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AEROSPACE AMERICA

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AEROSPACE AMERICA

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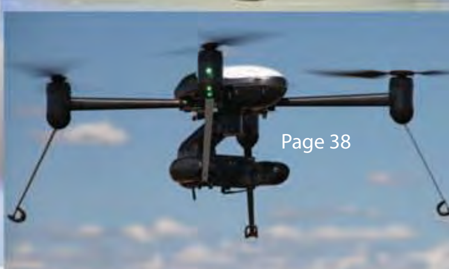

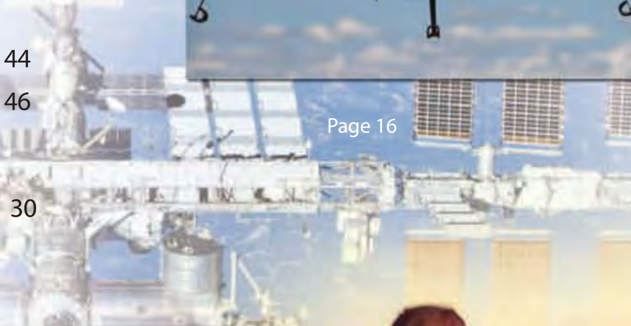

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ON THE COVER

A wheat field glows other-worldly in "Idaho Evening," a photo by Rick Barnard, a founding editor of Space News.

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AIAA
The World's Forum for Aerospace Leadership

New strategy, new era

The reference to the old National Aerospace Plane project in the letter-to-the-editor on the facing page got me thinking: In the years since that single-stage-to-orbit initiative fell apart in the 1990s, we've shifted to a new approach toward making aerospace advances. It seems like every big idea these days involves doing something else first. Want to go to Mars? Let's go to an asteroid first. Want to image an Earthlike planet? Let's start with a gas giant. Want an all-electric passenger plane, let's start with a hybrid.

We're clearly not in the age of Apollo, with its narrow focus on the skills and technology required to land humans on the moon, or NASP with its goal of building an X-30 demonstrator plane.

As a child of the 1960s, I grudgingly accept the necessity of a new approach for a new era, but I worry that we may be exaggerating its effectiveness and suitability for every aerospace or exploration breakthrough Americans might want to make.

You can definitely make aircraft and their fuels cleaner in a stepwise approach, but you can't *sort of* get to orbit in a single stage, *sort of* land a crew on Mars, or *sort of* deliver a photo of an Earthlike planet.

Speaking at the AIAA Space Forum in August, NASA's Steve Creech captured the fine line advocates of the Mars mission, in particular, must walk: "Sometimes the trap that we fall into is we say, 'Mars is too hard. We're going to do something along the way,' but then that becomes an end unto itself," he said. The challenge will be to communicate: "Yes, we're taking this step-wise approach, but the things that we're doing are getting us to Mars," he said.

Getting to Mars will require staying focused, but also answering the obvious question: Why? The first flight of an Orion crew capsule on Dec. 4 — albeit unmanned — will give advocates their best opportunity yet to explain the value of these missions. Will Americans galvanize around asteroid and Mars missions? I don't know the answer, but I suspect a winning case will have to go beyond the promise of jobs here on Earth or the possibility of mining rare minerals, as true as those benefits might be.

Advocates of delivering an image of an Earthlike planet have it easier and harder in some respects than advocates of the Mars mission. No one figures to mine a pale blue dot or put a flag on it any time soon, given the multi-light-year distances, and so there is no pressure to make grandiose claims of near-term benefits. This would be science for the sake of science, and there should be nothing wrong with that.

Ben Iannotta
Editor-in-Chief

Skeptical about the SABRE engine

My first reaction to “Going Hypersonic,” [July/August page 10] was “some bad ideas just won’t go away” and my second was “just let it go.” But I cannot.

First, development of an airbreathing engine that will self-start and accelerate to Mach 5 is a worthwhile goal for a number of potential missions, but it is insufficient for a single-stage-to-orbit, SSTO, vehicle.

At Mach 5, where the proposed Sabre engine must transition from ramjet to rocket, the Skylon vehicle will have only 4 percent of the kinetic energy needed to attain orbit at Mach 25. The rocket will have to supply the remaining 96 precent. This is based on taking the square of the vehicle Mach number ratio as a good approximation to the velocity ratio. As anyone who was involved in the ill-fated National Aerospace Plane, NASP, program knows, the resulting SSTO vehicle will be too large and too heavy to effectively replace a pure rocket.

An airbreathing engine can only earn its way onto a SSTO vehicle by reducing the gross takeoff weight far more than the added weight of the engine and thermal protection system needed for extended atmospheric flight at hypersonic speeds (during ascent as well as descent). A vehicle roughly the size and weight of an MD-80 aircraft, rather than an A-380, should be the goal. This can only be achieved by sharply reducing the weight of oxidizer that must be carried onboard for the final ascent to orbit on rocket power. This will require the airbreather to produce more kinetic energy; a goal might be to provide as much as 40 to 50 percent of orbital kinetic energy, rather than 4 percent. This goal means that it would have to operate out to 63 to 71 percent of orbital velocity, i.e., to Mach 16 to 18. Development of the technology that would have enabled scramjet operation well into the double-digit Mach range, if not to Mach 18, should have been the primary goal of the NASP Technology Maturation program. Without that, everything else was irrelevant.

Between an unwillingness to stretch scramjet technology beyond Mach 8, due to the absence of ground test facilities for measuring structural response to the aero-thermal environment, and imposing wide safety margins on the thermal protection system to cover enormous uncertainties, it was inevitable that the size and weight of NASP’s proposed X-30 vehicle would become excessive, unaffordable, and incapable of carrying a payload to orbit, leading to cancellation of the program.

Fortunately, NASA carried the NASP scramjet flowpath technology forward into its Hyper-X program, producing the X-43A which flew at Mach 8 and 10 a decade ago, and demonstrated positive net thrust at both speeds. (If it had been a flight-weight vehicle rather than boilerplate copper, the acceleration would have been eye-opening.) It was a successful milestone on NASA’s roadmap to an orbit-capable vehicle, a point the author of this article has overlooked. The X-51A, on which he focuses, also owes much to the NASP program, and provides the enabling technology for a Mach 5 cruise missile, but it is not on anyone’s roadmap to orbit. NASA did have plans to take the Hyper-X program to Mach 14 or 15 (with an X-43C, as I recall) before it was cancelled in order to fund the “back to the future” program for returning to the Moon, and then on to Mars, using heavy lift rockets. Where might we be today if the Hyper-X program had been allowed to continue on its successful path?

While I wish our friends “across the pond” at Reaction Engines, Ltd. every bit of good luck in developing their SABRE engine and Skylon spaceplane, neither history nor physics offers much encouragement. So, my advice to the team is to push their airbreathing engine to Mach 10 and beyond to see a real payoff from hypersonic airbreathing propulsion. That will, of course, mean abandoning the podded SABRE engine design in favor of an airframe-integrated design, which NASA pioneered and both the X-43A and X-51A successfully employed. And, of course, pay close attention to what the Australians continue to accomplish with their Scramspace flight test programs.

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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

SEPT. 7-12
Twenty-ninth Congress of the International Council of the Aeronautical Sciences, St. Petersburg, Russia.
Contact: www.icas2014.com

SEPT. 25
Symposium on Acoustic Testing and Upgrade of the LLF — Large Low-speed Facility — of the German Dutch Wind Tunnels, Marknesse, The Netherlands.
Contact: Siggi Pokörn, siggi.pokoern@dnw.aero; www.dnw.aero

SEPT. 29-OCT. 3
Sixty-fifth International Astronautical Congress, Toronto, Canada.
Contact: http://www.iac2014.org/

Now trending: passive radars

European radar manufacturers are in a race to become the first to sell a full network of operational passive radars to civil customers.

Passive radars detect planes by analyzing the radiation that bounces off them from radio, television or other emitters. The original broadcast signals are compared to the reflected signals. The concept was the basis of many early air defense systems built in the 1930s. However, more accurate and reliable conventional radars, which did not have to rely on non-cooperating signals, were developed and soon supplanted these passive radars. Now, advances in digital signal processing and directional antenna technologies have made it possible to develop a new generation of passive radars that are cheap to buy, easily portable, and capable of detecting aircraft without emitting any radiation signals themselves.

Dubai-based market analysts Signals and Systems Telecom said in a June 2013 press release, “In addition to cost-efficiency, passive radar is also covert, an effective counter to stealth technologies, and environmentally friendly.” By the end of 2023, according to the company, passive radar technology investments will account for more than $10 billion in revenue, following a compound annual growth rate of nearly 36 percent between 2013 and 2023.

Over the past five years European radar manufacturers have invested heavily in passive radar research, much of it sponsored by potential civil and military customers.

In May, the U.K.’s Civil Aviation Authority asked Airbus Defence and Space, based in Munich, and Czech manufacturer ERA to examine the feasibility of using passive radars for civil air traffic control, with the first demonstrations to take place next year.

Current active radars are susceptible to confusing echoes and interference from wind farms, according to the Civil Aviation Authority, but are not an issue for passive radars. ERA’s VERA-NG passive radar, launched in March 2012, is based on passive tracking of emissions from radars, jammers, transponders, ground-based navigation aid interrogators, data-link and other communication, navigation, and surveillance systems. In May ERA signed a contract with NATO to supply the system as part of a wider NATO air operations system based in Northern Italy. Airbus Defence and Space says it has already developed a working system that can detect ultra-light aircraft many kilometers away with accuracies down to 20 meters, as well as larger aircraft 200 kilometers away.

In March 2013 Spanish radar manufacturer Indra announced it had completed the development and demonstration of the world’s first high-resolution passive radar capable of offering images using inverse synthetic aperture techniques. Indra’s system uses the target’s movement to obtain its radar image. This research program is sponsored by the Brussels-based European Defense Agency.

Airbus Defense & Space

The Passive Radar developed by Cassidian (now Airbus Defence and Space). This radar has greatly increased range of detection yet remains virtually undetectable itself.

The program demonstrated a radar that “can cover the air traffic control requirements in areas with a low or zero coverage of conventional primary radars” and is particularly effective when used to detect low-flying aircraft, said the company’s March 2013 press release.

“Passive radar technology is exponentially evolving thanks to the new processing assets’ increasing capabilities and software-defined radio technologies,” says Javier Alvarez, Indra’s project manager for the program. “At the same time, the radio frequency population is becoming more and more suitable for passive radar technologies, especially digital transmissions, and particularly for high resolution imaging due to the increase of bandwidth of transmitted signals.”

The U.K.’s Technology Strategy Board began a two-year research program in February 2013 to analyze the potential of using passive radars as a possible replacement for conventional primary radars in civil air traffic control. These passive radars detect aircraft via reflections to television signals broadcast from transmitters around the U.K. The researchers have used a Thales and Roke Manor Research system as the basis for the study.

Meanwhile, in 2012, Italy’s Selex ES was awarded the Oscar Masi prize — given by the Italian Association for Industrial Research for innovation in environmental sustainability — for its Aulos passive radar. The judges praised the “environmentally friendly” nature of the surveillance system, which does not generate additional electromagnetic pollution and allows the radar to operate in and around inhabited areas.

New simulator targets seaplane training

The flight deck of a Viking Series 400 Twin Otter. De Havilland Canada is devising a simulator specifically for seaplane crews. Viking Air Limited

Landing a seaplane and taking off is notoriously challenging, and so TRU Simulation and Training is addressing that problem with a simulator it's building at the Pacific Sky Aviation training facility in Victoria, British Columbia. The de Havilland Canada Twin Otter simulator is due to be completed in 2016. It's designed to reduce training costs and timescales, potentially transforming the way seaplane pilots around the world are training.

Twin Otter pilots will be able to experience many configurations, from conventional wheel-based operations to landing on water during different sea conditions.

"The breakthrough is taking level D visualization and modeling techniques" — the industry's most advanced — "and transferring them from traditional wheel-based operations to taking off, landing, taxiing and docking on water," says Michael Coughlin, Pacific Sky Aviation chief executive officer. "The stretch is that new modeling techniques need to be developed to simulate how the two floats react to the water and the wind above. His company, he said, will provide aircraft instrument and flight data inputs so they can be put into the model to simulate different sea states, water conditions and effects of the wind blowing over the tips of the waves. "In particular it will be very important to simulate glassy water. In the seaplane world this is one of the biggest challenges of all — landing on a still, clear, glassy lake, where you lose your depth of perception."

The simulator will have other unusual features specific to Twin Otter operations. For example, the cockpit window can be opened and the pilot's head extended outside the plane to look back at a visual display that will accurately reflect how the Twin Otter docks.

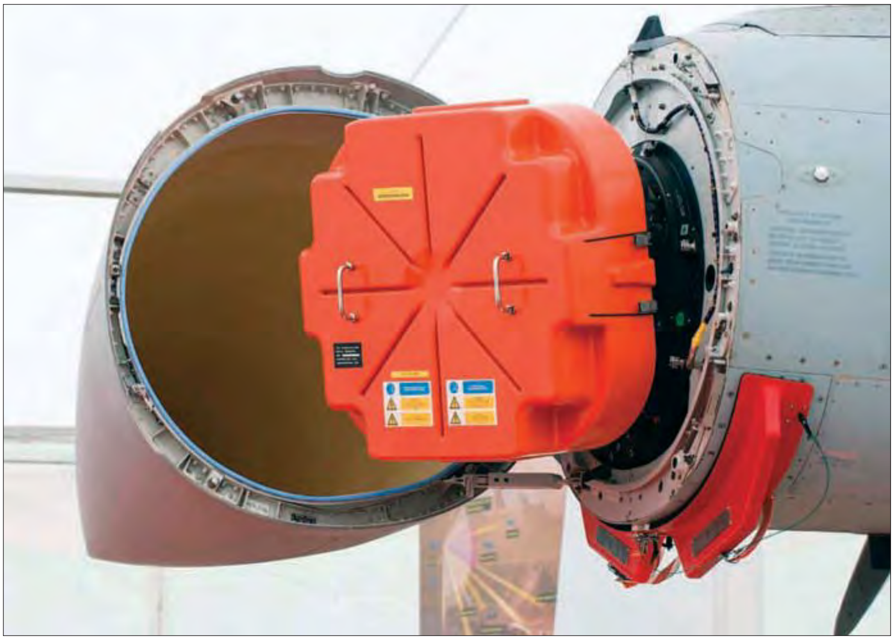
TRU Simulation, a Textron company formed earlier this year from the merger of Opinicus, AAI and Mechtronix, previously built a Bombardier CL-415 flight training device to simulate sea plane operations. However, more work is needed on developing algorithms to match the visuals and the motion of the aircraft interacting with different sea states.

