with four Rolls-Royce Merlin engines improves the plane. Renamed the Lancaster, it becomes one of the greatest heavy bombers of World War II. A. Jackson, Avro Aircraft Since 1908, Page 354.

100 Years Ago, July 1914

July 1 The British Admiralty decides to form its own air force and creates the Royal Naval Air Service. The Army's Royal Flying Corps is given the status of a corps. Sir Robert Saundry, "Air Bombardment," Page 10.

July 7 Robert H. Goddard takes out his second patent, No. 1,103,503, for a "Rocket Apparatus." It is the first of his inventions to feature a liquid-propellant rocket. E. Goddard and G. Pendray, eds., "The Papers of Robert H. Goddard, Vol. III," Page 1651.



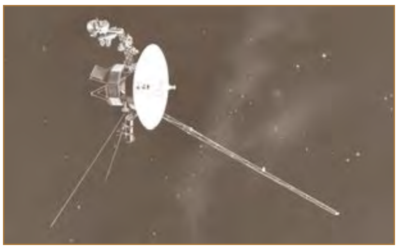
July 11 Walter L. Brock becomes the first man to travel from London to Paris and back in one day when he wins the London to Paris air race, flying a Morane monoplane. The Aeroplane, July 15, 1914, Pages 49, 66-68, 70-71.

July 18 U.S. military aviation takes the first step toward independence when Congress establishes the Aviation Section of the U.S. Army Signal Corps. G. Swanborough and P. Bowers, United States Military Aircraft Since 1909, Page 1.

July 28 Royal Navy Lt. Arthur Longmore makes the first test drop of a standard naval torpedo from an aircraft, a Short Folder Seaplane, at Calshot, near Southampton, England. D. Wragg, "Wings Over the Sea," Page 18.

Out of the

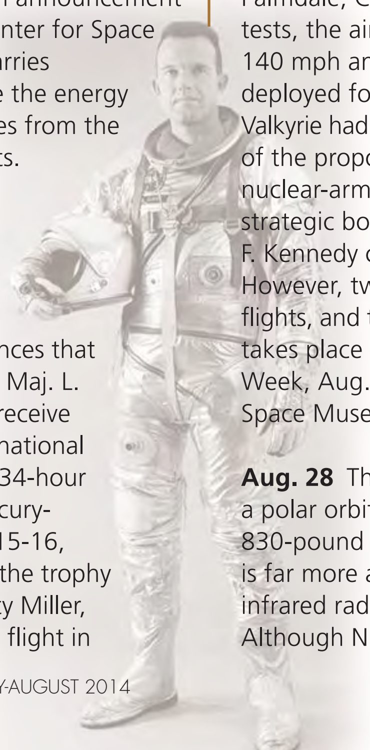
25 Years Ago, August 1989



Aug. 25 The Voyager 2 space probe makes its closest approach to Neptune, coming within 3,042 miles and making more discoveries. There are several rings around the planet and huge storm systems on the large moons Triton and Nereid. The spacecraft also measures the fastest wind speed yet found on any planet in the solar system, near Neptune's Great Dark Spot. Voyager 2, launched in 1977, has traveled for 12 years. Its sister probe, Voyager 1, encountered Saturn. After passing Neptune, Voyager 2 heads for interstellar space. NASA, Astronautics and Aeronautics, 1986-90, Pages 228-229; Flight International, Jan. 24-30, 1990, Page 22.

50 Years Ago, August 1964

Aug. 1 The French Dragon two-stage solid-propellant sounding rocket is fired to an altitude of 275 miles from a site in Iceland, according to an announcement by France's National Center for Space Research. The rocket carries instruments to measure the energy and direction of particles from the Van Allen radiation belts. Missiles & Rockets, Aug. 10, 1964, Page 11.



Aug. 2 The Clifford B. Harmon Trust announces that astronaut and Air Force Maj. L. Gordon Cooper Jr. will receive the 1964 Harmon International Aviator's Trophy for his 34-hour orbital spaceflight, Mercury-Atlas-9, made on May 15-16, 1963. Others receiving the trophy will include aviatrix Betty Miller, for her solo transpacific flight in a light plane. The Harmon awards are to be presented in a White House ceremony on Sept. 14. New York Times, Aug. 2, 1964, Page 78.

Aug. 10 Paul Haney of the NASA Public Affairs office at the Manned Spaceflight Center in Houston announces that NASA will not use a paraglider-type landing system for the recovery of the two-man Gemini capsule. The paraglider system, which has been under development since the Gemini program began in 1961, was to have enabled the capsule to land on a runway after its return from space rather than parachute into the ocean. Instead, NASA will use the more conventional water-landing system, although experimental development and testing of the paraglider will continue. Houston Post, Aug. 11, 1964.

Aug. 19 Syncom 3, the world's first geostationary satellite, is launched by a Thrust-Augmented Delta rocket from Cape Kennedy, Fla. Four hours later the communications satellite receives and broadcasts recorded music — "The Star Spangled Banner" — as well as voice and teletype messages. From its position over the Pacific, the satellite can communicate with surface stations at Clark Air Force Base in the Philippines, at Guam, and at Camp Roberts in California. The plan is for the satellite to transmit TV pictures of the coming 1964 Olympic Games from Tokyo. New York Times, Aug. 20, 1964, Page 51.

Aug. 25 Explorer 20 is launched from the Western Test Range in California by a four-stage Scout solid-propellant rocket. The satellite, nicknamed Topsi, is used to map the ionosphere and relay the data back to Earth. The findings are to be compared with those gathered by the Canadian-developed Alouette "topside sounder" satellite. Aviation Week, Aug. 31,1964, Page 25.

Aug. 25 The North American Aviation XB-70A makes two taxi tests at its Palmdale, Calif., plant. In one of the tests, the aircraft attains a speed of 140 mph and the drag chute is deployed for the first time. The XB-70 Valkyrie had been the prototype version of the proposed six-engined B-70 nuclear-armed deep-penetration strategic bomber, but President John F. Kennedy cancelled the program in March 1961, in part for budgetary reasons. However, two prototypes were built as the XB-70A for use in supersonic test flights, and these tests use one of those two planes. The first flight of the XB-70A takes place on Sept. 21, and the test flights continue into 1969. Aviation Week, Aug. 31, 1964, Page 25; North American XB-70A file, National Air and Space Museum.

Aug. 28 The Nimbus 1 experimental meteorological satellite is launched into a polar orbit by a Thor-Agena-B rocket at the Western Test Range. On the 830-pound satellite's sixth orbit, it begins transmitting weather photos. Nimbus is far more advanced than the Tiros satellites and carries a high-resolution infrared radiometer that is the first to be flown in a meteorological satellite. Although Nimbus 1 is designed for testing and evaluating new sensors and

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monitoring equipment, it does lead to the creation of eight more Nimbus satellites. Washington Evening Star, Aug. 29, 1964; D. Baker, Spaceflight and Rocketry, Page 170.

75 Years Ago, August 1939

Aug. 1 Congress authorizes construction of a second research station for NACA, the National Advisory Committee for Aeronautics, at Moffett Field, Calif. The station is later renamed the Ames Aeronautical Lab, after Joseph S. Ames, president emeritus of Johns Hopkins University. Ames, a member of NACA from its inception in 1915 to 1939, was its chairman between 1927 and 1939. E. Emme, ed., Aeronautics and Astronautics 1915-60, Page 38.

Aug. 1 Trans-Canada Airlines starts commercial radio ground-to-aircraft and aircraft-to-ground services, without charge to passengers, on the transcontinental run. Interavia, Aug. 22, 1939, Page 5.

Aug. 11 An Imperial Airways Caribou flying boat reaches Southampton, England, completing the first British round-trip transatlantic air mail service. Aircraft Year Book, 1940, Page 434.

Aug. 14 Messerschmitt delivers the first batch of an order of Bf 109 single-seat fighters and Bf 108 trainers to the Yugoslav air force in Belgrade. Yugoslavia is the second foreign buyer of this advanced German single-engined fighter; the first was Switzerland. Interavia, Aug. 18, 1939, Page 6.

Aug. 26 The first Japanese round-the-world goodwill flight, sponsored in part by a Tokyo newspaper chain, begins at Tokyo. A Mitsubishi twin-engine transport monoplane named Nippon, with a crew of six, heads first to Sapporo, 1,000 kilometers away. The Nippon is a modified Type 96 attack aircraft, also known as the G3M2 bomber. The aircraft then flies to Alaska and the lower U.S., South America, Africa, Spain, Italy, India and Siam, and then back to Tokyo, covering 32,846 miles in 55 days in a total of 194 flying hours. The flight ends on Oct. 20. Aircraft Year Book, 1940, Page 434.

Aug. 27 Erich Warsitz secretly completes the world's first flights of a jet-propelled aircraft, at Heinkel's Marienche airfield in Germany, flying a Heinkel He-178. The engine is a Heinkel HeS 3b designed by Hans Pabst von Ohain. J. Smith and A. Kay, German Aircraft of the Second World War, Page 291.