Coughlin says pressure from Twin Otter operators for such a simulator has been building for years. The operators, he says, "have an issue [with] managing growth and finding enough sea plane pilots. It takes typically between 3,000 and 4,000 hours in the right seat to become a proficient seaplane captain. We will be able to take those pilots and compress a year's experience of takeoffs and landings — with emergency situations on top to within two or three weeks."

Reducing the flight time needed for training should also leave more time for revenue-earning operations.

Around 600 Twin Otters are still in use worldwide. Although production ceased in the 1980s, Pacific Sky Aviation's sister company Viking is marketing an upgraded version of the type called the Series 400, which it has sold to more than 400 customers worldwide.

Typhoons, drones get U.K. government support



Eurofighter Typhoon

The Captor-E electronically scanned radar. Part of a large defense funding increase announced by U.K. Prime Minister David Cameron in July will go to upgrading this radar for the Eurofighter Typhoon.

The U.K.'s $1.8-billion-dollar defense spending increase will go mainly toward improving intelligence, surveillance and reconnaissance on the Royal Air Force's Eurofighter Typhoons and to a program of unmanned combat air vehicle research with France. The Typhoons will get Euroradar Captor-E electronically scanned radars.

The extra money, announced in July at the Farnborough air show, is part of a wider government policy to increase support for the country's aerospace and defense industries. Deputy Prime Minister Nick Clegg said the government would invest $260 million in new civil aerospace research and development projects, including $71 million to Airbus for research into lightweight wing technology, $34 million to Rolls-Royce for reduced carbon dioxide emission engine research, $83 million to GKN for 3D printing of metallic aircraft parts, and $22 million to Thales for research into in-flight connectivity.

The new funds are part of the Aerospace Growth Partnership, a program launched in 2011 by the government and U.K. aerospace industries to channel $3.4 billion of investment over seven years into several strategic research and development programs. A cornerstone of this investment has been the Aerospace Technology Institute at Cranfield, which is investing over $127 million in upgrading wind tunnels and research facilities throughout the U.K.

Prime Minister David Cameron also announced the creation of a new U.K. defense research center at Farnborough, focusing on military aircraft research into engines, platforms and systems.

The government will also help U.K. industry increase its share of the global space market through the development of a spaceport and will announce the launch site location in 2018, said Business Secretary Vince Cable.

U.K. aerospace and defense companies will need to increase their share of the global market as major purchases of defense equipment are likely to decrease over the coming years.

In the third quarter of 2015 the U.K. government is scheduled to announce the results of its Strategic Defence and Security Review, which will set out U.K. defense equipment spending plans for the next five years. The past five years have seen major changes in strategic priorities, which will probably mean a re-think of aircraft equipment purchases listed in the last review, in 2010. This scrapped the Nimrod MRA4 maritime patrol aircraft but reinforced the commitment to build two aircraft carriers and buy 138 Lockheed Martin F-35 Joint Strike Fighters for the Royal Air Force and the Royal Navy.

"Britain's retreat from large-scale discretionary operations began in 2010, when Prime Minister David Cameron decided to set an absolute deadline for withdrawal from Afghanistan," wrote Professor Malcolm Chalmers of London-based think tank Royal United Services Institute in a January 2014 paper, "Let Debate Commence: Key Strategic Questions for the 2015 Strategic Defense and Security Review." "In the space of a couple of years, therefore, the U.K. will have gone from being one of the most operationally active of NATO's major powers to being one of the least active."

The 2010 review committed the government to leasing 14 Airbus Military Multi-Role Tanker Transports; buying 22 Airbus Military transports; retiring the Lockheed Martin C-130J fleet in 2020, 10 years earlier than previously planned; retiring the Raytheon Sentinel RI ground surveillance aircraft; and cutting the number of Boeing CH-47 Chinooks from 22 to 12. However, some of these decisions have since been reversed: The U.K. government in 2011 ordered 14 CH-47 Chinooks and has since decided to extend the life of the Sentinel RI until at least 2018.

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A question mark in doomsday comms

Raytheon is testing hardware and software for satellite terminals that will let commanders and civilian authorities in ground and air command posts talk to each other during a nuclear crisis over the highly protected Advanced Extremely High Frequency satellite constellation. The question now is whether the new Family of Beyond-Line-of-Sight Terminals will be fitted onto the Air Force's nuclear armed B-2s and B-52s as well.

"It's very much up in the air," said Raytheon's Scott Whatmough, vice president of the company's communications systems division, which in June beat Boeing for the FAB-T contract.

The FAB-T terminals are designed to connect to the Air Force's Lockheed Martin-built Advanced Extremely High Frequency — AEHF — constellation of secure, jam-proof communications satellites. Right now, there are only three operational AEHF satellites — half the constellation — which is one reason the Air Force is no hurry to equip its bombers with the new terminal. If the Air Force were to decide to equip its nuclear-armed aircraft with FAB-T terminals, there could be a need for over 216 more units.

Beyond just the bombers, Whatmough said that there might be room for further growth as more of the AEHF satellites that would be connected to FAB-T reach orbit and the military services learn to use the system better. "The one thing that is consistent is that when this capability becomes available to the warfighter, more and more people want it," Whatmough said.

Raytheon won the contract to build FAB-T, the Family of Advanced Beyond-Line-of-Sight communication terminals. The Air Force has not yet decided whether to put the terminals on nuclear-armed bombers like the B-2, top, and B-52.

According to Raytheon officials, the current $298-million contract that was awarded on June 2 covers only 84 FAB-T command posts. That includes the terminals, modems and antennas. There are four versions of the FAB-T terminals — one is a fixed ground station, another is a mobile ground station, while another version fits onboard aircraft like the Air Force's Boeing E-4B Advanced Airborne Command Post and the Air Force's Boeing E-4B command post. The version for the bombers is a separate variant that would need some more development work.

The Air Force has decided that Raytheon must complete two lots of low-rate initial production for the FAB-T terminals before it will approve a Milestone C decision to begin full-rate production. Whatmough said that Raytheon hopes the Pentagon will make a decision within a year.

The Air Force is being particularly careful with the FAB-T contract, in part because of the program's long and troubled history.

Originally Boeing won the Air Force contract to build the next-generation terminals in 2002, but the company ran into trouble with cost overruns and massive delays on the program, according to the Government Accountability Office, GAO. "Due to continued cost and schedule growth in developing this design, the Air Force signed a development contract with Raytheon in September 2012 in an effort to establish an alternate source for a system with capabilities similar to Boeing's FAB-T effort," reads a March 2013 GAO report.

Eventually, the Pentagon contracted Raytheon to begin work on a backup system in 2012. But it wasn't until this year that Raytheon finally unseated its rival when the Air Force awarded the company the contract for the FAB-T.

Neither the Air Force nor Raytheon would say where the command posts would be located or exactly how the system is operated.

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Air Force: Nukes are 'number one'

US Air Force

Air Force Chief of Staff Gen. Mark A. Welsh III and Secretary of the Air Force Deborah Lee James. They unveiled the Air Force's 30-year strategy at a press conference on July 30.

Strategic nuclear deterrence has regained its Cold War-era preeminence among Air Force missions. The service makes this clear in its latest strategy document, proclaiming that "the nuclear mission must remain the clear priority of Air Force leaders at all levels."

At a media briefing, Air Force Chief of Staff Gen. Mark Welsh III and Secretary of the Air Force Deborah James discussed the strategy document, "America's Air Force: A Call to the Future," which outlines a 30-year strategy. They noted that the service has already begun paying more attention and devoting more resources to strengthening its strategic nuclear force of intercontinental ballistic missiles and bombers, and that its planned long-range strike bomber, LRS-B, will be indispensable to nuclear deterrence. Renewed emphasis on the nuclear mission, following 25 years of accent on tactical, conventional operations, comes at a time of strained relations with former Cold War adversaries and nuclear powers Russia and China.

The Air Force plans to field 80 to 100 LRS-Bs beginning around the mid-2020s. Welsh described the bomber as "an adaptable and highly capable system based upon mature technology" and "a long-range, air-refuelable, highly survivable aircraft with significant nuclear and conventional standoff and direct-attack weapons payloads." The Air Force foresees the LRS-B becoming but one element of a networked, operationally flexible family of long-distance strike systems. Each bomber's flyaway cost is pegged at $550 million in 2010 dollars. A Boeing-Lockheed Martin team has said it will compete for the LRS-B contract. Northrop Grumman has expressed interest.

The Air Force declines to discuss the specific technologies and capabilities in store for the highly classified LRS-B. It is a safe bet, though, that the bomber will be both supersonic and stealthy, combining the advanced-propulsion and low-observable technologies that enable combat aircraft to fly at supercruise speeds without spewing highly detectable heat from afterburners.

At a time of tight budgets and tough choices, the Air Force is hot in pursuit of "game-changing technologies" that will "amplify many of the enduring attributes of airpower — speed, range, flexibility, and precision," says its strategic vision report. Tops on the report's priorities are hypersonics, nanotechnology, directed energy, unmanned systems, and autonomous systems.

"The leap to effective hypersonic operational speed will have a profound impact that can revolutionize the way we approach our core missions in the future — from investments to force posture to tactics, techniques, and procedures," the report declares. "Though we may not always desire to operate at the fastest possible speed, the ability to do so creates a significant advantage."

Nanotechnology, too, is portrayed as vital to flying farther and faster. "By manipulating materials at the molecular level, we can create structures that are both stronger and lighter, contributing to both speed and range," the Call to the Future document asserts.

Directed energy technology and weapons should make it possible for the Air Force to "fundamentally alter operational concepts" by alleviating "the need for acquiring and transporting large stockpiles of munitions" into combat theaters, and by giving combat commanders more firepower options, the report notes. The utility of unmanned systems "is now growing exponentially and must be embraced," and "the development of artificial intelligence and like technologies will revolutionize the concept of autonomy" by enabling future weapons and other systems to "react to their environment and perform more situational-dependent tasks," the document notes.

The Air Force ranks the long-range bomber, the F-35 fighter, and the KC-46A aerial tanker as the most important — and indispensable — weapons in its future. But strengthening the nuclear force tops everything else. "We can't do everything," said Air Force Secretary Deborah James at the briefing, "and therefore we have to have some clear priorities, and nuclear is number one."

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The tech behind WorldView-3

For satellite imagery provider DigitalGlobe of Longmont, Colo., timing is everything. Its WorldView-3 satellite arrived in orbit in August, just months after the U.S. Department of Commerce relaxed commerical satellite resolution restrictions, giving companies like DigitalGlobe permission to collect and sell imagery showing details as fine as 25 centimeteres across. The previous limit was 50 centimeters for imagery provided to non-U.S. government customers. First sales are targeted for Spring 2015.

WorldView-3 will generate images with a 31-centimeter resolution once it is declared operational. Six months after that, DigitalGlobe will be free to sell the imagery commercially.

The 2,800-kilogram satellite was built by Ball Aerospace in Boulder, Colo., and launched from Vandenberg Air Force Base, Calif., atop a United Launch Alliance Atlas 5, joining three other DigitalGlobe satellties in orbit.

WorldView-3 will collect imagery with 31-centimeter panchromatic or black-and-white resolution; 1.24-meter multispectral or color resolution; and 3.7-meter short-wave infrared resolution. The level of resolution is made possible by a 1.1-meter aperture telescope built by Exelis Inc. of Rochester.

DigitalGlobe expects the satellite to be in demand for more than its resolution, however. The satellite has 16 multispectral bands and an atmospheric instrument called CAVIS, for Cloud, Aerosol, water Vapor, Ice, Snow. CAVIS will monitor the atmosphere and provide correction data to improve WorldView-3's imagery. CAVIS allows targeting of ground scenes through haze, soot, smoke and dust and will basically "true up" its color readings, says Ball Aerospace's Jeff Dierks, senior program manager for the company's WorldView-3 work.

The 16 spectral bands are another key attribute. Various materials reflect sunlight differently, and so they can be distinguished by multiple bands, including some not visible to the naked eye.

"From seeing the visible to the invisible, WorldView-3 will offer dramatically more information in every image collected," explains Craig Oswald, manager of commercial imaging at Exelis Geospatial Systems, which in addition to making the telescope for WorldView-3 provided its shortwave infrared sensor.

The satellite is also more responsive than other designs. By using advanced Control Moment Gyroscopes, the spacecraft can be reoriented over a desired collection area in 4 to 5 seconds, compared to 30 to 45 seconds needed for traditional reaction wheels. "The spacecraft can take images very rapidly, up to about 35 degrees off its orbit track, and gives you quicker access to any point in the world," explains Dierks, the Ball manager.

WorldView-3 will have an average revisit time of less than one day and will be capable of collecting up to 680,000 square kilometers of imagery per day. It flies in a sun-synchronous altitude of about 617 kilometers.