100 Years Ago, August 1914

Aug. 2 World War I begins when Germany attacks Luxembourg. The following day, as the German army enters Belgium, the first aerial bombardment of the war is made by a German airplane, over Lunéville, France. On Aug. 6, the Germans make their first bombardment by dirigible, the Zeppelin Z VI, on the square of Liège, Belgium. C. Christienne and P. Lissarague, "A History of French Military Aviation," Page 61.

Aug. 19 An Avro 504 piloted by Lt. Vincent Waterfall of the Royal Flying Corps' Number 5 Squadron becomes the first British aircraft destroyed in combat when it is shot down during a reconnaissance mission over Belgium. F. Mason and M. Windrow, Know Aviation, Page 17.

Aug. 20 A Zeppelin falls to anti-aircraft fire, becoming the first airship known to be destroyed in the war. The craft was flying at 2,500 feet and crossed a field in the forest of Badonvillers, near Epinal, France, where a solitary 66-type field gun is stationed and shoots it down. The Aeroplane, Nov. 18, 1914, Pages 429, 440.

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In honor of the Lunar Reconnaissance Orbiter's (LRO) fifth anniversary in space, the LRO project kicked off the Moon as Art Campaign. The public was asked to select a favorite orbiter image of the moon for the cover of a special image collection. This image of Tycho Central Peak was selected—Tycho Central Peak rests inside an impact crater and has a boulder over 100 meters wide (about 328 feet) at its summit. Tycho crater's central peak complex, shown here, is about 9.3 miles (15 km) wide, left to right (southeast to northwest in this view). For more information on the Moon as Art Campaign, go to http://www.nasa.gov/content/goddard/nasa-lro-s-moon-as-art-collection-is-revealed/#.U6HL16j7p3A (*Image Credit: NASA/Goddard/Arizona State University*)

JULY–AUGUST 2014

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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			
13–17 Jul†	**International Conference on Environmental Systems**	Tucson, AZ (Contact: Andrew Jackson, 806.742.2801 x230, Andrew.jackson@ttu.edu, http://www.depts.ttu.edu/ceweb/ices/)	
15–18 Jul†	**ICNPAA 2014 – Mathematical Problems in Engineering, Aerospace and Sciences**	Narvik University, Norway (Contact: Seenith Sivasundaram, 386.761.9829, seenithi@aol.com, www.icnpaa.com)	
28–30 Jul	**AIAA Propulsion and Energy 2014 (AIAA Propulsion and Energy Forum and Exposition)** **Featuring:** **50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference** **12th International Energy Conversion Engineering Conference**	Cleveland, OH	**14 Jan 14**
31 Jul–1 Aug	**2nd AIAA Propulsion Aerodynamics Workshop**	Cleveland, OH	
31 Jul–1 Aug	**Hybrid Rocket Propulsion**	Cleveland, OH	
31 Jul–1 Aug	**Missile Propulsion Design, Technologies, and System Engineering**	Cleveland, OH	
31 Jul–1 Aug	**Application of Green Propulsion for Future Space**	Cleveland, OH	
2–10 Aug†	**40th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events**	Moscow, Russia http://cospar2014moscow.com/	**14 Feb 14**
3–4 Aug	**Decision Analysis**	San Diego, CA	
4–7 Aug	**AIAA SPACE 2014 (AIAA Space and Astronautics Forum and Exposition)** **Featuring:** **AIAA/AAS Astrodynamics Specialist Conference** **AIAA Complex Aerospace Systems Exchange** **32nd AIAA International Communications Satellite Systems Conference**	San Diego, CA	**21 Jan 14**
26–27 Aug†	**Transformational Vertical Flight Concepts Workshop**	Arlington, VA (Contact: Mark Moore, 757.506.5609, mark.d.moore@nasa.gov)	
7–12 Sept†	**29th Congress of the International Council of the Aeronautical Sciences (ICAS)**	St. Petersburg, Russia (Contact: www.icas2014.com)	**15 Jul 13**
25 Sept†	**Acoustic Testing and Upgrade of the LLF—A Symposium Dedicated to Aero-Acoustic Testing on the Occasion of the Finalization of the Acoustic Upgrade of the DNW-LLF**	Marknesse, The Netherlands (Contact: Siggi Pokörn, +31 610 279 923; siggi.pokoern@dnw.aero, www.dnw.aero)	
29 Sep–3 Oct†	**65th International Astronautical Congress**	Toronto, Canada (Contact: http://www.iac2014.org/)	
5–10 Oct†	**33rd Digital Avionics Systems Conference**	Colorado Springs, CO (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)	
22–26 Oct†	**30th Annual Meeting of the American Society for Gravitational and Space Research**	Pasadena, CA (Contact Cindy Martin-Brennan, 703.392.0272, executive_director@asgsr.org, www.asgsr.org)	
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)	
2015			
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** **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**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
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)**	Laurel, MD	
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)	
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)	
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	
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	
31 Aug–2 Sep	**AIAA SPACE 2015 (AIAA Space and Astronautics Forum and Exposition)**	Pasadena, 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.).

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Sandy H. Magnus, Executive Director

We live in an interesting time; a time that calls for a unity of purpose and to be mission-driven, yet one that seems to celebrate individuality, self-expression, and diversity unlike any other time in human history. In evolutionary biology, having a unique trait or behavior may mean survival, while being too specialized could spell doom in an environment of rapid change. This also plays out in politics: will electoral and legislative success come from having a big tent and fostering collaboration and compromise? Or is it better to harden a position and form strong, reliable partisan bases? And you see it in businesses and organizations of all sizes and types. We see it within AIAA. These paradoxes have been with us for quite some time and probably always will.

Another essential truth is that by either innate biology or spirit, humans are driven to explore our environments and bend the forces of nature and physics to our will. This is the essence of engineering. For those of us that love flight, the desire to conquer gravity has time and again driven people to seek knowledge, to design, test, and ultimately succeed. There is no greater example of this than the Apollo 11 lunar landing, the 45th anniversary of which we celebrate in July. It was a feat that—to this day—stands out as one of the most amazing human accomplishments ever. It grew out of that same desire to conquer gravity that drove Chanute, Lilienthal, Santos Dumont, and ultimately the Wrights. The desire, as President Reagan said, to slip “the surly bonds of earth” and go onward to the moon was shared by many individuals, including Oberth, Tsiolkovskii, Goddard, and von Braun, to name but a few. It was then focused by politics and tempered by conflict. In the United States, it was given eloquent voice by President Kennedy, who in an increasingly unsettled time, set a goal to put a man on the moon: “We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win.” It took a strong and dedicated team of individuals across government, industry, and academia to work together through the numerous challenges, issues, and milestones to send humans to the moon, and get them safely back to Earth. The effort integrated myriad skills and specialties, not only technical but managerial, operations, political (yes), and practical. Looking back on the skills required from the different sectors of our industry, one can see that diversity still reflected today in the AIAA community. (As a matter of fact, if you look up some of our early presidents and Board members you will recognize a lot of names!)

AIAA has branched out from teams of people focused on putting men on the moon (or making aviation a safe and practical feature of modern life) to a community that is constantly pushing the state of the art across multiple boundaries: hypersonic and transonic flight, safety and efficiency improvements, modeling techniques, manufacturing technology, life support, advanced avionics and autonomy, thermodynamics, system engineering, project management, materials applications—the list is limited only by human imagination. Engineers, who make up a significant portion of the aerospace profession—and thus AIAA’s membership—know that ideas start with individuals but they are refined by colleagues and reach fruition through teams. Working together we can achieve anything! And as AIAA and our industry looks to the future we are prepared to continue to tackle the tough problems. We are a diverse community of “can-do” people tackling every problem with dedication and enthusiasm, always ready to take on the next great challenge. We did not stop at Kitty Hawk. We did not stop at Tranquility Base!

About the time this edition arrives in your inboxes and mailboxes, we will be well on our way to completing our first year of AIAA’s forum model—integrating dozens of our specialist conferences into five cutting-edge forums. The forums provide a place for all sectors of the aerospace profession—from students and young professionals to research and development engineers, project managers and CEOs, deans of engineering, and government leaders—to interact, share problems, and discuss the issues facing the whole industry. A glance at the content of this year’s forums highlights how much activity is underway in the aerospace industry. Examining the incredible amount of technical information presented, listening to the presentations of the issues and accomplishments paints a picture of a vibrant, active, and diverse community of people advancing the boundaries of what is possible. The varied and wide-ranging viewpoints that intersect at AIAA’s forums create a dynamic environment where creativity can flourish. In the same way we are endeavoring to bring together separate but related topics under a big tent at our forums, AIAA itself is bringing aerospace professionals together under one standard.

This focus on identifying, welcoming, and integrating diverse communities threads throughout the AIAA strategic plan. It is reflected in organizational changes to staff, bringing a renewed focus on content for all of AIAA’s many communities: young and old, student and professional, domestic and international, theoretical and operational, and technology, management, and policy. So it is appropriate on the anniversary of the first lunar landing to reflect on the tremendous positive results that come from creating something unified from many diverse elements. That is, AIAA will continue to be a big tent, growing larger and stronger, and reliant upon the diversity of thought, gender, race, technical expertise, etc., to shape the future of aerospace. The integration of those diverse elements will make us a single, dynamic, forward-leaning, and strong organization. AIAA is one community of enlightened professionals, focused on taking a common journey of exploration and shaping the forces of nature and physics to our will. *One AIAA, one future*.