Ball Aerospace

The WorldView-3 satellite is encapsulated within the Atlas 5 rocket. Its August launch came shortly after relaxation of government restrictions on satellite imagery for commercial customers.

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Wanted: More diversity in engineering

The U.S. National Academies, a collection of government think tanks, wants the U.S. to take steps to add more diversity in the engineering fields, and it is sharing suggestions it has received for how to do that.

"Part of our goal is to start a conversation within the stakeholder community, including industry," said Catherine Didion, senior program officer at the National Academy of Engineering in Washington, D.C., by email. She is a co-author of the report, "Advancing Diversity in the US Industrial Science and Engineering Workforce."

Women and some minorities are underrepresented in science, technology, engineering and math, or STEM, careers in the United States, according to the report. Its call to enhance diversity is based on the summary of information and discussions presented during a 2012 workshop that brought together industry leaders, academics and representatives of professional associations to discuss the problem of workplace diversity in the science and engineering field.

Catherine Didion, senior fellow at the National Academy of Engineering. She is co-author of a report presenting ideas for encouraging women and minorities to pursue technical and scientific careers.

NASA

The report summarizes the findings of the National Science Foundation data brief that looked at the percentages of women and minorities in the STEM fields compared to the gender and ethnicity breakdown of the overall U.S. population. While white men account for 32.2 percent of the U.S. population, they represent 50 percent of scientist and engineers, according to the foundation. When looking at the number of top-level managers and executives in the industry, the discrepancy is even greater, with white men accounting for 72.2 percent.

The report summarizes some of the methods workshop participants suggested to address this lack of diversity. One step would be to introduce children as early as kindergarten to science education and make sure high school students have an understanding of STEM careers available to them before they set off for college. The industry also needs to focus on recruiting and retaining minority and women scientists and engineers and taking steps to help advance their careers. That may involve having a more diverse recruitment team, greater flexibility in the workplace — including offering flexible work schedules to help women with children balance career and family — and providing women and under-represented minority workers with additional training and mentoring to help them advance into management roles.

The authors acknowledge that more data analysis needs to be done to better understand the challenges facing women and minorities in their career paths from college all the way to top management. There is also a need to break down the data by industry and study the differences between industrial sectors as varied as aerospace, pharmaceuticals and information technology.

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Surviving a bad day

Veteran astronaut Tom Jones understands spaceflight safety issues firsthand, having experienced a space shuttle master alarm before one of his four missions. Jones takes a look at the abort and escape systems in the coming generation of crew spacecraft, from Orion to the planned commercial spacecraft.

On a hazy, humid Florida morning 20 years ago — August 18, 1994 — I was strapped into shuttle Endeavour for the dawn launch of STS-68, the second Space Radar Lab mission. My crewmates and I braced against the jarring rattle of main engine ignition, which shook the entire shuttle stack with more than a million pounds of thrust. Just 1.5 seconds before solid rocket booster ignition and liftoff, we instead heard through our headphones the shocking clamor of the master alarm. Pilot Terry Wilcutt called "Right engine down!" as the engine roar died, and we realized we had a pad abort.

Jeff Wisoff and I, stationed on the middeck, threw off our seat straps and parachute harnesses and prepared to swing the hatch open for an emergency egress. If a fire or explosion had threatened the shuttle stack, which turned out not to be case, we had just one option: Get out as fast as we could and scramble across the swing arm for a 55-mph, quarter-mile ride down the slidewires to what we hoped was safety.

Slidewires and parachutes have inherent limitations, and they couldn't save the Challenger or Columbia crews. The new generation of spacecraft will have to do better. Assuring crew escape and survival on a "bad day" will be key elements of the winning proposals when NASA awards commercial crew service contracts, probably by late September, for transportation to the International Space Station.

NASA

In an emergency, a rocket assembly would drag an Orion crew capsule away from the launch vehicle and reorient it for a safe landing under a parachute.

Tugging Orion

NASA's current commercial crew requirement calls for the probability of loss of crew during ascent to remain less than 1 in 500. What this means in terms of escape design is that during launch, the crew vehicle must get away fast enough to escape the failed launcher's expanding blast wave.

Getting NASA's 23-metric-ton Orion spacecraft free from a failing Space Launch System booster early in the ascent would be no small challenge. Lockheed Martin chose to attach a rocket assembly at the top of the capsule to drag the capsule away from the launch vehicle and reorient it for a safe landing under a parachute. This tractor-motor-based Launch Abort System is similar to the solid-rocket-powered escape systems on Mercury, Apollo and Soyuz. (In 1983, the Soyuz T-10-A launch abort system pulled its crew module free of a leaking, burning booster on the pad, saving the two cosmonauts.)

In the case of the Orion's Launch Abort System, the crew module would be pulled away by a solid-fueled abort motor that fires upward into a reverse-flow manifold, whose four nozzles protrude from the body of the abort rocket assembly to direct thrust downward. The reverse-flow design yields a lighter, more compact propulsion stack — called an escape tower — than the lattice-mounted Apollo motor. ATK supplies the 400,000-lb thrust, composite-case abort motor and also an attitude control motor whose variable thrust vents would guide the tower, shroud and capsule away from the launch pad or booster. Once the crew module is safely away, an Aerojet Rocketdyne-supplied jettison motor would separate the tower assembly from the crew module.

The Orion reverse-flow configuration was flight tested at White Sands Missile Range in 2010 during Pad Abort 1. The test showed how the motor would pull Orion clear of a pad emergency and then position the capsule for shroud separation and main parachute opening. Steve Sarah, ATK's Launch Abort System program director, says the test validated the system design and verified performance predictions.

After that test, the LAS development program slowed, Sarah says, but it is gearing up again for a series of Orion tests. ATK has switched from a steel flow manifold to a lighter, stronger version made of titanium and has changed the propellant grain to reduce acceleration loads on Orion and the crew. "We have an igniter qualification test in September, and a qual test on the new titanium manifold coming up," says Sarah. On its first orbital flight scheduled for Dec. 4, Orion will fly unmanned and with an inert abort motor. Only the jettison motor will be live during Exploration Flight Test-1. A high-altitude Ascent Abort 2 test is planned for sometime in 2018.

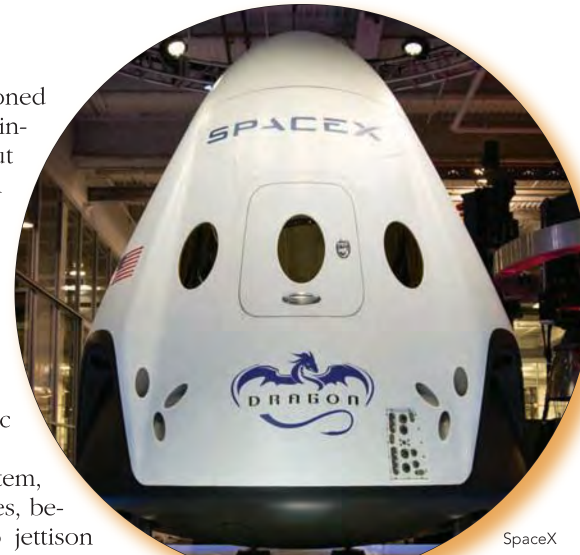
Rex Walheim, chief of the Astronaut Office's Exploration Branch, says the Orion LAS offers comprehensive abort protection. "Even after the LAS tower is jettisoned, Orion can still separate propulsively from the second stage all the way to orbit," he says. Orion can't steer to a "specific splashdown point" near rescuers, he adds, but that's not a problem because a deep space liftoff would take the crew over relatively warm Atlantic waters with no risk of a splashdown in the frigid, remote North Atlantic.

A shove to safety

Unlike Orion and early crew capsules, SpaceX's Dragon capsule would be pushed to safety from below rather than pulled. This pusher approach "is an improvement over Mercury or Apollo," says shuttle and space station astronaut Garrett Reisman, now the senior engineer for astronaut safety and mission assurance at SpaceX. Those tractor systems jettisoned their towers a couple of minutes into the flight, but "Dragon retains its LAS all the way to orbit, all the way to the end of powered flight," says Reisman. This allows the crew "to abort even in the second stage," and to thrust so as to splash down close to rescuers near north Atlantic coasts.

"By using a pusher system, we reduce our failure modes, because there's no tower to jettison routinely on every ascent," Reisman adds. "We don't have to worry about jettison failure."

The Dragon Version 2 houses its abort fuel in streamlined blisters along the capsule's sides; they feed eight SuperDraco abort motors, each with 16,000 pounds of thrust for clearing a failing Falcon 9 booster. "The engines have a very quick response time, measured in fractions of a second. They also give us active attitude control during the abort," says Reisman.



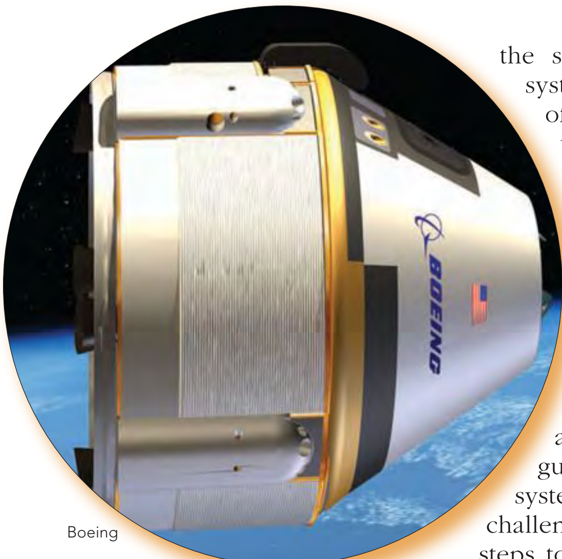
SpaceX

The Dragon V2 from SpaceX. Unlike Orion and early crew capsules, it would be pushed to safety from below rather than pulled.

On a nominal flight, where the abort system is not activated, the engines and excess fuel can be used for orbital maneuvering and rendezvous. "Essentially," Reisman says, "we're using our ejection seat on every mission,

A stack of solid rocket motors, called an escape tower, would blast an Orion crew away from a failing launch vehicle.

NASA



Boeing

Boeing's CST-100 capsule. Unused fuel from its abort engines could be used for rendezvous and docking or space station reboost.

rather than very rarely, and we gain greater confidence in our system, so we'll know it works." Eventually, SpaceX plans to use unspent abort propellant to brake Dragon to a guided, soft touchdown on land.

The company plans a series of qualification and flight tests to demonstrate system performance at the extremes of the abort envelope, says Reisman. In addition to a pad abort test, SpaceX will fly a test out of Vandenberg Air Force Base "to show we can escape a Falcon 9 very close to the maximum drag case, near Max Q," maximum dynamic pressure.

The Boeing push

Boeing's CST-100 capsule, like Dragon's, is designed with a pusher abort system. Its launch abort engines will be below the heat shield in a service module. All the abort propellant will be below the heat shield, "which is where you want it," says Chris Ferguson, who commanded NASA's last shuttle mission and is now Boeing's director of crew and mission operations. "If you store your abort prop above the heat shield, you will run into size problems or reduce your payload."

The engines each have a thrust of about 40,000 pounds. The service module also includes maneuvering thrusters in "dog houses," similar to the shuttle's orbital maneuvering system pods, carrying two types of engines: the orbital maneuvering and control motors, and lower-thrust reaction control system jets. These jets are more powerful than the shuttle's vernier jets, at 25 pounds of thrust each, but have a rapid cycle time for very precise control.

Ferguson acknowledges that a pusher design requires a more complex control and guidance system than a tractor system, but "we recognize that challenge, and we're taking active steps to minimize the impact of the aerodynamic factors you encounter around Max Q."

On a northeasterly ascent trajectory from Kennedy Space Center toward the international space station, the CST-100 LAS will have no "black zones" — abort regions that are unsurvivable because the cabin or crew cannot survive extreme deceleration loads. Ferguson says, "Late in the ascent we might use the abort system to reach a safe orbit, like a shuttle AOA [abort-once-around], where we know we've lost the mission but we can use the propellant to get to orbit and then perform a normal reentry."

On nominal launches, CST-100 can use saved abort propellant for rendezvous and docking margin as well as space station reboost.

DreamChaser

Sierra Nevada's DreamChaser resembles a mini-shuttle, but unlike NASA's orbiters, the stubby lifting body would provide full launch abort capability. Steve Lindsey, former shuttle commander and Astronaut Office chief, is Sierra Nevada's senior director of Space Explorations Systems. He says DreamChaser will use a pair of hybrid abort motors to push the vehicle rapidly clear of a failing Atlas 5 rocket. "One disadvantage of a tractor abort system," he says, "is that during separation it has to overcome a suction effect created between the spacecraft and booster. The pusher motors eliminate that problem; you get to safe separation with less thrust."

Boeing

The CST-100 in an artist's rendering. Its two launch abort engines each have a thrust of about 40,000 pounds.

The DreamChaser engines, which burn synthetic rubber — hydroxyl-terminated polybutadiene — and nitrous oxide, are positioned on opposite sides of the craft's aft fuselage. "The engines' time to 90 percent thrust shows we'll have no significant risk of asymmetric thrust, and we'll eliminate any worry through testing," says Lindsey.

"DreamChaser will be able to execute an on-pad abort and land back at the Shuttle Landing Facility, a maneuver similar to the shuttle's RTLS [return to launch site] abort mode. Unlike the orbiter, though, we'll have no risk of re-contacting an external tank," he says. "Our plan is that for ISS missions, we can abort to runways anywhere along the ascent profile." These include East Coast or transatlantic airfields. If DreamChaser cannot make it to a runway, the crew can jettison the aft docking hatch and bail out to a water landing. "Late in the ascent we'll have the ability to abort to orbit," Lindsey adds.

He says that on a nominal ascent, DreamChaser will arrive in orbit with about 40 percent excess delta-V, the ability to change velocity over that needed for its nominal mission. "We'll be able to use that prop in orbit for very creative purposes." The abort engines "have completed full-duration abort burn testing, as well as nominal mission firings," says Lindsey.

In designing its safety system, Sierra Nevada applied experience from its role as supplier of the motors for the SpaceShipOne and SpaceShipTwo suborbital space planes.

Sierra Nevada

Sierra Nevada's DreamChaser. Its two hybrid abort motors would push the capsule clear of a failing Atlas 5 rocket.

Escaping the pad

The Apollo 1 fire in 1967 showed the need to provide for the crew's rapid escape during a launch pad emergency. In the shuttle era, crews would have reached the safety of a blast-resistant bunker via the slide-wire baskets at the pad's 195-foot level. The challenge with that kind of system, says NASA's Walheim, is that "the SLS pad is much higher than with shuttle, and you can get going pretty fast on a long slide wire like that. But that can be engineered. We not only need the slide wires for the crew; the pad personnel need a way out, too."

To provide rapid ground egress at Atlas 5's launch Complex 41, CST-100 and DreamChaser will use a swing arm, slide wires, and perhaps a high-speed elevator to exit the pad area. "Essentially, we'll give the crew a fire escape," says Boeing's Ferguson, referring to the CST-100. "My preference would be to leave the pad safely via ground egress, rather than fire an ejection seat-type system [the LAS] and put myself in a different, dynamic emergency situation."

CST-100 crews, like those on Apollo, will use their capsule's side hatch for egress. On the pad, DreamChaser astronauts will use the cabin's overhead hatch for rapid access to the swing-arm.

Over at Kennedy Space Center's Complex 40, SpaceX plans to add slide wires and a high-speed elevator to give Dragon crews a path to safety.

Orion and the commercial spacecraft all have the option of using "the equivalent of a zero-zero ejection seat," which enables them to leave the pad vertically, via rocket-powered pad abort. "We don't want crews descending the launch pad into a fire or explosion situation," says Sierra Nevada's Lindsey.

The abort decision can be made not just by the booster's automatic fault sensing systems, but also by the launch control center or the astronauts. The call is made only if the booster and pad are headed for a structural failure or imminent explosion.

My STS-68 crew was the last to experience a pad abort. When our right engine shut down at T-1.5 seconds, we didn't yet know the cause. Had there been a serious fire or explosion, our only way out was through the side hatch, across the swing arm and pad structure, and down the wire — an awfully long path to safety with a hydrogen fire brewing. Launch controllers quickly determined we'd had a safe shutdown, with no fire danger, so we exited normally about 45 minutes later.

NASA and its commercial suppliers plan to do a lot of flying beginning in 2017; planning for the worst case now can give crews a fighting chance at survival, on the pad and during ascent. The stars may be your destination, but you'd better have options if your booster balks.

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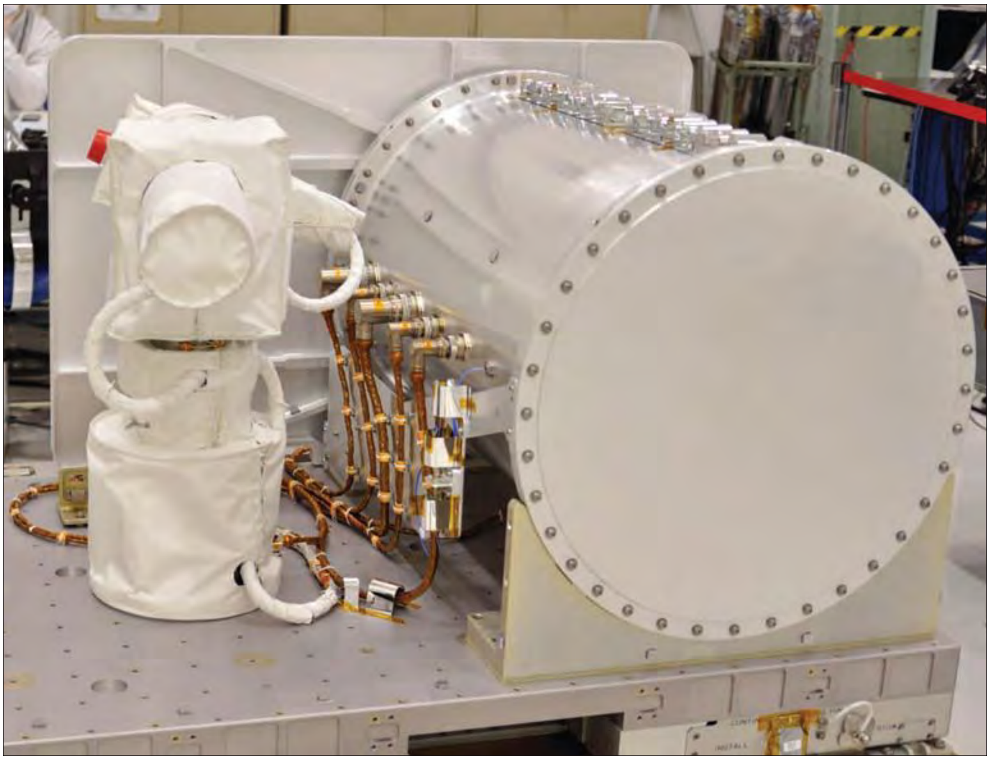
Demonstrating laser comms

A small communications package attached to the exterior of the International Space Station could have an outsized impact on the future of communications from space to Earth. Marc Selinger explains the technology underlying OPALS, the Optical Payload for Lasercomm Science.

On a June night, Jet Propulsion Lab engineers Matt Abrahamson and Bogdan Oaida ran outside their mission control room for the joy of watching the space station cross overhead. They knew by telemetry that the station had just transmitted a 36-second, high definition video montage showing a Pony Express rider; a hand tapping a telegraph machine; a floppy disk being inserted into a computer; and a computer display rich with graphics. This "Hello World!" video was an homage to the progression of communications technology, and it was sent via what could be the next step in that progression: Laser light beamed through space to the ground.

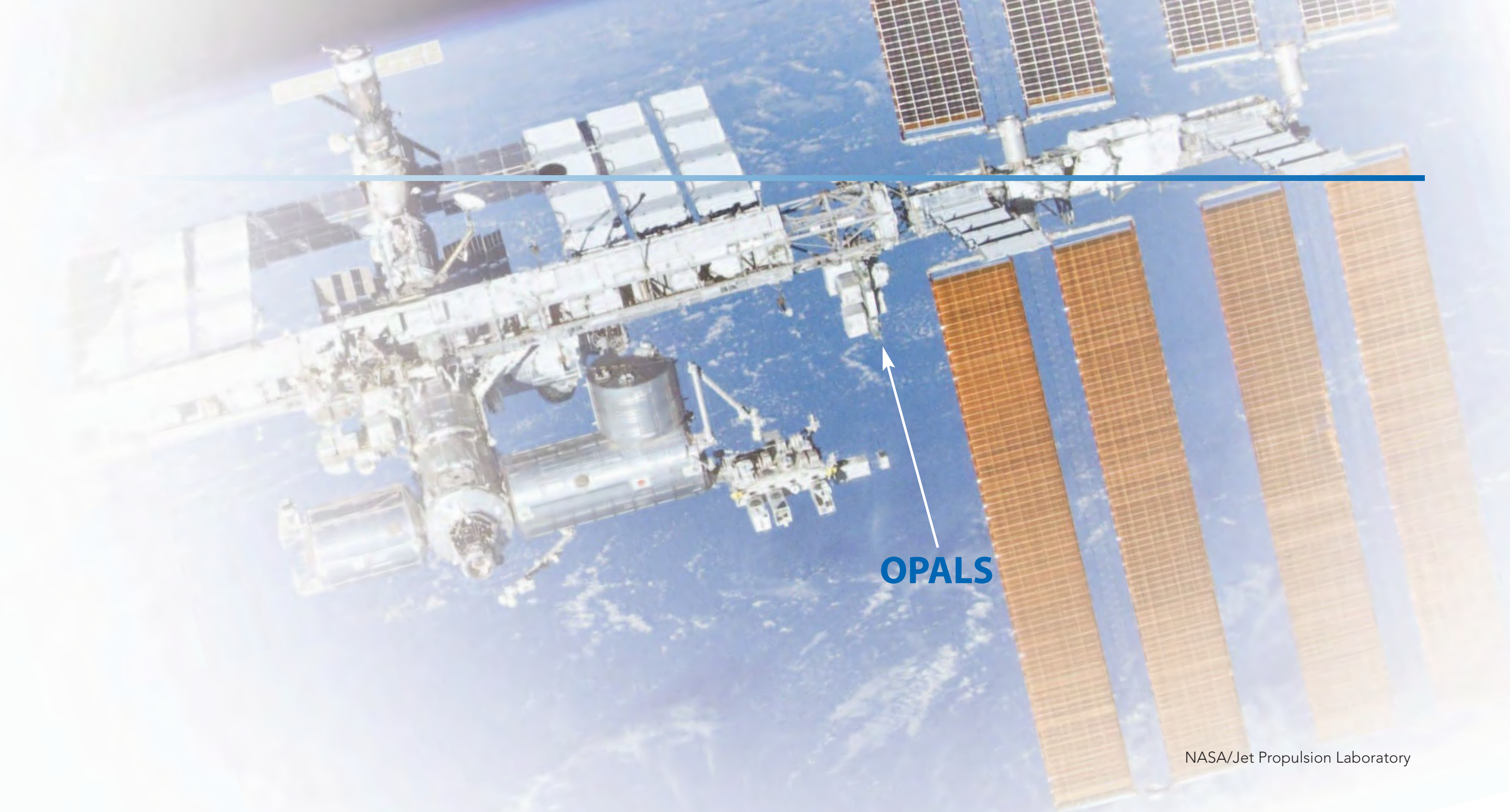
Abrahamson is mission manager for the Optical Payload for Lasercomm Science, or OPALS, and Oaida is the project's systems engineer. The 159-kilogram package of electronics was launched to the international space station in April inside a SpaceX Dragon module and attached to the exterior of the station by the station's Dextre mechanical arm as directed by a robotics team in Houston. OPALS consists of a box with laser electronics and a computer, plus an optics box attached to a mechanical gimbal. The "Hello World!" video was beamed to a ground station at Table Mountain Observatory high in the San Gabriel Mountains above Los Angeles.

The OPALS team had to solve numerous technical challenges to get to the point where it has now repeated the downlink feat a dozen times. On each pass, OPALS must keep its laser locked onto a receiving telescope at Table Mountain, a task Oaida likens to keeping an office laser pointer on "an area that's the diameter of about a human hair, from about 20 or 30 feet away, while I'm moving at about half a foot per second." Coming soon, engineers plan to show how OPALS can be redirected to another ground station to avoid cloud cover. There were also challenges related to



NASA/JPL-Caltech

The electronics and laser for OPALS, the Optical Payload for Lasercomm Science, are protected by a cylindrical housing. The gimbal that steers OPALS is to the left.



NASA/Jet Propulsion Laboratory

getting OPALS to space, including integrating it with the new SpaceX Dragon module. But perhaps most significantly, space station safety overseers needed to be satisfied that the laser would not accidentally touch the exterior of the space station. The laser starts out at 2.5 watts with some energy dissipating through cables and optics, leaving a 2-watt beam – about the equivalent of 400 laser pointers. That's probably not enough to burn a hole, but it might be enough to render some of the cells on the station's solar arrays nonfunctional, Oaida says. Astronauts are never at risk, because the laser is not operated if an astronaut is outside the station.

The team's ability to work through those problems suggests it might be possible to make a miniaturized version of the technology for deep space applications, including NASA's planned Mars 2020 Rover mission.

Game-changing speed

The advantage of laser beams is that they have shorter wavelengths than radio waves, which means more bits and bytes can be packed onto them. Light waves also spread out less over long distances, so more of the signal reaches the intended receiver. The "Hello World!" high definition video took 3.5 seconds to download via laser; radio waves would have needed 10 minutes, a contrast that has NASA excited about laser communications at Mars. Today, "it takes minutes to almost hours to get just single images down from Mars," Abrahamson says. With lasers, "you might be able to get streaming video from the surface of Mars, and I think that's a game-changer," he says.

The first challenge was to get OPALS to the space station. Work was progressing on the OPALS design in 2010 and 2011 at the same time SpaceX was finishing up its Dragon design. "Since we were designing our payload in parallel with the Dragon design, we encountered an issue with our power interface," says Abrahamson. The power connector pin planned for OPALS turned out to be incompatible with Dragon. "So SpaceX designed a custom power interface for OPALS," he says.

Also, electronics like those in OPALS must be designed to withstand specific launch vibrations. Calculations of the intensity of those vibrations were revised repeatedly during the design, because OPALS and Dragon were to be launched on an updated version of a Falcon 9 rocket. "In the end, it did not require any change to our design, but it did require extra effort to understand the new implications with each change," Abrahamson says.