SELTZNER AWARDED INAUGURAL BRILL LECTURESHIP

AIAA and the National Academy of Engineering (NAE) are pleased to announce that **Dr. Adam Seltzner**, JPL Fellow at the NASA Jet Propulsion Laboratory, has been awarded the inaugural Yvonne C. Brill Lectureship in Aerospace Engineering. The lecture will take place on 30 September 2014, during a symposium in conjunction with the NAE Annual Meeting in Washington DC. Dr. Seltzner will speak on “Engineering the Mars Entry Descent and Landing (EDL) System.”

The Yvonne C. Brill Lectureship in Aerospace Engineering, sponsored by AIAA with the participation and support of NAE, was created in memory of the late pioneering rocket scientist, Yvonne C. Brill, who was an AIAA Honorary Fellow and NAE member. Brill was best known for developing a revolutionary propulsion system that remains the industry standard for geostationary satellite station-keeping. The lectureship emphasizes research or engineering issues for space travel and exploration, aerospace education of students and the public, and other aerospace issues such as ensuring a diverse and robust engineering community.

For information about the lectureship or the AIAA Honors and Awards program, contact Carol Stewart, carols@aiaa.org or 703.264.7623.

MEMBERSHIP ANNIVERSARIES

AIAA would like to acknowledge the following members on their continuing membership with the organization.

25-Year Anniversaries

Rhett W Jefferies	Central Pennsylvania
James N Zaiser	Central Pennsylvania
Timothy C Ayer	Connecticut
Joachim W Hoelzer	Connecticut
Robert E Owens	Connecticut
Thomas J Vasko	Connecticut
Peter A Cavallo	Greater Philadelphia
John L Dillon, IV	Greater Philadelphia
Todd A Gallagher	Greater Philadelphia
Ronald J Ungewitter	Greater Philadelphia
Frederick W White	Greater Philadelphia
James W Woodburn	Greater Philadelphia
Ingrid A Carlberg	Hampton Roads
Kevin Cunningham	Hampton Roads
David R Gingras	Hampton Roads
Kenneth H Goodrich	Hampton Roads
Fang Q Hu	Hampton Roads
William A Kilgore	Hampton Roads
William L Kleb	Hampton Roads
Renjith R Kumar	Hampton Roads
John C Lin	Hampton Roads
Michael M Madden	Hampton Roads
Anthony V McCormick	Hampton Roads
David M McGowan	Hampton Roads
William E Milholen, II	Hampton Roads
Thomas E Pinelli	Hampton Roads
Paul A Robinson	Hampton Roads
Robert Thornburgh	Hampton Roads
Travis L Turner	Hampton Roads
Richard G Wilmoth	Hampton Roads
Marsha J Berger	Long Island
Thomas Ferguson	Long Island
Richard F Baker	Mid-Atlantic
Michael J Gillum	Mid-Atlantic
Markus B Heinimann	Mid-Atlantic
John A Hughes	Mid-Atlantic
Scott R Klavon	Mid-Atlantic
Karl J Leodler	Mid-Atlantic
Andrew W Lewin	Mid-Atlantic
Molly Macauley	Mid-Atlantic
Richard J McIntosh	Mid-Atlantic
Gary J Morris	Mid-Atlantic
Donald P Seyler	Mid-Atlantic
Christopher D Sontag	Mid-Atlantic
Eric F Sorton	Mid-Atlantic
Thomas L Wilson	Mid-Atlantic
Michael S Woronowicz	Mid-Atlantic
Nancy F Andersen	National Capital
Jason C Baker	National Capital
W Douglas Barron	National Capital
Kevin T Bell	National Capital
Kathleen A Beres	National Capital
Jeffrey B Binckes	National Capital
Jay P Boris	National Capital
John W Bradley	National Capital
Wesley G Bush	National Capital
Tricia A Carr	National Capital
John A Cavolowsky	National Capital
Carissa B Christensen	National Capital
Calvin B Cotner	National Capital
Davis R Gamble	National Capital
Peter M Gill	National Capital
Anthony A Giunta	National Capital
Shahab Hasan	National Capital
Patrick W Hewitt	National Capital
Ronald D Hochstetler	National Capital
Rhoda S Hornstein	National Capital
Kyle R Kelly	National Capital
Farid M Khadduri	National Capital
William H Kim	National Capital
Gregory A Kirk	National Capital
Andrew J Knoedler	National Capital
Jesse A Leitner	National Capital
Donald H Lilienthal	National Capital
Robert L Meakin	National Capital
Aaron R Newman	National Capital
Lauri K Newman	National Capital
Dipak H Oza	National Capital
Geoffrey S Pierce	National Capital
Kidambi V Raman	National Capital
Ms. Marion M Riley	National Capital
Christopher J Rollins	National Capital
Steven S Scott	National Capital
Mark S Secunda	National Capital
Saul A Volansky	National Capital
Aerich J von Strobel	National Capital
Charles E Webb	National Capital
Norman M Wereley	National Capital
Andrew D Zeitlin	National Capital
Anuradha M Annaswamy	New England
Kurt D Annen	New England
Ms Stacey M Gage	New England
Jonathan F Galloway	New England
William H Greenberg	New England
Thomas D Hesbach, Jr.	New England
Anthony Linn	New England
Jeremy J Medicus	New England
Lynn B Olson	New England
Matthew L Slavich	New England
Steven G Webb	New England
Jerry D Welch	New England
Mark L Whittum	New England
Keith J Owens	Niagara Frontier
Kathleen M Atkins	Atlanta
Dimitri N Mavris	Atlanta
Mark A Neas	Atlanta
Panagiotis Tsiotras	Atlanta
Mary K Solomon	Cape Canaveral
Chelakara S Subramanian	Cape Canaveral
Karl C Wentzel, III	Cape Canaveral
Jack R Edwards	Carolina
Patrick J Gouhin	Carolina
Kara J Peters	Carolina
Bruce A Rutledge	Carolina
John C Seymour	Carolina
Jeff M Snyder	Carolina
Gregory T Strickland	Carolina
Lawrence N Virgin	Carolina
Justin Y Wu	Carolina
Michael H Bennett	Central Florida
William T Boyd	Central Florida
Mark A Connell	Central Florida
Corin Segal	Central Florida
Stanley I Adelfang	Greater Huntsville
Anwar Ahmed	Greater Huntsville
Joseph R Andrzejewski	Greater Huntsville
John Baker	Greater Huntsville
G Robert Bennett	Greater Huntsville
Thomas E Carter	Greater Huntsville
Pasquale Cinnella	Greater Huntsville
Anthony P Ewing	Greater Huntsville
Roger M Glaese	Greater Huntsville
Rebecca L Griffin	Greater Huntsville
Joseph R Herdy, Jr	Greater Huntsville
Thomas J Kelly	Greater Huntsville
Charles F Kopicz, Jr	Greater Huntsville
Michael G Landers	Greater Huntsville
Michael R LaPointe	Greater Huntsville
Crandell E Mc Cloud	Greater Huntsville
Achille Messac	Greater Huntsville
Mark J Ostrander	Greater Huntsville
Andrew S Prince	Greater Huntsville
Ram R Ramachandran	Greater Huntsville
Frederick G Robinson, Jr.	Greater Huntsville
Christopher S Talley	Greater Huntsville
Damon W Johnson	Greater New Orleans
Peter L Vallandigham	Northwest Florida
Sylvia Ospina	Palm Beach
Thomas J Greiner	Savannah
Randy W Hobbs	Tennessee
Carl B Overall	Tennessee
Ruel Russell	Tennessee
Lafayette K Taylor	Tennessee
Joseph A Wehrmeyer	Tennessee
Terry Conlisk	Columbus
Michael A Bolender	Dayton/Cincinnati
Keith B Bowman	Dayton/Cincinnati
C. F. Lance Chenault	Dayton/Cincinnati
William W Copenhaver	Dayton/Cincinnati
Susan K Cox-Stouffer	Dayton/Cincinnati
Charles J Cross	Dayton/Cincinnati
Mathias L Kolleck	Dayton/Cincinnati
Anthony L Lighthill	Dayton/Cincinnati
James H Miller	Dayton/Cincinnati
Christopher T Noll	Dayton/Cincinnati
Mark S Pearson	Dayton/Cincinnati
Harbinder S Pordal	Dayton/Cincinnati
Daniel J Schreiter	Dayton/Cincinnati
Rolf Sondergaard	Dayton/Cincinnati
Ronald J Stauffer	Dayton/Cincinnati
Mark K Wilson	Dayton/Cincinnati
Joseph Zelina	Dayton/Cincinnati
David L Carroll	Illinois
Ravi K Iyer	Illinois
James Sebastian	Illinois
Weinong W Chen	Indiana
Lisa A Eagleson-Roever	Indiana
Stephen D Heister	Indiana
Iain D Boyd	Michigan
Carlos E Cesnik	Michigan
Brian E Gilchrist	Michigan
Edward J Pluter	Michigan
Keith Velleux	Michigan
Peter G Batterton	Northern Ohio
Ann M Delleur	Northern Ohio
Tom T Hartley	Northern Ohio
Ann O Heyward	Northern Ohio
Mohammad Kassemi	Northern Ohio
Kenneth T Moore	Northern Ohio
Kim D Otten	Northern Ohio
Denise S Ponchak	Northern Ohio
Kurt R Sacksteder	Northern Ohio
John E Brandenburg	Wisconsin
Christopher J Rutland	Wisconsin
Ronald S Saunders	Wisconsin
Ronald R Banning	Albuquerque
Vance L Behr	Albuquerque
Richard D Chronister	Albuquerque
Lawrence J DeChant	Albuquerque
Peter E Dunn	Albuquerque
William B Heath	Albuquerque
Benjamin K Henderson	Albuquerque
Patricia A McFate	Albuquerque
Vincent G Weirs	Albuquerque
John R Bain	Houston
Michael T Boczon	Houston
David W Crook	Houston
Steven E Everett	Houston
David L Fleeger	Houston
Joseph H Frisbee, Jr.	Houston
Andrew J Meade	Houston
Wayne Rast	Houston
Larry W Roberts	Houston
Joel W Sills, Jr.	Houston
Douglas J Zimpfer	Houston
Craig A Bradford	North Texas
Eric F Charlton	North Texas
Daniel J Clancy	North Texas
Thomas Pinkney Davis	North Texas
Kevin M Fuller	North Texas
Robert E McKinley	North Texas
Vittal S Rao	North Texas
Steven G Russell	North Texas
Jason D Schwarz	North Texas
Thomas E Tyson	North Texas
Ms Melissa G Allin	Oklahoma
Jon M Bass	Southwest Texas
E.M. Collins	Southwest Texas
Leszek F Demkowicz	Southwest Texas
Mehmet E Erengil	Southwest Texas
James M Henry	Southwest Texas
James D Hillhouse, IV	Southwest Texas
Conrad H Ottenhoff	White Sands Space Harbor
Vinay Dayal	Iowa
Salvatore Alfano	Rocky Mountain
Scott T Dennis	Rocky Mountain
David F Giere	Rocky Mountain
Paul H Graf	Rocky Mountain
Siew Mun Ha	Rocky Mountain
Daniel P McCutchon	Rocky Mountain
Bruce K Ray	Rocky Mountain
Hanspeter Schaub	Rocky Mountain
Scott J Schreck	Rocky Mountain
Eric J Stephen	Rocky Mountain
Paul A Baldwin	St. Louis
Victor Birman	St. Louis
Stephen P Brod	St. Louis
Thomas A Kaemming	St. Louis
Salvatore L Liguore	St. Louis
Kenn R Luecke	St. Louis
Andrew J Miller, Jr	St. Louis
Richard Navarro	St. Louis
David W Riggins	St. Louis
Ervin Y Rodin	St. Louis
Charles R Saff	St. Louis
Michael A Swartwout	St. Louis
Forrest M Utsman	St. Louis
Todd P Carpenter	Twin Cities
Steven R Null	Twin Cities
Terrence W Simon	Twin Cities
Timothy N Timmerman	Twin Cities
David L Whitaker	Twin Cities
Yiyuan Zhao	Twin Cities
Willem A Anemaat	Wichita
Mario J Asselin	Wichita
Randal A Atkeisson	Wichita
How Meng Au	Wichita
George W Carroll	Wichita
Scott L Dimick	Wichita
Craig A McLaughlin	Wichita
Trong T Bui	Antelope Valley
Daniel A Klotz	Antelope Valley
Thane Lundberg	Antelope Valley
Cam Martin	Antelope Valley
Lee G Meyer	Antelope Valley
Theodore K Rothaupt	Antelope Valley
Alan M Sutton	Antelope Valley
Suzanne M Blee	Los Angeles-Las Vegas
Wingsiu R Chan	Los Angeles-Las Vegas
Andrew B Dawdy	Los Angeles-Las Vegas
David M Garza	Los Angeles-Las Vegas
David J Gorney	Los Angeles-Las Vegas
George C Jackson	Los Angeles-Las Vegas
James G Love	Los Angeles-Las Vegas
Van S McKenny, IV	Los Angeles-Las Vegas
Gregory V Meholic	Los Angeles-Las Vegas
Mark J Mueller	Los Angeles-Las Vegas
Richard A Patla	Los Angeles-Las Vegas
Calina C Seybold	Los Angeles-Las Vegas
Gregor A Waldherr	Los Angeles-Las Vegas
Bryan W Westra	Los Angeles-Las Vegas
John R Whittenbury	Los Angeles-Las Vegas
Richard E Wirz	Los Angeles-Las Vegas
Kyle Y Yang	Los Angeles-Las Vegas
Patrick P Yee	Los Angeles-Las Vegas
James M Ball	Orange County
Yueping Guo	Orange County
Ronald E Hlavac	Orange County
Sun I Hong	Orange County
John C Hsu	Orange County
John C Klug	Orange County
Alan H Ross	Orange County
Yoram Yadlin	Orange County
David E Anderson	Pacific Northwest
Wilford D Baker	Pacific Northwest
Clive E Berryere	Pacific Northwest
J. R Bowen	Pacific Northwest
Douglas E Chappelle	Pacific Northwest
Dianne Chong	Pacific Northwest
Jonathan K Elliott	Pacific Northwest
Frank C Fickeisen	Pacific Northwest
Michael E Henderson	Pacific Northwest
Tim T Lachenmeier	Pacific Northwest
Fernando Paredes	Pacific Northwest
Krishna Viswanathan	Pacific Northwest
David P Witkowski	Pacific Northwest
Kenneth A Bordignon	Phoenix
Paul A Forness	Phoenix
Mark E Giroux	Phoenix
Brian E O'Laughlin	Phoenix
David E Reinbold	Phoenix
Gary E Yale	Phoenix
Philip T Zeilinger	Phoenix
Rudolf Panholzer	Point Lobos
Rashid A Ahmad	Sacramento
Michelle M Bright	San Diego
Duane F Bruechert	San Diego
W Bruce Eatock	San Diego
Gholam R Ghanimati	San Diego
Robert E Matson	San Diego
Gerald M Stenovec	San Diego
William C Strobl	San Diego
Kirstie L Bellman	San Fernando Pacific
Richard J Choate	San Fernando Pacific
John P Latz	San Fernando Pacific
Mengyen Yin	San Fernando Pacific
John R Carlson	San Francisco
Alain C Carrier	San Francisco