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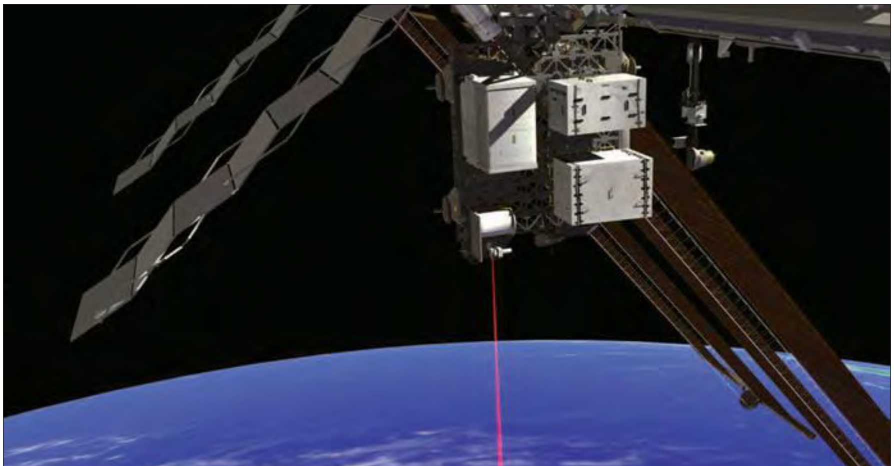


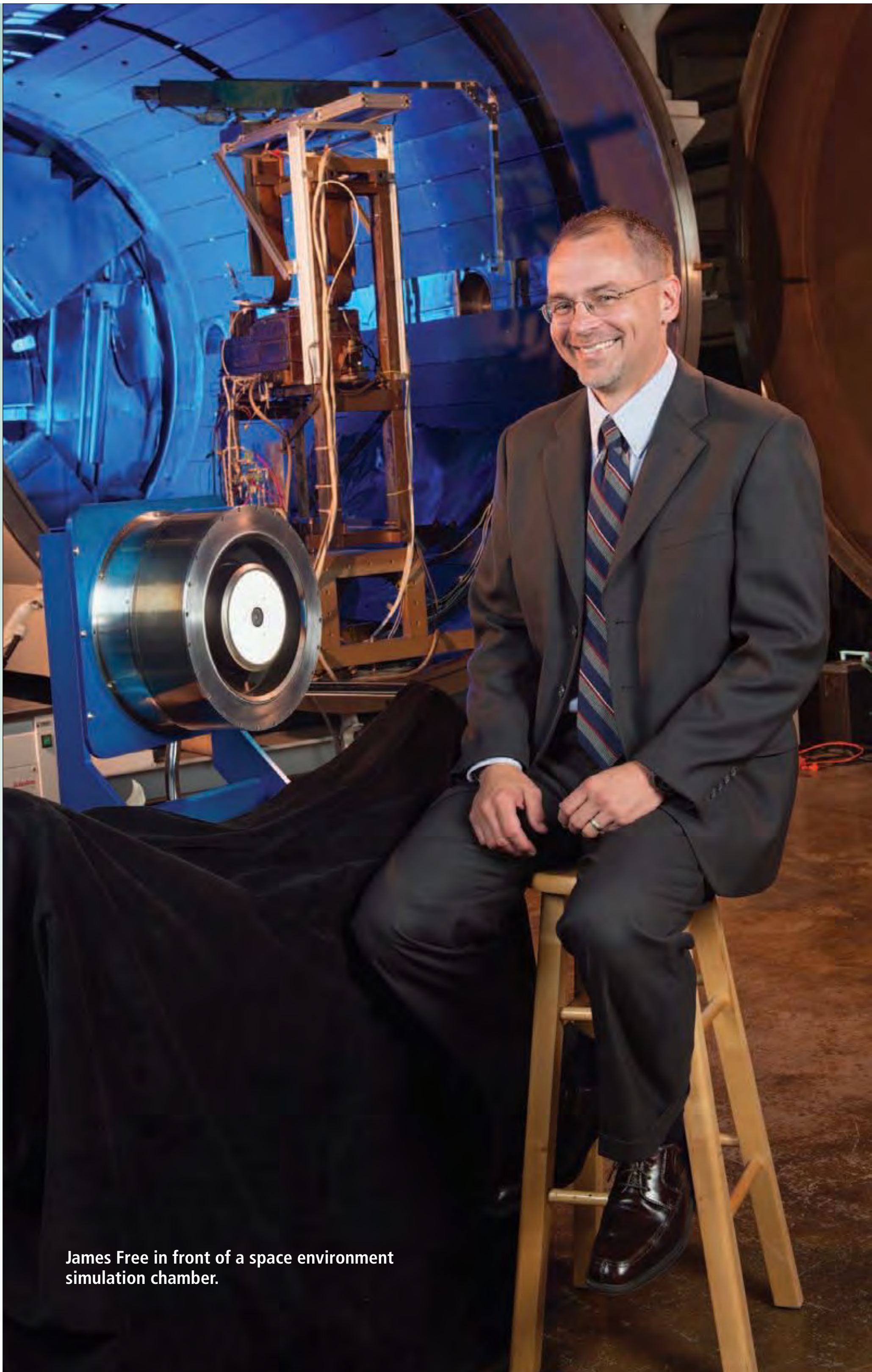
NASA/JPL-Caltech

This artist's rendering shows the Optical Payload for Lasercomm Science operating from the International Space Station. In the real world, the laser is invisible.

Optimist-in-chief

James Free, Director NASA Glenn Research Center

The three most important words at NASA's Glenn Research Center might be solar electric propulsion. The technology will be central to the U.S. plan to send humans to Mars, and that's one reason Glenn Director James Free predicts that his center's budget pain is about to ease. Free is a self-described "dumb space propulsion guy" who in January 2013 rose to become director of Glenn and its aeronautics and space facilities at Lewis Field near Cleveland and in Plum Brook, Ohio. He has a bachelor's degree in aeronautics from Miami University in Ohio and a master's in space systems engineering from Delft University in the Netherlands. Free spoke with Ben Iannotta about space power, wind tunnels, and NASA's initiative to make aircraft and satellites run a whole lot cleaner.



NASA

James Free in front of a space environment simulation chamber.

Interview by Ben Iannotta

I saw the Cleveland Plain Dealer story from July that painted a bleak outlook for funding at Glenn if nothing changes. How worried are you about 2015?

We're at about $567 million for fiscal year 14, and we've been proposed at $587 million for fiscal year 15. So I'm confident that we will be right around that number, and my confidence comes from the fact that we're right at the center of solar electric propulsion, which is enabling technology in multiple architectures. And [we have] some continued work on the aeronautics side that has some big highlights in fiscal year 15.

What missions is solar electric propulsion most relevant to?

It's relevant to the overall architecture of getting people to Mars, and the agency has been fortunate in that our budget looks a little brighter than it did before. The agency recently published our three steps to Mars: We understand our low Earth orbit environment. We're now going to go work in and around the moon with the Asteroid Retrieval Mission, and that puts us on the long term path to Mars. For each one of those steps, solar electric propulsion is enabling.

For a human mission to Mars, wouldn't that be where nuclear propulsion would come in, so you could travel faster and not expose people to as much radiation?

There's a couple places that solar electric propulsion fits in, and it doesn't really involve humans for the reasons you just stated. It's highly efficient but very slow, so what you need solar electric propulsion for is pre-positioning the cargo. So there's a lot of supplies and systems that can be moved out ahead of the crew, so that they're in place when the crew gets there.

Back to the budget: How is Glenn faring compared to other centers?

I'm not the kind of person that compares. We have gone through some throes along with our partners in Space Technology Mission Directorate of funding technology, which is always a challenge in the government. Some of the other centers that aren't as dependent on the Space Technology Mission Directorate haven't seen those swings that we have. But we are really a strong supplier to the other centers.

It sounds like you think the budget pain might be over because you're at the point where what you're providing is critical to the other centers.

Yes, if I didn't believe that, I'd owe the employees a different response.

At your funding level, are you still able to support two sites, Lewis Field and Plum Brook?

Yes. We don't look at it as, if we get below a certain level we need to consolidate our sites. What we look at it as is utilization of both sites. Lewis Field has a set of incredible capabilities. Plum Brook has a set of incredible capabilities. The work going on at Plum Brook in the Space Power Facility has strong usage from now out through 2020. You can't exactly pick up and move SPF back to Lewis Field. That would be quite a reality show if you did that. Everybody looks at Plum Brook. We have 6,000 acres. Well, we're actually just about to access about a 100 acres to the county for them to use for access to freshwater. So we're doing things to be innovative but also not giving up on the unique capabilities we have out at Plum Brook or here. We're a member of this agency, and we will always look at what's best. If we have things that other centers need to use by dropping capability, that should happen. If we have things that we should drop, and go use somewhere else, that should happen as well.

Langley has wind tunnels, you have wind tunnels. What kind of work do you do compared to Langley?

The thing to look at with wind tunnels is: Okay you can go up to Mach point 9, and center X can go up to Mach point 9. What can you do unique at that speed regime? In Langley's case, they can put in different sized models or look at the flow differently. We can put in bigger models and go faster. So, while there's an overlap in speed regime, the capability may not necessarily be the same. We'll continue to look at that, just being good stewards of the taxpayer's dollars.

It wouldn't make sense to say, "All our wind tunnels are going to be at Center X"?

No. There's some at Langley that have capabilities that by the time we tried to recreate them here, would just be too expensive. That wouldn't make sense. And there's ones here that would be the exact same situation. You'll notice across the agency there's been wind tunnels that have been shut down and bulldozed. Two of our Propulsion Systems Lab test cells were bulldozed and Langley has gone through the same thing recently.

Can modeling, simulation and computational work substitute for some of the work you're doing in wind tunnels?

That's a look that's been done agency-wide now by the Office of Chief Engineer with a consortium of center folks and engineering expertise. I'm just a dumb space propulsion guy who's tried to pick up the aero piece, but the experts say you're always going to have to test to some level. I think we've done ourselves a world of hurt, both on the DOD and NASA sides over a lot of years. When you eliminate testing, you see your failure rates go up. Testing's always the first thing cut because it seems so expensive. If we find the right balance between modeling and simulation and testing, you can drive your test costs down and still keep your reliability up.

What is the balance, budget-wise, between aeronautics and space at NASA Glenn?

I always characterize it as 50–50. We're very well balanced between space and aeronautics here on average, not year to year.

Why did you decide to merge engineering and research into a single Research and Engineering directorate this year?

I'm sure you've heard the term Valley of Death for technology. We were set up to almost encourage the Valley of Death. So, we get people in the same organization who are responsible for the really great innovative ideas mixed with the people who are eventually going to fly them. It allows them to begin to talk the same language, which may break down barriers to the technology flying. The second [reason] is purely efficiency.

Did staff literally move or was this about changing signage and email signatures?

Some of the moves have occurred. Some of them are still to be done. We actually just opened a new building that'll bring some of the groups together and people together. So it'll be a gradual thing.

Do you feel good about the personnel and resources for a hybrid aircraft, and would that be a transport-plane idea or for general-aviation planes?

I absolutely feel good about it. I don't think it's going to occur anywhere else in the U.S. but within NASA. It, to me, is a range of aircraft from personal aircraft to general aviation, all the way through transport. I think the smaller aircraft will come first. But the technology's needed for that continuum. There's a lot of commonality amongst them, so the four research center directors are getting together to get a plan to Jai Shin at the Aeronautics Research Mission Directorate, and Jay Dryer [director of the fundamental aeronautics program office] to give them our plan for how we support the development of that range of aircraft, and what technology investments span that entire range. I honestly believe from the engine perspective, a lot of that expertise and know-how is here at Glenn.

What about an all-electric plane that can carry significant numbers of people?

I started saying all-electric, and our folks here quickly cautioned me: "Hey, focus on more electric first." That's more realistic for us to get to — looking at the phases of flight as separate technologies, taking off with some kind of turbofan, potentially, and going to all-electric in a cruise phase. That may be one architecture. As with anything, the safety of flight's the most important thing.

On this initiative to make aircraft and spacecraft that will operate cleaner, is it the Obama administration or the market driving this? Is the trend here to stay?

On the aircraft, the cost of fuel is the single biggest expense that the airlines have. They operate on small profit margins. So, anything you can do to open up the profit margin and get away from that dependence is going to look good to the airlines, which then the engine manufacturers are going to be responsive to. NASA's ultimate goal is reducing fuel burn and our CO2 impact on the atmosphere. I think that is independent of administrations. Some may stress it more than others, but it still is a theme that we would deal with. On the spacecraft side, as a person who used to be loading hydrazine, that's an expensive and costly operation just do to the loading, let alone make the propellant and store it. Anything you can do to drive down the operations and manufacturing costs of the propellant reduces the cost per dollar per pound to orbit. That helps close the business case on commercial geo-comm, on commercial space travel. Again, I think that's independent of administration. It obviously has impact on the environment too, when you stop using hydrazine or nitrogen tetraoxide.

(Continued from page 17)

Canada's two-armed Dextre robot was photographed installing the Optical Payload for Lasercomm Science on the space station exterior.

Safety first

On the safety issue, space station officials told the OPALS team to make sure the laser would swivel only within a 110 degree area during each pass. If you were looking straight down from the station, this communications window would extend 75 degrees ahead and 35 degrees behind. The OPALS team needed to devise three ways to keep the laser within that window: "If any two would fail, there would be a third feature preventing the laser from pointing outside of this window," Oaida explains. Specifically, the team devised a system of electrical switches and mechanical hard stops. "The electrical limit switches are tied to the power distribution board and designed to cut power to the laser when actuated. The hard stops prevent any movement beyond the field of regard," says Abrahamson. The hard stops counted as two features, a certification that took a lot of paperwork, adds Oaida.

Safety considerations were paramount. "This required many design iterations with ISS safety engineers and a significant amount of documentation to capture the design and how it works in practice," Oaida says.

A big challenge was finding and staying locked onto the ground station. With the station flying at 17,500 miles per hour, the communications window would open for at most 165 seconds, and the connection had to be made quickly to provide plenty of time for downloading. On each pass, OPALS's onboard camera must detect a laser beacon sent from Table Mountain. OPALS locks onto it and begins firing its laser, rotating at about 1 degree per second to maintain this precision pointing. Devising a system to meet that challenge required early testing of the gimbal components and at least one redesign of the pointing software.

Possible partnering

OPALS is not the first time NASA has used lasers to communicate. The Lunar Atmosphere and Dust Environment Explorer spacecraft launched in 2013 did too. LADEE didn't have the challenge of rotating rapidly to stay locked on a ground station. In its lunar orbit, it was almost stationary relative to the ground station that received its transmissons in New Mexico.

The OPALS and LADEE demonstrations have engineers talking about how the two concepts might work together at Mars in a hybrid approach. The Mars laser would send video and images from the Martian surface to a spacecraft orbiting Mars, which is similar to what OPALS has done but in the opposite direction. The Mars laser would then beam the information to Earth, which is similar to what LADEE did from the moon.

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Reflecting on radars

Advances in defense technology can have geopolitical consequences beyond their immediate tactical or strategic impacts. U.S. development of radar and missile technology since World War II is a case in point. D. Kenneth Richardson, a retired president of Hughes Aircraft, chronicles the major advances during his tenure at Hughes from the 1950s to the 1990s.

Photo courtesy of D. Kenneth Richardson

The author, second from left, after an F-14 flight. The aircraft used a weapons system and missile built by Hughes.

After World War II, the U.S. saw an urgent need to improve fighter aircraft so they would be capable of intercepting hostiles at long range and in bad weather. Until then, pilots had to rely on their eyesight and the agility of their planes to get close enough to fire their machine guns or cannons. Most encounters were at short range in daylight; the odds of success were increased by a ground-based warning system that predicted where the enemy was likely to be so the friendly fighter could place itself in an ideal intercept position. In WW I that was done by troops using their eyes and ears. The same was done in World War II, soon enhanced at long range by rudimentary radar surveillance equipment such as the British Chain Home and the German Freya.

By the early 1950s, the Soviet Union was flying high-altitude turbojet intercontinental bombers armed with nuclear weapons, to be followed a few years later by jet aircraft approaching at supersonic speed. The newly created U.S. Air Force needed the ability to intercept these planes as far as possible from U.S. airspace. In addition to advancing early warning capability, the challenge was to devise a radar with extensive performance, using vacuum tube technology that would be small enough to fit on fighter planes such as the F-86. Fighters on patrol or positioned overseas could then intercept the hostiles in international airspace and fire recently developed guided missiles at them.

In 1946, the Air Force turned to Hughes Aircraft in Culver City, Calif., to meet its intercept radar and missile development needs. Other companies were eager to avoid government contract obligations in order to greatly expand their consumer product lines.

Over the next four decades, the research staff and engineers at Hughes and its successor companies would help roll out increasingly capable fighter radars and guided missiles. Thankfully, these would never be proven in a hot war with the Soviet Union, but they helped drain the USSR of resources as it tried to catch up. This brought a peaceful end to the Cold War.

Something often overlooked are the impacts of these technologies in the consumer world, including air traffic control systems, satellite communications, CD and DVD players, cell phones and digital cable decoders.

Here are seven major breakthroughs in radar and missile technology:

1. Pulsed Power—early 1950s

Vacuum tubes and independent component circuitry were used to enable emission of X-band microwave radio frequency signals at 10 billion cycles per second. The frequency setting and amplification were done by a cavity magnetron tube. X-band penetrated clouds and debris, and could be constructed with adequate power and an ideal antenna beam size. The key was to emit the X-band in bursts at a low pulse repetition frequency — PRF — of about 2,000 times a second. This meant there would be enough time to turn off the receiver during bursts, and turn it on again to sense echoes arriving between bursts. The radar's "clock" accurately measured time, from which distance — range to the target — can be determined. Radio signals travel at 186,000 miles per second, so the target distance is that 186,000 divided by half the time the pulse takes to make a round trip to the target. The quiet period between pulses allows targets up to 50 miles distant to be "seen." A cockpit display showed a blip for the target position. Fighter-sized targets reflected enough echo to be seen at 30 miles.

A 36-inch parabolic antenna was protected by a fiberglass radome that caused little signal restriction. A gimbaled base allowed sweeps of 120 degrees horizontally and 60 degrees vertically, and kept the scan parallel to the Earth.

A daunting problem was to avoid "ground clutter" return caused by the main beam striking the Earth when the antenna was pointed downward. This return can be 1,000 times stronger than an echo from a hostile aircraft. Also, "sidelobe clutter" came from reflections from the ground directly beneath the pilot's own aircraft. To avoid these, pilots knew to point the beam upward. When a target was spotted, the pilot switched to a tracking mode. The antenna remained pointed at that target regardless of maneuvers by the combatants. Range and angle tracking provided steering and timing for effective gunfire. Hughes produced 5,718 of these pulsed radars, equipping fleets of planes including the F-86 Sabre, F-89 Scorpion and F-84 Starfighter.

2. Digital Computer Controlled — early 1960s

Massed Soviet bombers bearing nuclear weapons could approach anywhere on our widespread borders. The U.S. created an extensive new ground radar network immune to countermeasures, supersonic fighters with intelligent fire control systems, and smartly guided missiles. New digital computer technologies permitted operational integration and coordination of ground tracking, command and control, and airborne intercept squadrons. The Hughes computer-controlled MA-1 fire control system was installed on the F-102 Delta Dagger and the F-106 Delta Dart supersonic interceptor jets; 2,308 were produced.

Using solid-state diodes and incorporating the first airborne digital computer permitted the MA-1 to amass many complex functions in a relatively compact space.

New weapon types overcame limits of weather, close-range encounters, and target evasion. This era saw the appearance of infrared Sidewinders and radar Sparrows, as well as radar and infrared Falcons. Future years saw development of four generations of such weapons.

University of Nevada Las Vegas

F-86, F-94 and F-89 fighters. Pulsed power radar used in the 1950s enabled these planes to sense echoes arriving between pulses and determine distance to the target.

UNLV

The MA-1 fire control system, bottom center, with Falcon missiles and an F-106 aircraft. The MA-1's radar used an airborne digital computer.

3. Look Down/Shoot Down — late 1960s

To overcome the clutter constraints associated with low-PRF radars when they are pointed downward, engineers exploited the Doppler effect. This occurs when a train whistle sounds higher-pitched to a listener as the train approaches, and lower-pitched as it departs. A similar frequency shift occurs between an echo and the illuminating radar pulse, exactly proportional to relative speeds of the combatants.

Pulsed cavity magnetron frequency stability was too erratic to form a base point for target Doppler shift measurement. In the 1960s, precise carrier frequency was achieved with a crystal oscillator, a frequency multiplier, and a traveling-wave tube. This 12-inch long, 4-inch-diameter device creates an electron beam constrained by a doughnut-shaped series of magnets. A microwave signal is boosted to a 250-kilowatt peak without affecting the input frequency. This input could quickly be changed to evade enemy countermeasures or friendly interference. High PRF bursts at 250,000 per second provided much greater average power for significantly longer range detections. Moving target echoes could now be distinguished from clutter.

Range computation used both the echo time and a slight outgoing frequency change while the beam was on target. The Hughes ASG-18 fire control system achieved this with transistor electronics to further increase performance and shrink physical size. Unfortunately, successive cancellations of the F-100 Raptor, YF12 Blackbird and F-111B "Flying Edsel" meant that this essential capability had to wait for the F-14 Tomcat and F-15 Eagle.

A dramatic demonstration occurred in 1962 when a YF-12 interceptor, derived from the SR-71, released a Hughes Super Falcon missile from an altitude of 74,000 feet over a New Mexico test range. The missile scored a direct hit on a QB-47 Stratojet drone ground-skimming at 500 feet and 49 miles away. The YF-12 went on to complete its 3-hour non-stop mission from California to the skies over Florida and back.

US Air Force

A YF-12 Interceptor. In a 1962, test the plane released a Super Falcon missile from an altitude of 74,000 ft and scored a direct hit on a low-flying drone 49 miles away.

UNLV

An F-14 Tomcat equipped with pulse-Doppler AWG-9 radar. The system provided multiple tracking by storing target snapshots during each 2-second antenna scan.

4. Multi-Target Tracking — 1970s

To protect large battle groups from enemy aircraft and cruise missiles, the Navy chose to fly F-14 Tomcats in 360-degree rings around the fleet. Each fighter was equipped with a fire control system that could track up to 24 hostiles as far away as 200 miles, and simultaneously steer up to six Hughes Phoenix missiles launched from their bellies to widely spaced targets flying as high as 80,000 feet.

The key to achieving this capability was to equip the F-14s with the Hughes pulse-Doppler AWG-9 radar containing a gimbaled flat-plate antenna, a central computer and operator displays. Multiple tracking was done by storing target snapshots during each 2-second antenna scan. Each missile received only its assigned snapshot for midcourse guidance; then, with 10 miles to go, it turned on its internal radar for continuous illumination until impact.

Proof-of-the-pudding was a 1973 six-on-six multi-shot test: five direct impacts, and one proximity-fuse hit. Two fully equipped Tomcat squadrons deployed on the USS Enterprise in 1973. Seven-hundred twenty-five Tomcats and 6,000 Phoenix missiles were manufactured.

5. Digital Signal Processing — 1980s

This breakthrough made it possible to analyze echoes to understand target behavior, shape, vulnerable positions, and background terrain features. Also desired were quick changes between many operating modes: detection and track, target identification, missile guidance assistance, passive sniffing, and ground strike. Echoes were converted into digital format and rapidly manipulated to study minute details. An agile signal processor formed high-resolution images of the hostiles and permitted nimble mode switching. Hughes developed a software-managed programmable signal processor — PSP — to perform 98-225 million complex operations each second. PSPs first appeared in the F/A-18 Hornet with installation of the APG-65 radars. Hughes produced over 1,400 APG-65 systems, and improved versions are still being manufactured.

6. Stealth — 1990s

A maxim for warfighters in most scenarios goes like this: Be not seen; be not heard; be not recognized. Combat is more effective if the enemy is un-

Photo courtesy of D. Kenneth Richardson

The APG-65 radar for the F/A-18 Hornet fighter. Its agile signal processor provided detailed images of hostile aircraft and terrain.

US Air Force

The F-15 Strike Eagle. It was the first fighter to use stealth in its APG-70 radar systems.

aware of your presence. “Be not seen,” or stealth, programs were begun in 1960 and evaluated at the secret Nevada Area 51 site. “Be not heard” radar culminated in the Hughes system for the B-2 Spirit bomber, and adaptations were soon applied to fighters.

Radars emit electromagnetic energy that may be detected by hostile “sniffers.” Details on how we achieved be-not-heard capability are still security classified, but test and combat results have been extraordinary. Design and operating changes brought improvements such as non-reflective antennas, random transmitter changes in frequency and power output, as well as AMRAAM — advanced medium-range air-to-air missile — alterations in the PRF and pulse waveforms.

“Be not recognized” techniques can confuse hostile sniffers that cannot sort your signal from their own when the signals are matched in frequency and behavior.

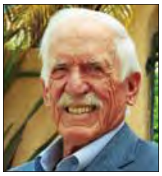
The F-15 Strike Eagle became the first fighter to employ stealth in its APG-70 radar systems. Hughes produced 1,200 of these. Modern fighters were now well matched to the Hughes AMRAAM, which in the Gulf War scored 28 victories with no friendly fighter losses.

7. Active Arrays — 2000s

The pinnacle of radar development was the advent of independent transmit-and-receive elements, which are used today and will likely be the source of future innovations. Hundreds of small elements are shaped to fit each aircraft or combat ship. These modules benefit from digital formatting, exotic software and microelectronic miniaturization. The versatility of this approach is virtually unbounded: beams of any shape can be formed; several pencil beams can be simultaneously projected at different angles; beam positioning can be instantly changed; operating frequencies, pulse shapes and power levels can be altered. Large total power can be radiated, being the sum of many elements emitting at low levels. Active arrays are part of the combat might behind the F-22, F-35 and improved versions of the F-15 and F/A-18.

US Air Force

Two F-22 Raptor stealth fighters. These and other advanced aircraft use active arrays consisting of hundreds of independent modules that provide extreme versatility.



D. Kenneth Richardson is the author of “Hughes After Howard: The Story of Hughes Aircraft Company,” which includes more details on the history and technologies discussed here.

Auto industry brings inspiration to engine researchers

Marc Soracco Photography Inc.

Journalist Graham Warwick leads a discussion about the future of propulsion and energy.

Dramatically improving the efficiency of power and propulsion systems aboard aircraft is going to require openness to tapping developments in other disciplines.

That was one of the themes struck by members of the opening panel of AIAA's Propulsion and Energy forum in Cleveland. The session, "Perspectives on the Future of Propulsion and Energy — The Art of the Possible," was moderated by James Free, director of NASA's Glenn Research Center.

"We are watching closely what's going on with the automobile industry," said Eric Bachelet, executive vice president for research and engineering at Safran of Paris. He said a "cross-disciplinary approach" is needed. He lauded the auto industry for pushing forward with electric cars, even though 15 years ago "no one believed" they were feasible.

Looking out to the year 2064, Bachelet said, "We believe that gas turbine is not dead. It's very likely to be complemented with fuel cell." He said propulsion and airframe integration is likely to be "highly optimized."

Insertion of new technologies in "vintage aircraft fleets will be a challenge," he added. Innovation will be fueled in the coming years by the public: "The demand for mobility will continue to grow," Bachelet said.

Ric Parker, director of research and technology at Rolls-Royce, also brought up the auto industry, comparing the hybrid technologies in the company's Distributed Electrical Aerospace Propulsion or DEAP project to those in a Toyota Prius. He said more work will be required for aircraft applications: "None of that technology is light enough today to get in the air," he said.