Andre S Chan	San Francisco
Terry W Fong	San Francisco
Mark C Frassinelli	San Francisco
Veronica M Hawke	San Francisco
Martin C Hegedus	San Francisco
Prefix Ty Hoang	San Francisco
Nick Itsines	San Francisco
Jaewoo Jung	San Francisco
Srinivas Kodiyalam	San Francisco
Sesi B Kottapalli	San Francisco
Dora Nakafuji	San Francisco
Shishir A Pandya	San Francisco
Ann Patterson-Hine	San Francisco
Scott C Pendleton	San Francisco
Patrick H Reisenthel	San Francisco
Venke Sankaran	San Francisco
Ernest M Thurlow	San Francisco
Lawrence B Barraza	San Gabriel Valley
Todd J Bayer	San Gabriel Valley
Leo K Chan	San Gabriel Valley
Peter O. Dille	San Gabriel Valley
Todd Ely	San Gabriel Valley
Dominique Fourguette	San Gabriel Valley
Yungsun Hahn	San Gabriel Valley
Edward D Lynch	San Gabriel Valley
Humphrey W Price	San Gabriel Valley
Jeffrey W Umland	San Gabriel Valley
Joseph P Cammarota	Tucson
William T Carpenter	Tucson
Gary A Honea	Tucson
Robert F D`Ausilio	Utah
Rebecca J Garzella	Utah
Ronald B Thue	Utah
Eric M Miller	Vandenberg
Cees Bil	International
Herman Deconinck	International
J Guido Damilano	International
Ulisses C Oliveira	International
Luc Bauwens	International
Pascal J Hubert	International
Gilles F Leclerc	International
Meyer Nahon	International
Carl F Ollivier Gooch	International
Robert M Vaive	International
Jenkin Y Lai	International
Dominique R Valentian	International
Christopher S Welch	International
Josef Ballmann	International
Juergen H Fecher	International
Rolf Radespiel	International
Hannes G Ross	International
Dimitris A Saravanos	International
Kai Yuen E Leung	International
Rakhab C Mehta	International
Enrico C Lorenzini	International
Takanori Iwata	International
Kazuyuki Nakakita	International
Toshiyuki Ohtsuka	International
Kei Senda	International
Toru Shimada	International
Shinji Suzuki	International
Nobuhiro Tanatsugu	International
Kazuhiro Tsuboi	International
Tatsumi Tsunoda	International
Kenji Uchiyama	International
Yasuhide Watanabe	International
Isao Yamaguchi	International
Kunio Yasuda	International
Johannes J Meijer	International
Boris Gubanov	International
COL Igor Volk	International
Cheolkeun Ha	International
ChunGon Kim	International
Seungsoo Lee	International
Usik Lee	International
Julio Beneyto-Ribera	International
Ndaona Chokani	International
Kung-Ming Chung	International
Chiung-Chieh J Su	International
MengKao Yeh	International
Frans W Zee	International
Altan Kayran	International
Michael Kim	International
Arnold W Nayler	International
Shahrokh Shahpar	International
Chiung-Chieh J Su	International
MengKao Yeh	International
Frans W Zee	International
Altan Kayran	International
Michael Kim	International
Arnold W Nayler	International
Shahrokh Shahpar	International

Important Announcement: New Editor-in-Chief Sought for the *AIAA Journal*

AIAA is seeking an outstanding candidate with an international reputation for this position to assume the responsibilities of Editor-in-Chief of the *AIAA Journal*, which is devoted to the advancement of the science and technology of astronautics and aeronautics through the dissemination of original archival research papers disclosing new theoretical developments and/or experimental results. The chosen candidate will assume the editorship of AIAA's flagship journal at an exciting time as new features and functionality intended to enhance journal content are added to Aerospace Research Central, AIAA's platform for electronic publications.

The Editor-in-Chief is responsible for maintaining and enhancing the journal's quality and reputation as well as establishing a strategic vision for the journal. He or she receives manuscripts, assigns them to Associate Editors for review and evaluation, and monitors the performance of the Associate Editors to ensure that the manuscripts are processed in a fair and timely manner. The Editor-in-Chief works closely with AIAA Headquarters staff on both general procedures and the scheduling of specific issues. Detailed record keeping and prompt actions are required. The Editor-in-Chief is expected to provide his or her own clerical support, although this may be partially offset by a small expense allowance. AIAA provides all appropriate resources including a web-based manuscript-tracking system.

Interested candidates are invited to send letters of application describing their reasons for applying, summarizing their relevant experience and qualifications, and initial priorities for the journal; full résumés; and complete lists of published papers, to:

Heather Brennan
Director, Publications
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
Fax: 703/264-7551
Email: heatherb@aiaa.org

A minimum of two letters of recommendation also are required. The recommendations should be sent by the parties writing the letters directly to Ms. Brennan at the above address, fax number, or email. To receive full consideration, applications and all required materials must be received at AIAA Headquarters by **1 October 2014**, but applications will be accepted until the position is filled.

A selection committee appointed by the AIAA Vice President–Publications, Vigor Yang, will seek candidates and review all applications received. The search committee will recommend qualified candidates to the AIAA Vice President–Publications, who in turn will present a recommendation to the AIAA Board of Directors for approval. All candidates will be notified of the final decision. This is an open process, and the final selection will be made only on the basis of the applicants' merits. All candidates will be notified of the final decision.

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 October. Awards are presented annually, unless other indicated. 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.

Premier Awards & Lectureships

Distinguished Service Award gives unique recognition to an individual member who has provided distinguished service to the Institute over a period of years.

Goddard Astronautics Award, named to honor Robert H. Goddard—rocket visionary, pioneer, bold experimentalist, and superb engineer—is the highest honor AIAA bestows for notable achievement in the field of astronautics.

International Cooperation Award recognizes individuals who have made significant contributions to the initiation, organization, implementation, and/or management of activities with significant U.S. involvement that includes extensive international cooperative activities in space, aeronautics, or both.

Reed Aeronautics Award is the highest award AIAA bestows for notable achievement in the field of aeronautics. The award is named after Dr. Sylvanus A. Reed, the aeronautical engineer, designer, and founding member of the Institute of Aeronautical Sciences in 1932.

Dryden Lectureship in Research was named in honor of Dr. Hugh L. Dryden in 1967, succeeding the Research Award established in 1960. The lecture emphasizes the great importance of basic research to the advancement in aeronautics and astronautics and is a salute to research scientists and engineers.

Durand Lectureship for Public Service, named in honor of William F. Durand, recognizes notable achievements by a scientific or technical leader whose contributions have led directly to the understanding and application of the science and technology of aeronautics and astronautics for the betterment of mankind.

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)

Technical Excellence Awards

Aeroacoustics Award is presented for an outstanding technical or scientific achievement resulting from an individual's contribution to the field of aircraft community noise reduction.

Aerodynamics Award is presented for meritorious achievement in the field of applied aerodynamics, recognizing notable contributions in the development, application, and evaluation of aerodynamic concepts and methods.

Aerodynamic Measurement Technology Award is presented for continued contributions and achievements toward the advancement of advanced aerodynamic flowfield and surface measurement techniques for research in flight and ground test applications.

Aerospace Communications Award honors an outstanding contribution in the field of aerospace communications. Candidates are individuals or small teams (up to 4 members) whose achievements have had a positive impact on technology and society.

Aircraft Design Award is presented to a design engineer or team for the conception, definition, or development of an original concept leading to a significant advancement in aircraft design or design technology.

Chanute Flight Test Award recognizes significant lifetime achievements in the advancement of the art, science, and technology of flight test engineering. (Presented even years)

Engineer of the Year is presented to an individual member of AIAA who has made a recent significant contribution that is worthy of national recognition. Nominations should be submitted to your AIAA Regional Director.

F. E. Newbold V/STOL Award recognizes outstanding creative contributions to the advancement and realization of powered lift flight in one or more of the following areas: initiation, definition and/or management of key V/STOL programs; development of enabling technologies including critical methodology; program engineering and design; and/or other relevant related activities or combinations thereof which have advanced the science of powered lift flight. (Presented every 18 months)

Fluid Dynamics Award is presented for outstanding contributions to the understanding of the behavior of liquids and gases in motion as related to need in aeronautics and astronautics.

Ground Testing Award is given for outstanding achievement in the development or effective utilization of technology, procedures, facilities, or modeling techniques or flight simulation, space simulation, propulsion testing, aerodynamic testing, or other ground testing associated with aeronautics and astronautics.

Hap Arnold Award for Excellence in Aeronautical Program Management is presented to an individual for outstanding contributions in the management of a significant aeronautical or aeronautical related program or project.

Hypersonic Systems and Technologies Award recognizes sustained, outstanding contributions and achievements in the advancement of atmospheric, hypersonic flight and related technologies. (Presented every 18 months)

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

Losey Atmospheric Sciences Award recognizes outstanding contributions to the atmospheric sciences as applied to the advancement of aeronautics and astronautics.

Multidisciplinary Design Optimization Award is given to an individual for outstanding contributions to the development and/or application of techniques of multidisciplinary design optimization in the context of aerospace engineering. (Presented even years)

Otto C. Winzen Lifetime Achievement Award is presented for outstanding contributions and achievements in the advancement of free flight balloon systems or related technologies. (Presented odd years)

Piper General Aviation Award is presented for outstanding contributions leading to the advancement of general aviation. (Presented even years)

Plasmadynamics and Lasers Award is presented for outstanding contributions to the understanding of the physical properties and dynamical behavior of matter in the plasma state and lasers as related to need in aeronautics and astronautics.

Jay Hollingsworth Speas Airport Award is presented to the person or persons judged to have contributed most outstandingly during the recent past toward achieving compatible relationships between airports and/or heliports and adjacent environments. The award consists of a certificate and a $10,000 honorarium. Cosponsored by AIAA, the American Association of Airport Executives, and the Airport Consultants Council.

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

Thermophysics Award is presented for an outstanding singular or sustained technical or scientific contribution by an individual in thermophysics, specifically as related to the study and application of the properties and mechanisms involved in thermal energy transfer and the study of environmental effects on such properties and mechanisms.

James Van Allen Space Environments Award recognizes outstanding contributions to space and planetary environment knowledge and interactions as applied to the advancement of aeronautics and astronautics. The award honors Prof. James A. Van Allen, an outstanding internationally recognized scientist, who is credited with the early discovery of the Earth's "Van Allen Radiation Belts." (Presented even years)

Service Award

Public Service Award honors a person outside the aerospace community who has shown consistent and visible support for national aviation and space goals.

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

THIS SUMMER AND FALL—ALL AEROSPACE IS LOCAL!

Duane Hyland

Each summer and early fall, through AIAA's "All Aerospace is Local" initiative, sections and members reach out to their congressional, state, and local legislators, inviting them to section dinners, events, or tours of corporate facilities, and educate them about the importance of aerospace.

The "All Aerospace is Local" initiatives reminds elected officials that all aerospace initiatives are comprised of individuals who support families as well as local communities with their work and wages, and that the aerospace industry is a bulwark of good paying jobs that propels our nation forward to ever greater engineering and scientific advancements. By making legislators and other officials realize that all aerospace is local, ideally by involving them in local aerospace happenings, we build a stronger base of support on Capitol Hill and in other legislative venues—as each legislator comes to realize the importance of our industry to the areas they represent. The initiative also encourages a continuation of the discussion about important aerospace issues that was started in March as part of the Congressional Visits Day program.

Last year, 34 sections hosted "All Aerospace is Local" events, so we hope that this year even more sections will take part—but only you can make that goal a reality! For program ideas and to report successful "All Aerospace is Local" events, please contact Duane Hyland, AIAA Grassroots Public Policy Coordinator at duaneh@aiaa.org or 703.264.7558.