During the question and answer session, an audience member noted that none of the speakers had portrayed a future filled with supersonic transports. Parker ventured an explanation:

"It's taken a bit of a back seat for two reasons. One is it's never going to be as good for the planet in terms of CO_2 and everything else…as conventional flight. So there's a sort of guilt factor that's come in," he said. But he noted that there's been progress toward reducing the noise of supersonic aircraft. "From there, we may get back to supersonic transport," Parker added.

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Quotable:

"There's a lot of hype [about] additive manufacturing… It's just another tool in the toolbox, albeit a very powerful tool. The hype will get us into more trouble than we want."

— Edward Morris, director of America Makes.

Five things

Additive manufacturing is all the rage, and for good reason. It can speed up product development and cut the cost of manufacturing complex parts for rockets and other hardware.

We need to embrace this," said Christine Furstoss, global technology director for manufacturing and materials technology at GE Global Research.

Furstoss and members of the panel she moderated, "Advanced Manufacturing Solutions for P & E Systems – The View from Users," offered advice on how to adopt the technology wisely:

Avoid over-promising >> Edward Morris, director of the America Makes institute in Youngstown, Ohio, cautioned against excessive exuberance. "There's a lot of hype with additive manufacturing," he said. "It's not a hammer that hits everything. It's just another tool in the toolbox, albeit a very powerful tool," he added. "The hype will get us into more trouble than we want."

Better tools, inspection >> H.D. Stevens, director and chief engineer of Lockheed Martin's Advanced Technology Center, cautioned that "we have a ways to go in terms of getting what I would call aerospace-quality machines on the market." He added that he "would like to see inspection as a post-processing step eliminated. You do it as

"Today more knowledge is generated in a day than everything that was known in the 1800s."

— Dimitri Mavris of Georgia Tech on the educational challenges of keeping up with change.

"It was only 50 years between [Robert] Goddard's first liquid-fueled rocket launches and the moon landing."

— Alton Romig of Lockheed Martin on the potential speed of progress in advanced energy systems.

"The challenge is… rethinking completely the borders of what is traditionally an aircraft and what is traditionally an engine."

— Sebastien Remy of Airbus Group Innovations on using electricity to propel aircraft.

to remember about additive manufacturing

part of your manufacturing process and it goes away. That's really how you're going to get the cost out — by cutting out entire steps, entire portions of your process. So having in-situ inspection that goes right along with your manufacturing process I know is one thing that we're looking for in the future."

Spread the risk >> Furstoss said technical risk should no longer be addressed only in the design phase. "That worked for decades. It was a wonderful model, but it was slow. It had limited interactions, and it really meant that we put all our risk into the early part — into the design," she said. "It limited what we could do."

Low-volume production >> Joaquin Castro, senior manager for space advanced programs at Aerojet Rocketdyne, said additive manufacturing works well for equipment that is developed and produced in small numbers, such as the rocket engines his company makes. "We make single to perhaps double-digit numbers of engines a year. Additive manufacturing has the potential to be a disruptive technology and significantly impact the cost of the hardware we produce," he said. "We change the design of the part and within two weeks you have the same part, and bring it back and test again. It's revolutionary in the fact that it's specially suited for low-volume manufacturing."

Help for a liquid engine >> Additive manufacturing could speed up engine work, said Tom Williams, manager of the propulsion division of NASA's Marshall Space Flight Center. "Today it takes a long time and a lot of money to develop a liquid engine system," he said. "That's one of the impasses we face with regard to new development, so we're using the additive manufacturing technology to address not only design and manufacturing, but test, certification, evaluation — the entire process to make us better."

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Christine Furstoss, global technology director for manufacturing and materials technology at GE Global Research, moderates the panel discussion, "Advanced Manufacturing Solutions for P & E Systems – The View from Users."

Marc Soracco Photography Inc.

Comet's Mars encounter: Concern, but no panic

A comet's close approach to Mars in October is unlikely to endanger spacecraft orbiting the planet, but the encounter will nevertheless create concern for scientists and engineers, reported speakers during an astronomy panel at SPACE 2014. On Oct. 19, Comet Siding Spring, or 2013A1, will approach within about 150,000 kilometers of Mars — just under one-third the distance between Earth and the moon. The comet's dust will pass over the Martian north pole, possibly endangering spacecraft on station in the region during a 30-minute window.

Three spacecraft are currently in Martian orbits: NASA's Mars Reconnaissance Orbiter and Mars Odyssey, and the European Space Agency's Mars Express. Joining them this month will be NASA's Mars Atmosphere and Volatile Evolution — MAVEN — and India's Mars Orbiter Mission, which are en route to the planet.

However, concerns about the dust may turn out to be "much ado about nothing," said panelist Paul Chodas, a senior scientist at NASA's Jet Propulsion Laboratory. "Multiple studies at JPL, the University of Maryland and other sites have confirmed that the comet's dust trail is unlikely to threaten the orbiting systems," Chodas said. He added that the comet did not begin to eject dust at the critical distance — between 15 and 20 astronomical units from the sun — which would have to have happened for the dust cloud to fully impact the orbiters' operations. Chodas said "the comet's bulk dust is being ejected at speeds below 1 meter per second," well below the speeds where it would pose a threat to systems.

Based on the data, researchers have concluded that the cloud will pass up and over Mars, barely skirting a 1-kilometer edge of the orbiters' operating zone for a half-hour. This prompted Joseph Guinn, manager of the mission design and navigation section at JPL, to joke that the situation is not one of "seven minutes of terror, but more like 30 minutes of concern." Chodas added, however, that if the models are wrong, there will be particles measuring between 1 millimeter and 1 centimeter, "about the size range of a sunflower seed to a grain of rice," impacting the orbiters like "cannonballs, causing extensive, most likely catastrophic, damage."

Comet Siding Spring is "unlikely" to harm spacecraft, says Paul Chodas of NASA's Jet Propulsion Laboratory.

AIAA

Charles D. Edwards, Jr., chief technologist of the Mars Exploration Program and telecommunications engineer at JPL, said, "Despite the low risk of impact posed by the dust, NASA, ESA and ISRO [Indian Space Research Organisation] did develop plans to shield the orbiters during the 30-minute window," with each agency having plans to adjust the attitudes of their spacecraft, including "hiding" them behind Mars during the window to shield them from any impacts. The mitigation plans are especially critical for MAVEN and the Mars Orbiter Mission, which will arrive on station shortly before the comet's flyby.

The minimized dust risk means researchers can focus on gleaning valuable scientific data from the fly-by, including Siding Spring's spin speed, nucleus shape and corona composition, Edwards said.

Richard Zurek, chief scientist of the Mars Exploration Program at JPL, said this is "a unique chance to get a first-ever resolution of the nucleus of a long-period comet, especially as the nucleus is thought to be a kilometer wide."

Additional areas of study, according to Zurek, "will be the comet's effect on the upper Martian atmosphere, at about 150 kilometers, especially allowing scientists to better understand how atoms potentially escape the Martian atmosphere, as well as the potential for the comet's ejaculate to form cirrus clouds above Mars." Cameras on the Curiosity and Opportunity rovers will also provide excellent images of the comet.

Zurek concluded the session by warning that the data from the fly-by can only come about if the dust models are right, saying there are "no guarantees here — all the dice are being thrown, but it only takes one particle. The chance…that we get damage" is "very low," said Zurek, "but it's not zero."

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Making MILSATCOM more resilient and affordable

It's time for the government to take a fresh look at how the Pentagon manages its military communications: That was the major theme sounded by a panel of experts at AIAA's SPACE 2014 Forum in San Diego in August. Robert Aalseth, chief of the Advanced Concepts Division at the Air Force's MILSATCOM Systems Directorate, said that although people often speak of the MILSATCOM enterprise, "it's sort of a misnomer." Rather than an enterprise, he said, "we have a consortium of different programs and systems that comprise different discrete networks, and we have a process in which we provision that communication to warfighters, but in a very static way — maybe in a very antiquated way."

Looming budget crises might be enough to challenge industry to come together again and manage as an enterprise, "to govern this thing we call MILSATCOM, as a whole," said Aalseth. He added that "it's not a technical problem — it's a problem of will, governance, leadership."

Moderating the panel, titled "Connecting, Protecting, and Enhancing a Global Society," was retired Air Force Lt. Gen. Larry D. James, deputy director of the Jet Propulsion Laboratory and an AIAA Fellow. James pointed out that coalition forces in Afghanistan and Iraq relied on commercial communication satellites, "not those purely MILSATCOM capabilities."

Aalseth said that the old way of doing business is not going to work forever for MILSATCOM, and that "it's on all of us, collectively as a team" to move the ball forward. "It requires an enterprise-governance approach," he said. Aalseth cited GPS as a model to follow, calling it the "gold standard for the world on position navigation and timing."

Addressing how some of the MILSATCOM challenges could be met from the commercial side was Skot Butler, vice president of satellite networks and space services at Intelsat General. "Cost is a critical piece going forward," he said, but it's "just one element." Another element might be to have a single


AIAA

Retired Air Force Lt. Gen. Larry James, deputy director of the Jet Propulsion Lab, moderates the military communications panel.

authority for SATCOM, he said. Efficiencies might be gained "both operationally and financially, with a single authority who is in charge of the requirements, budgeting and acquisition of these capabilities," Butler said. He added that a larger commitment is needed, not just from government but from commercial partners as well. "There are things that can be done when and if commercial becomes a part — an integrated part — of the long-term MILSATCOM architecture," he said.

Scott Lindell, director of business development for military space at Lockheed Martin Space Systems, said, "We have to find more affordable ways to meet a broader set of capacity requirements, [for] those disadvantaged users that need to fight the fight in an interference and threat environment," he said. That will require more adaptable and flexible management of the architecture. The focus now, said Lindell, must be on how to "make ourselves more resilient…more affordable." And I think there's a lot of opportunity to do just that."

Also working to meet these MILSATCOM challenges is Boeing, which has focused on how to "leverage commercial practices" and "leverage product line efficiencies on our platforms to decrease the costs," said Chris Johnson, deputy director of business development for Government Space Systems, a unit of Boeing Space & Intelligence Systems. Recent technology investments by government and industry into "low-cost platform and low-cost launch," for example, "are going to enable that architecture to meet the resiliency and affordability targets into the future," he said.

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SPACE 2014:

"You need to not get too worked up about it… to recognize your limitations… and adapt. We had to do that in Orion, right? We were the big part and we were hated, right? And we survived."

— Mark Geyer of NASA, on program managers facing changes of presidential administrations.

"Who knew if you had a sharp rock on bedrock that the weight of the [Curiosity] rover coming down on it would damage the tire? Now we know. Sand is much better."

— Ashwin Vasavada of JPL, on lessons learned for future Mars landings.

"[There are] no guarantees here; all the dice are being thrown, but it only takes one particle. The chance [of damage to orbiting spacecraft] is very low, but it's not zero."

— Richard Zurek of JPL, on Comet Siding Spring's October flyby of Mars.

Beaming home a photo of a planet like ours will require money, some luck and a giant telescope rich with technical advances. Erik Schechter looks at NASA's 30-year technology roadmap toward the discovery that could change everything.

by Erik Schechter

Sara Seager, a professor of planetary science and physics at MIT, has developed an equation positing that in the next decade at least one life-bearing planet will be found orbiting one of our galaxy's M-class dwarf stars – fainter versions of our sun and attractive targets because of their relative proximity to Earth. It's a bold prediction, but Seager is buoyed by the Kepler mission, which detected 4,200 new planet candidates by searching for the telltale dips in the intensity of light when a planet crosses in front of its host star. A thousand of those transits have been confirmed as planets, including a few Earth-sized ones. Extrapolating from the small patch of sky examined

FINDING EARTH 2.0

An artist's rendering of exoplanet Kepler 186f.

NASA Ames/SETI Institute/JPL-Caltech

by Kepler, scientists believe that small planets, as opposed to lifeless gas giants, should be common. "They're basically everywhere," says Seager.

The ultimate feat would be to return a picture of a planet resembling Earth, and so NASA and university technologists have devised a 30-year technology roadmap spelling out how this might be achieved. Weighty funding decisions will be required by NASA and Congress; optics will need to be tested on the ground and maybe in space; technical lessons will have to be drawn from a succession of planned and proposed astrophysics telescopes; the small list of Earthlike candidates will have to be expanded. At stake is what one astronomer calls a second Copernican revolution: "There will be a fundamental change in how the human race views itself on the day that we look out there and say there is a planet out there that we believe has other life on it," says Doug Hudgins, the program scientist for the Exoplanet Exploration Program at NASA headquarters.

A big challenge for planet hunters is that light is diffracted the moment it touches a telescope, which is why a host star obscures the view of any Earth 2.0 that might be nestled near it in the Goldilocks, or habitable, zone. In the coming years, scientists and technologists will need to settle on a technique for suppressing that starlight so the dimmer light reflected by the planet becomes visible.

Planet hunters will also be watching to see how things go with the James Webb Space Telescope when it is launched in 2018 on an Ariane 5 rocket. Its main mission will be to study the early universe in the infrared, but it will also look at infrared and visible light that has passed through exoplanet atmospheres. On top of that, Webb must undergo a complex metamorphosis in space. Success could boost confidence about deployment of an even larger space telescope whose astrophysics mission would include giving humanity the equivalent of the famous Valentine's Day 1990 "pale blue dot" photo of Earth, taken by the Voyager 1 probe. Planet hunters don't want to stop there. They want to deliver a photo showing continents and oceans — a lower resolution version of the iconic Earth-rise scene taken by the Apollo 8 crew in orbit around the moon on Christmas Eve 1968. That would require something even more advanced: A formation of space telescopes designed for interferometry, in which the interference patterns of light waves are used to stitch together images almost as if they came from a giant unitary aperture. Scientists have a name for that telescope, the ExoEarth Mapper, but not much more. Building it "might be a little bit out there on the edge of the 30 years," NASA's Gary Blackwood told an audience at the AIAA Space Forum in San Diego in August. Blackwood is manager of the Exoplanet Exploration Program at the Jet Propulsion Laboratory.