CALL FOR PAPERS FOR *JOURNAL OF AEROSPACE INFORMATION SYSTEMS*

Special Issue on "Precision Air Traffic Operations in Terminal Airspace"

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

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

Future air traffic operations that depend on the precise and predictable movement of aircraft along prescribed paths are called Precision Air Traffic Operations (PATO). PATO are included in plans (e.g., NextGen, SESAR, and SAS) to modernize air traffic systems, but are particularly difficult to implement in congested terminal airspace surrounding major airports. Papers are sought for the special issue that present novel solutions to conducting PATO in congested terminal airspace by providing control algorithms subject to PATO constraints. Topics of special interest include: routing of aircraft in the PATO terminal area, robustness and resilience of PATO, feasible and optimal control of PATO, analysis and classification of perturbations to PATO, analysis and classification of admissible PATO controls, and economic effects (e.g., from a viewpoint of interest to a policymaker) of PATO implementation that would lead to increased system capacity. Papers are also sought that investigate the airspace usage, operational procedures, and safety assurance mechanisms for increased operator autonomy (i.e., minimal dependence on Air Traffic Control [ATC]), increased automation of ATC functions and of flight control, and accommodation of highly disparate characteristics of such diverse airspace user categories as air carrier, general aviation, and unmanned aircraft systems.

Key research areas included in the special issue are:

- Automated feasible ATC in terminal airspace
- Automated optimal ATC in terminal airspace
- Flight Routing in terminal airspace
- Robustness and resilience of PATO
- Analysis and classification of perturbations to PATO
- Analysis and classification of admissible PATO controls
- Models of response of airline economics to PATO implementation

These areas are only indicative. The special issue is also open to manuscripts that are relevant to the applied science and engineering of aerospace computing, information, and communication but do not fit neatly into any of the above areas. We do envisage, however, that successful manuscripts will include experimental results, sophisticated simulations of aerospace systems, or (in the case of a paper in the areas of education or policy) well-researched and thorough arguments for policies and their implementations.

Deadline: Submissions are due by **30 September 2014**
Anticipated Publication Date: **January 2015**
Contact Email: Alexander Sadovsky, Alexander.V.Sadovsky@nasa.gov or Douglas Isaacson, Douglas.R.Isaacson@nasa.gov

CALL FOR BOARD OF DIRECTORS NOMINATIONS

The 2014–2015 AIAA Nominating Committee will meet in August to review nominees and select candidates to participate in the Board of Directors (BoD) election to fill the following vacancies by election in 2015:

- Vice President-Elect, Education
- Vice President-Elect, Public Policy
- Director–Technical, Aerospace Design and Structures Group
- Director–Technical, Aerospace Sciences Group
- Director–Region II
- Director–Region III
- Director–Region VI
- Director–At-Large
- Director–At-Large, International

AIAA BoD Duties Highlights

When running for the Board of Directors, keep in mind:

- Volunteer Board service (commitment to attend 3–4 meetings per year in person)
- Need employer time and travel commitment
- Support Institute mission and vision
- Provide strategic discussion and input when required
- Duty to protect assets and exercise fiduciary prudence
- Serve in BoD leadership or support capacity as required
- Be vigilant of the aerospace landscape and identify business opportunities for the Institute
- Support AIAA Executive Director and staff as appropriate

AIAA members may submit themselves or other members qualified for the chosen position as nominees by submitting a nomination through the AIAA website (go to **www.aiaa.org**, log in, and select Board of Director Nomination from the left-hand navigation bar) no later than **28 July 2014**.

Bill Seymore
AIAA Corporate Secretary/Treasurer

OBITUARIES

AIAA Honorary Fellow Puckett Died in March

Allen E. Puckett, president of the Institute from 1972 to 1973, and chairman, emeritus, of Hughes Aircraft Company, passed away on 31 March. He was 94 years old.

A 1941 graduate of Harvard University, Puckett received an invitation from Theodore von Kármán to enter the doctoral program at the California Institute of Technology. Under von Kármán's guidance, Puckett helped design the nation's first supersonic wind tunnel, and later developed the calculations needed for the development of delta wing theory, which allowed the prediction of the aerodynamics of supersonic aircraft. Puckett's doctoral thesis, "Supersonic Wave Drag of Thin Airfoils," is a classic text in the field of supersonic aircraft development. Puckett also co-wrote the seminal textbook, *Introduction to Aerodynamics of a Compressible Fluid*, and co-edited *Guided Mission Engineering* with Simon Rao.

Puckett graduated from Cal Tech with his Ph.D. in aeronautics in 1949, and joined Hughes Aircraft Corp., switching his area of research to electronics. Puckett was instrumental in bringing about a new era in satellite communications. He championed the development of the world's first geosynchronous satellite, which enabled the 1964 Tokyo Olympic Games to be broadcast live to the world. Puckett also led Hughes' involvement in NASA's Surveyor program, producing unmanned spacecraft that helped to determine if a lunar landing was possible and transmitted images of the lunar surface back to Earth. Puckett became president of Hughes Aircraft in 1977 and chairman of the board in 1978.

Among Puckett's many honors were AIAA's Lawrence Sperry Award, the American Astronautical Society's Lloyd V. Berkner Award, the Brandeis University Award for Distinguished Achievement in the Field of Technology, the IEEE Frederick Phillips Award, and the Electronics Industries Association Medal of Honor. Puckett was elected to the National Academy of Engineering and the National Academy of Sciences, and was also awarded the Legion of Honor by the government of France.

AIAA Fellow Adamson Died in May

Arthur P. Adamson died on 3 May. He was 95 years old.

From his childhood in rural Kansas and education in a one-room schoolhouse, Mr. Adamson went on to graduate at the top of the class of 1941 from the University of Southern California's School of Engineering.

He spent his entire career in engineering and engineering leadership with General Electric, working near Schenectady and at several other sites before spending the last 30 years of his career at GE's Evendale (Cincinnati), OH, plant. While with GE, Mr. Adamson led advanced rocket and jet engine design programs, and became a world leader in jet engine design, responsible for the design of engines that remain widely used on commercial wide-body jet aircraft.

Mr. Adamson received many awards for excellence in engineering leadership from GE and other engineering organizations.

AIAA Associate Fellow Escher Died in May

William J. D. (Bill) Escher, 83, died on 12 May.

Mr. Escher was an aerospace engineer involved in the development of the U.S. rocket programs and long-time aerospace industry visionary. An internationally recognized expert in the field of high-speed airbreathing propulsion and hypersonic flight, he was a proponent of combined-cycle propulsion systems for space access and his visionary "Synerjet" concept is industry recognized. He wrote over a hundred technical papers on this subject, as well as others on hydrogen energy and lunar exploration. He was the author of the SAE book entitled *Synerjet Engine: Airbreathing/Rocket Combined-Cycle Propulsion for Tomorrow's Space Transports*.

He had a long career in aerospace spanning more that 60 years. While in the Army and assigned to the Naval Research Lab, Mr. Escher was a countdown officer for the Vanguard rocket program in 1957. He was later employed by NASA Lewis, NASA Marshall, and NASA Headquarters, Marquardt, Kaiser-Marquart, North American Rockwell and Rocketdyne, Astronautics Corporation of America, University of Toronto, Escher Technology Assoc., Escher-Foster Technology Assoc., SAIC, and SpaceWorks. He was one of the co-founders and long-time members of the Space Propulsion Synergy Team (SPST).

As an AIAA member, Mr. Escher worked on the Terrestrial Energy Systems Technical Committee (1987–1997) and the HyTASP Program Committee (1996–2008). In 2002, he was awarded the AIAA George M. Low Space Transportation Award "For outstanding and sustained contributions to the field of space transportation, from Vanguard to Spaceliner, and for tirelessly promoting a vision for low cost, reliable access to space based on the Synerjet combined-cycle engine."

He held a Bachelor of Science in Engineering degree from George Washington University, after earlier studies in mechanical engineering at Cornell University and Cleveland State University. At Cornell, he served as the president and experimental committee chairman of the Cornell Rocket Society. He also conducted graduate studies at the University of Southern California and the University of Wisconsin-Madison.

AIAA Science and Technology Forum and Exposition

The World's Largest Event for Aerospace Research, Development and Technology

5–9 January 2015
Gaylord Palms Hotel and Convention Center
Kissimmee, Florida

Executive Steering Committee

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Complete list of organizers at ***aiaa-scitech.org/Organizers***

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Explore the SciTech 2015 Forum

Find innovative solutions to challenges and create new opportunities for advancement at the world's largest event for aerospace research, development, and technology. Join the conversation with over 3,000 of your peers and find answers to questions such as:

- What are the driving constraints on international cooperation?
- Affordability, reliability, and sustainability will continue to drive design—what does this mean for our future methodologies and technologies?
- In what way are we developing future aerospace designers to address the needs of a global market?
- How do entrepreneurial perspectives drive global aerospace research and development?
- How are government entities addressing entrepreneurial technology investments?

Participation is Power

Participating in this event will help you:

- Find out what lies ahead, as thought-leaders discuss their programs and business challenges during plenary and keynote addresses.
- Expand your knowledge with FORUM 360, as expert engineers and scientists cover a spectrum of timely topics including programs, systems, policy, operations, applications, and platforms.
- Test your ideas, develop your skills, and build your reputation as you present your research to others from around the world during the technical program.
- Network, discuss challenges, and share ideas during special events, awards, luncheons, networking breaks, and social activities.

Technical Program

More than 2600 abstracts have been submitted for presentation consideration at AIAA SciTech 2015. What innovative ideas and solutions will you find among colleagues within your discipline and experts in other disciplines? Areas of focus include: Aerospace Sciences, Aerospace Design and Structures, and Information Systems.

Technical conferences meeting as part of SciTech 2015 include:

23rd AIAA/ASME/AHS Adaptive Structures Conference
2nd AIAA Spacecraft Structures Conference
53rd AIAA Aerospace Sciences Meeting
AIAA Atmospheric Flight Mechanics Conference
AIAA Infotech@Aerospace
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

Ignite and Celebrate

Join us as we celebrate accomplishments by innovators in our aerospace community. Recognition activities offer unique social and networking opportunities with the most accomplished individuals in our field.

- AIAA Associate Fellow Dinner
- Awards Luncheon—Celebrating Achievements in Aerospace Sciences, Information Systems, and Literature
- Awards Luncheon—Celebrating Achievements in Aerospace Design and Structures
- Almost 20 student awards, including AIAA Foundation Awards
- Durand Lectureship for Public Service
- Dryden Lectureship in Research

Plan Your Trip

Located in the heart of the sunshine state, Kissimmee, Florida, offers the most adventure and best attractions on Earth. Just minutes from Orlando, Kissimmee puts you right in the middle of all the activities and attractions that turn family vacations into experiences that last a lifetime. It's located next to world-class theme parks such as Walt Disney World® Resort, Universal Orlando® Resort, and SeaWorld® Orlando.

Florida ranks #2 among states for aviation and aerospace establishments, with more than 2,000 companies employng 82,000+ workers. As a result, Florida has a rich supply chain and talent pool benefiting industry businesses. It's no wonder industry leaders including Boeing, Embraer, General Dynamics, Lockheed Martin, Northrop Grumman, Pratt & Whitney, Sikorsky, and so many more have significant operations in Florida.

Accommodations

AIAA has made arrangements for a block of rooms at the

Gaylord Palms Hotel & Convention Center
6000 West Osceola Parkway
Kissimmee, Florida 34746 USA
Phone: 1.407.586.0000 • Fax: 1.407.586.9556 • Toll-free: 1.877.350.3236

Room rates are $199 for a standard room (single or double occupancy), which does not include the non-negotiable $10 amenities fee (applied at checkout). Applicable taxes will apply. One night's room and tax is required when booking the reservation. This deposit is refundable until 72 hours prior to arrival. These rooms will be held for AIAA until **17 December 2014** or until the room block is full, then released for use by the general public. To make reservations, go to https://resweb.passkey.com/Resweb.do?mode=welcome_gi_new&groupID=25428151.

There are also a small number of federal government per diem rooms available. One night's room and tax will be charged to the credit card on file two weeks prior to arrival. Deposit is refundable until 72 hours prior to arrival. If you reserve a government room you will need to present a government ID upon check-in. To make a Government Reservations, go to https://resweb.passkey.com/Resweb.do?mode=welcome_gi_new&groupID=25429126.

Exposition (exhibitors, as of 5/5/14)

Book your exposition space today. Contact Christopher Grady at chrisg@aiaa.org

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Higher Orbits & ISSET
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Intelligent Light
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National Institute of Aerospace (NIA)
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Tri Models, Inc.
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Vigyan, Inc.
Wolverine Ventures, Inc.

Learn more: **aiaa-scitech.org**

25th AAS/AIAA Space Flight Mechanics Meeting

11–15 January 2015
Williamsburg Lodge
Williamsburg, Virginia

Abstract Deadline: 15 September 2014

The 25th AAS/AIAA Space Flight Mechanics Meeting will be held 11–15 January 2015 at the Williamsburg Lodge in Williamsburg, VA. The conference is organized by the American Astronautical Society (AAS) Space Flight Mechanics Committee and cosponsored by the AIAA Astrodynamics Technical Committee. Manuscripts are solicited on topics related to space-flight mechanics and astrodynamics, including but not necessarily limited to:

- Asteroid and non-Earth orbiting missions
- Atmospheric re-entry guidance and control
- Attitude dynamics, determination and control
- Attitude-sensor and payload-sensor calibration
- Dynamical systems theory applied to space flight
- Dynamics and control of large space structures & tethers
- Earth orbital and planetary mission studies
- Flight dynamics operations and spacecraft autonomy
- Orbit determination and space-surveillance tracking
- CubeSat & Nano Satellite mission design & operations
- Orbital debris and space environment
- Orbital dynamics, perturbations, and stability
- Rendezvous, relative motion, proximity missions, and formation flying
- Reusable launch vehicle design, dynamics, guidance, and control
- Satellite constellations
- Spacecraft guidance, navigation, and control (GNC)
- Space Situational Awareness (SSA), Conjunction Analysis (CA), and collision avoidance
- Trajectory/Mission/Maneuver design and optimization

Manuscripts will be accepted based on the quality of the extended abstract, the originality of the work and/or ideas, and the anticipated interest in the proposed subject. Submissions that are based on experimental results or current data, or report on ongoing missions, are especially encouraged. Complete manuscripts are required no later than **6 January 2015**. English is the working language for the conference.

Additional and up-to-date information can be found at the conference website: http://www.space-flight.org/docs/2015_winter/2015_winter.html.

Special Session

In addition to the above general topics, papers are also solicited for two special sessions. The first is on *Astrodynamics Innovation and Data Sharing*. This session focuses on research resulting from the Air Force effort to make space surveillance data more widely available to researchers. The second special session is on the *flight dynamics aspects of the LADEE mission*. Authors are asked to indicate on the abstract submission if you would like to be considered for inclusion in this special session. Manuscripts not selected for the special session will be allocated to other relevant sessions.

Breakwell Student Travel Award

The AAS Space Flight Mechanics Committee announces the John V. Breakwell Student Travel Award. This award provides travel expenses for up to two U.S. and Canadian students presenting at this conference. Students wishing to apply for this award are strongly advised to submit their completed manuscript by the abstract submittal deadline. The maximum coverage per student is limited to $1000. Details and applications may be obtained via http://www.space-flight.org.

Information for Authors

Because the submission deadline of 15 September 2014 has been fully extended for the convenience of contributors, there are no plans to defer this deadline due to the constraints of the conference planning schedule. Notification of acceptance will be sent via email by **15 October 2014**. Detailed author instructions will be sent by email following acceptance. By submitting an abstract, the author affirms that the manuscript's majority content has not been previously presented or published elsewhere.

Authors may access the web-based abstract submittal system using the link available via the official website: http://www.space-flight.org. During the online submission process, authors are expected to provide:

1) A paper title, as well as the name, affiliation, postal address, telephone number, and email address of the corresponding author and each co-author,

2) An extended abstract in the Portable Document File (PDF) format of at least 500 words that includes the title and authors, and provides a clear and concise statement of the problem to be addressed, the proposed method of solution, the results expected or obtained, and an explanation of its significance to astrodynamics and/or space-flight mechanics, with pertinent references and supporting tables and figures as necessary, and

3) A condensed abstract (100 words) to be included in the conference program, which is directly typed into the text box provided on the web page and avoids the use of special symbols or characters, such as Greek letters.

Foreign contributors requiring an official letter of acceptance for a visa application should contact the Technical Chairmen by email at their earliest opportunity.

Technology Transfer Notice—Technology transfer guidelines substantially extend the time required to review abstracts and manuscripts by private enterprises and government agencies. To preclude late submissions and withdrawals, it is the responsibility of the author(s) to determine the extent of necessary approvals prior to submitting an abstract.

No-Paper/No-Podium Policy—A complete manuscript must be electronically uploaded to the web site prior to **6 January 2015** in PDF format, be no more than 20 pages in length, and conform to the AAS manuscript format. If a complete manuscript is not received on time, then its presentation at the conference shall be forfeited; and if a presentation is not made by an author at the conference, then the manuscript shall be omitted from published proceedings.

Questions concerning the submission of manuscripts should be addressed to the technical chairs:

AAS Technical Chair: Dr. Roberto Furfaro, University of Arizona, 1127 E James E Rogers Way, Tucson, AZ 85721; 520.312.7440; robertof@email.arizona.edu

AIAA Technical Chair: Dr. Stefano Casotto, University of Padua, Vicolo Osservatorio, 3, 35121 Padova, Italy; +39-049-827-8224; stefano.casotto@unipd.it

All other questions should be directed to the General Chairs:

AAS General Chair: Dr. Aaron Trask, 13215 Jasper Rd, Fairfax VA 22033; 703.298.4132; aaron.trask@gmail.com

AIAA General Chair: Dr. Zimmer, Optensity, Inc., 1592 Carlin Ln., McLean, VA 22101; 512.299.7218; szimmer@optensity.com

Upcoming AIAA Continuing Education Courses

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

2nd AIAA Propulsion Aerodynamics Workshop

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

Hybrid Rocket Propulsion (Instructor: Joe Majdalani)

This course reviews the fundamentals of hybrid rocket propulsion with special emphasis on application-based design and system integration, propellant selection, flow field and regression rate modeling, solid fuel pyrolysis, scaling effects, transient behavior, and combustion instability. Advantages and disadvantages of conventional and unconventional vortex hybrid configurations are examined and discussed.

Key Topics
- Introduction, classification, challenges, and advantages of hybrids
- Similarity and scaling effects in hybrid rocket motors
- Flowfield modeling of classical and non-classical hybrid rockets
- Solid fuel pyrolysis phenomena and regression rate: mechanisms & measurement techniques
- Combustion instability and transient behavior in hybrid rocket motors
- Metals, other energetic additives, and special binders used in solid fuels for hybrid rocket applications

Missile Propulsion Design, Technologies, and System Engineering (Instructor: Eugene L. Fleeman)

A system-level, integrated method is provided for missile propulsion design, technologies, development, analysis, and system engineering activities in addressing requirements such as cost, performance, risk, and launch platform integration. The methods presented are simple closed-form analytical expressions that are physics-based, to provide insight into the primary driving parameters. Sizing examples are presented for rocket-powered, ramjet-powered, and turbo-jet powered baseline missiles. Typical values of missile propulsion parameters and the characteristics of current operational missiles are discussed as well as the enabling subsystems and technologies for missile propulsion and the current/projected state-of-the-art. Videos illustrate missile propulsion development activities and performance.

Key Topics
- Key drivers in the missile propulsion design and system engineering process
- Critical tradeoffs, methods, and technologies in propulsion system sizing to meet flight performance and other requirements
- Launch platform-missile integration
- Sizing examples for missile propulsion
- Missile propulsion system and technology development process

Application of Green Propulsion for Future Space (Instructors: Alan Frankel, Dr. Ivett Layva, and Patrick Alliot)

Liquid propulsion systems are critical to launch vehicle and spacecraft performance, and mission success. This two-day course, taught by a team of international experts, will focus on the movement to green propulsion for a range of spacecraft applications. Topics include a brief history of hypergols; what is considered green and what is driving the green propulsion movement; figures of merit and lessons learned in the development of green propellants; flight experience and applications for the various classes of satellites; and challenges for current and future green thrusters and systems.

Key Topics
- History of storables
- What is green and what is driving the green movement
- Green propellants
- Green flight experience
- Applications of green propulsion

3–4 August 2014
Course at AIAA Space and Astronautics Forum and Exposition 2014 (AIAA SPACE 2014)
www.aiaa-space.org

Decision Analysis (Instructor: John Hsu)

Decision analysis is an important part of system life cycle development throughout all phases and system hierarchical levels. This course presents the trade study process as part of the systems engineering process and introduces different decision analysis methods including the traditional trade study methods, trade space for Cost as Independent Variable (CAIV), Analytic Hierarchy Process (AHV) as part of the Analytic Network Process (ANP), Weighted Sum Model (WSM), Potentially All Pairwise Rankings of All Possible Alternatives (PAPRIKA), and Decision Analysis with Uncertain information/data. The highlights are: evaluation criteria weights assignment methods including objective determination via QFD methodology; how to down-select too many alternatives; various scoring methods for evaluation criteria; how to develop decision trees; mathematical eigenvector calculations to assist the AHP analysis; how to handle billions pairwise combinations and rankings for PAPRIKA; and five methods to reach decisions with uncertain information/data, and more. Several ways of writing credible and thorough trade study report are introduced.

Technical Committee Nominations

Membership nominations are now open for AIAA Technical Committees (TC) for 2015/2016. Our TCs have between 30 and 35 members each. Nearly one-third of the members rotate off the committees each year, leaving six to ten openings per TC.

The TC chairs and the Technical Activities Committee (TAC) work diligently to maintain a reasonable balance in (1) appropriate representation to the field from industry, research, education, and government; (2) the specialties covered in the specific TC scopes; and (3) geographical distribution relative to the area's technical activity. TAC encourages the nomination of young professionals, and has instituted a TC associate member category (see associate membership guidelines). Associate members, with identified restrictions, are included on TCs in addition to the 35 regular member limit.

If you currently serve on a TC, do not nominate yourself. You will automatically be considered for the 2015/2016 TC year.

Enclosed are instructions for nominations. Nominations are submitted online. The TC nomination form can be found on the AIAA Web site at **www.aiaa.org**, under My AIAA, Nominations and Voting, Technical Committee Online Nomination. We look forward to receiving your nominations. If you have any questions, please call Betty Guillie at 703.264.7573.

Nominations are due by **1 November 2014**.

Current AIAA Technical Committees

Adaptive Structures
Aeroacoustics
Aerodynamic Decelerator Systems
Aerodynamic Measurement Technology
Aerospace Power Systems
Air Breathing Propulsion Systems Integration
Air Transportation Systems
Aircraft Design
Aircraft Operations
Applied Aerodynamics
Astrodynamics
Atmospheric and Space Environments
Atmospheric Flight Mechanics
Balloon Systems
Communications Systems
Computer Systems
Design Engineering
Digital Avionics
Economics
Electric Propulsion
Energetic Components and Systems
Flight Testing
Fluid Dynamics
Gas Turbine Engines
General Aviation
Ground Testing
Guidance, Navigation and Control
High Speed Air Breathing Propulsion
History
Hybrid Rockets
Information and Command and Control Systems
Intelligent Systems
Legal Aspects of Aeronautics and Astonautics
Life Sciences and Systems
Lighter-Than-Air Systems
Liquid Propulsion
Management
Materials
Meshing, Visualization and Computational Environments
Microgravity and Space Processes
Missile Systems
Modeling and Simulation
Multidisciplinary Design Optimization
Non-Deterministic Approaches
Nuclear and Future Flight Propulsion
Plasmadynamics and Lasers
Product Support
Propellants and Combustion
Sensor Systems and Information Fusion
Small Satellite
Society and Aerospace Technology
Software
Solid Rockets
Space Architecture
Space Automation and Robotics
Space Colonization
Space Logistics
Space Operations and Support
Space Resources
Space Systems
Space Tethers
Space Transportation
Spacecraft Structures
Structural Dynamics
Structures
Survivability
Systems Engineering
Terrestrial Energy Systems
Thermophysics
V/STOL Aircraft Systems
Weapon System Effectiveness

Instructions for Completing Technical Committee Nomination Forms

1. Nominations are submitted online via www.aiaa.org, My AIAA, Nominations and Voting, Technical Committee Online Nomination. Nominees who are not selected for committee membership for 2015 will automatically be considered for membership in 2016. As the nomination forms are held for an additional year, it is not necessary to resubmit a form for someone not selected for the 2014/2015 term. You may send updated information to be attached to an existing nomination form.
2. You do not have to be nominated by someone else; you may submit an application for yourself.
3. A resume or biographical data can be attached and submitted with the nomination form.
4. Membership is usually restricted to one technical committee (TC) at a time. Please list the TCs in order of preference if applying to two TCs. If accepted to the 1st priority, the nominee will be added to that TC. All information should be detailed and complete.
5. The Technical Activities Committee (TAC) strongly suggests that special consideration be given to members 34 years of age and under or who obtained their professional degree less than 10 years ago. See attached Technical Committee Associate Membership Guidelines.
6. All TC members must join AIAA (if they are not already members) within 45 days of their appointment to a technical committee.
7. TC membership is generally for one year with two additional years possible, but contingent upon committee participation, ongoing projects, and AIAA membership. It is not necessary to send a new nomination form for someone who is already on a committee. All committee members are automatically considered for a second and third year of membership.
8. Deadline for receipt of nominations is **1 November 2014**. Nominations received after this date will be held for consideration until the next year.

Technical Committee Associate Membership Guidelines

1. Associate membership is restricted to those who have not yet reached their 35th birthday, or who obtained their professional degrees less than 10 years ago.
2. Associate membership is a one-year term renewable to three years.
3. Associate membership is restricted to current AIAA members.
4. Selection to associate membership is based on technical merit. The associate members should show promise within the field of the technical committee.
5. Associate members may attend TC or subcommittee meetings and will assist in carrying out committee work.
6. At the discretion of the TC, associate members may be assigned a volunteer full member as a counselor. The counselor will advise and guide the associate member on TC procedures and activities.
7. Associate members will have no voting privileges on the TC, but may (with consent) act as a substitute for their counselor.
8. Associate members will not count toward the TC regular membership limit.
9. Application forms for associate membership are the same as those of full membership, but a resume is a required attachment. Applicants for full membership who were not selected may be considered associate members provided they meet the age restriction.
10. At least two associate members should be appointed to each TC. At no time should the number of associate members exceed that of full members.
11. An endorsement statement from the nominee's department head, indicating that the nominee may travel to two meetings per year and have some time to devote to committee business, must be completed during the online process.

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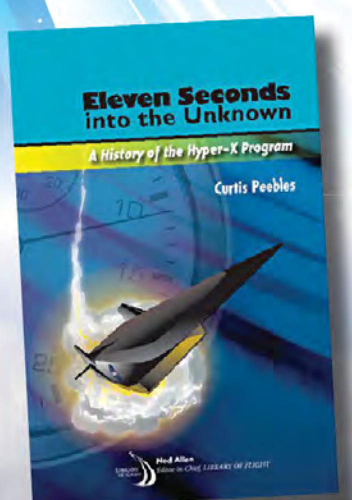

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