Northrop Grumman

Exposing exoplanets:
A starshade, like the one here being prepared for testing in Nevada by Northrop Grumman and NASA JPL staff, would block light from a host star.

Looking at the neighbors

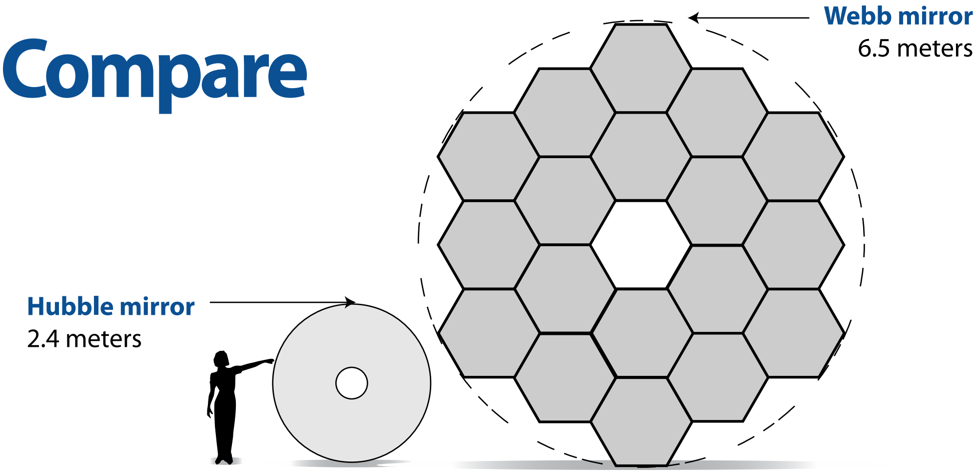
The work of expanding today's handful of planetary candidates will fall to designers of the Transiting Exoplanet Survey Satellite, scheduled for launch in 2017. TESS was proposed by the Massachusetts Institute of Technology and chosen by NASA in 2013 for construction and launch under the agency's Astrophysics Explorer Program. The spacecraft, in development by Orbital Sciences Corp., will look for dips in the intensity of light emitted by stars, which sounds a lot like what Kepler did before its collections were halted in May 2013 by a reaction-wheel failure that left it unable to maintain its observing position. "People ask, 'Why do we need TESS?'" says astrophysicist Natalie Batalha, the Kepler mission scientist. "And the answer is simple: TESS is going to look all around the sky, at every single patch of sky."

The TESS goal of gradually surveying the entire sky over the course of two years led to a very different design. Kepler collected light with a 1.4-meter-diameter mirror. That was fine for staring in one direction at a patch of sky measuring 100 square degrees – less than a quarter of 1 percent – of the total view. TESS must examine the whole sky by assembling patches measuring 2,300 square degrees, or 5.5 percent of the sky. Designers opted to equip TESS with four 16.8-megapixel cameras developed by MIT Lincoln Lab. Each will be a tenth of the size of the Kepler telescope and will be capable of detecting infrared and red-orange visible wavelengths.

There was a tradeoff for this wide field of view: Kepler peered 1,200-3,000 light-years into space in the direction of the constellations Cygnus and Lyra. The best TESS will do is scan stars 4.3-150 light-years away. Its targets will be the M-class dwarfs, whose habitable planets would have to be close in, with a shorter orbit than Earth's. Batalha compares the situation to camping at night. "If you've got weak campfires, and in order to be at that just-right temperature, you have to cozy up next to them," she says. Of particular interest would be planets whose orbits suggest they would be the right temperature and atmospheric pressure to allow for surface water in liquid form.

TESS will travel in a lunar resonant orbit, a lopsided circuit that sends the spacecraft out past the moon and close to Earth every two weeks. This orbit will keep its sensors protected from heat and radiation and, on the return trip, position the spacecraft close to ground stations so it can download data via its 100-Mbps Ka-Band antenna. Flying with its back to the sun, TESS will scan the whole northern hemisphere of the sky in a gradual, "step-and-stare" approach the first year. Then it will do the same with the southern hemisphere the second year. In addition, TESS will always have one camera fixed on a location

Compare



	HUBBLE PRIMARY MIRROR	WEBB TELESCOPE PRIMARY MIRROR
Material:	Glass coated with aluminum	Beryllium metal coated with gold
Mass:	828 kilograms*	362 kilograms (18 segments of 20.1 kg)*
Thickness:	46 centimeters	5 centimeters
Resolution:	0.05 arc-seconds (14 millionths of a degree)** *Could distinguish two fireflies a meter apart at a distance of 4,800 kilometers.*	0.1 arc-seconds (28 millionths of a degree)** *Could see details the size of a penny at a distance of 40 kilometers.*
Spectrum:	Primarily ultraviolet and visible	Optimized for infrared
Manufacturer:	Perkin-Elmer Corp., Danbury, Conn. (Now part of UTC Aerospace Systems)	Ball Aerospace, Boulder, Colo., and Tinsley Laboratories, Richmond, Calif. (Now part of L-3 Integrated Optical Systems)
You should know:	Hubble's primary mirror was ground to the wrong specification, requiring a spacewalk in 1993 to install a set of optics to correct its focus.	Webb must operate at minus 370 degrees Fahrenheit to maximize its infrared sensitivity. Beryllium holds its shape well across a range of temperatures, sheds heat easily and is strong. Coating it with gold maximizes infrared reflectivity. Seven motorized actuators on each segment will fine tune alignment and curvature.

** Figure includes mirror material only – does not include support equipment.*
*** Resolutions are based on observed wavelengths and can be misleading. Webb is designed to look back in time by sensing longer-wave, infrared radiation, something Hubble does not do.*

Source: NASA

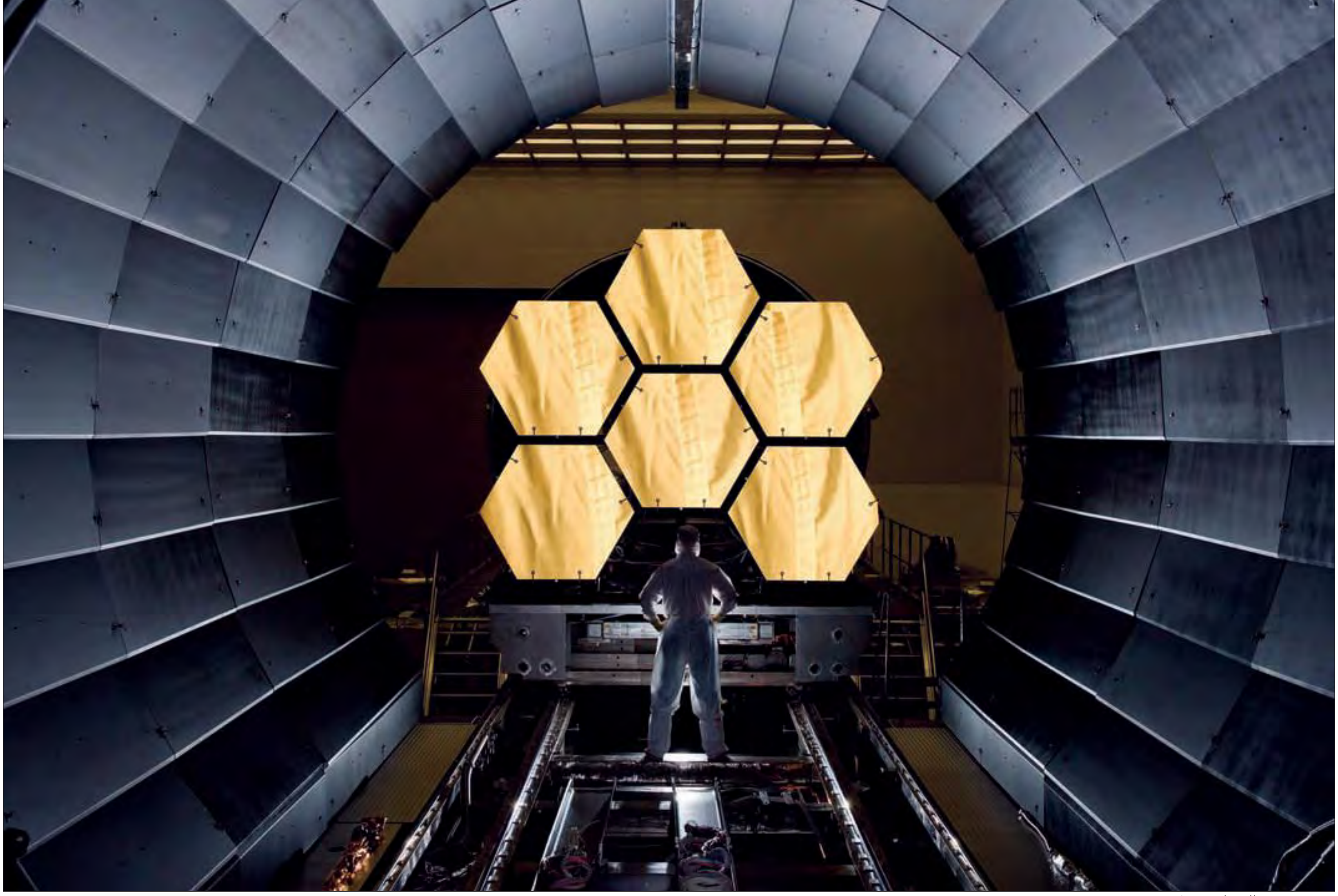
in the sky known to astronomers as the ecliptic pole of the Zodiac plane. "It is a special place in the sky, because that's also the location that the Webb telescope can look at any time of the year," says George Ricker, the principal investigator for TESS at MIT's Kavli Institute for Astrophysics. "If you want to find a target for Webb, that's the sweet spot in the sky."

Based on Kepler, researchers expect TESS to find at least 3,000 exoplanet candidates, including some 40 Earth-sized and 330 "Super Earth" planets. Of course, finding a right-sized planet in a habitable zone is one thing. Being sure you've found a rocky planet, like Earth, is another. For that, scientists need to know the density of the exoplanet. Scientists using TESS will be able to calculate the diameter and volume of a transiting planet, but to get density, one also needs the mass. So researchers will need a ground-based telescope with a spectrograph to study the planet's host star and look for a telltale wobble. "That's induced by the planet revolving around its host star," Ricker says. Density can be calculated from that wobble. "If you get a number that's roughly five grams or six grams per square centimeter, you've got a rocky planet like the Earth," he explains.

How Webb can help

Planet hunters are excited about Webb, for two reasons:

Webb's 18 mirror segments will be arranged in three petals and stowed inside the launch shroud, along with solar arrays, antennas, and a tennis-court sized, multilayered sunshield made of a flexible Dupont Kapton polyimide film. All this must unfold and unfurl in a complex series of maneuvers within two weeks of the launch. Something like that technique is likely to be required for a telescope capable of delivering the first rough image of an Earthlike planet. Scientists have a preliminary name for this envisioned telescope, LUVOIR, short for Large UV/Optical IR sur-



NASA and Ball Aerospace

An engineer in front of mirror segments bound for the James Webb Space Telescope. Successful deployment in 2018 could build confidence for projects like the proposed Large Ultraviolet Optical Infrared Surveyor.

veyor. They plan to draft a white paper in hopes of winning a coveted nod in 2020 from the National Research Council's Decadal Survey scientific panel, a blessing that could clear the way for technology investments and construction. For LUVOIR, "We're almost certainly looking at some kind of segmented, deployable or assembled aperture," said Blackwood, the exoplanet manager at JPL.

Webb also will collect starlight that has passed through the atmospheres of some of the planetary candidates identified by TESS. Molecules in those atmospheres will take signature "bites" out of particular wavelengths, and scientists will show how this transmission spectroscopy can be used to search for specific chemical signatures. The same transmission phenomenon can be seen here on Earth with rainbows. "If you look really closely at the rainbow, you'll see some colors missing. Not, like, big colors, but you'll see small chunks of some of the colors actually missing," says Seager. "And that's because of molecules in our own Earth's atmosphere that are actually absorbing the sunlight."

Webb's main planetary targets will be Neptune-sized gas giants, but Webb also will examine Earth-sized planets. Whatever Webb learns about exoplanets will be interesting, but MIT's Seager and other scientists hope that the spacecraft finds biosignatures. This would indicate that the TESS planet not only inhabits a Goldilocks zone, but is home to life or is at least capable of supporting it. Besides water vapor, biosignature chemicals would include carbon dioxide to help create a greenhouse effect; methane, a building block of organic life; and ozone to block harmful ultraviolet radiation from the host star. Free oxygen might indicate the presence of alien vegetation, because it vanishes from an atmosphere unless plant life is replenishing it. Webb might also pick up thermal emissions from an exoplanet by tracking its mid-infrared radiation over the course of an orbit. But don't expect to see signs of vast alien cities or nuclear reactors. Webb might "see what I would call very gross thermal features on the planet by monitoring all the way through a transit," giving researchers a "very crude idea of what sort of atmospheric dynamics" are at play," explains astronomer Mark Clampin, the Webb observatory project scientist. Detecting a civilization visually from deep space would be hard, based on the look the Galileo probe gave Earth in 1990 after approaching within 960 kilometers on a flyby toward Jupiter. Carl Sagan and other scientists examined the Galileo images and saw no "unambiguous sign of technological geometrization," according to their 1993 Nature magazine paper, "A search for life on Earth from the Galileo spacecraft."

Distant imaging

Trying to make out a planet orbiting a sun is like trying to spot a firefly next to a lighthouse. Earth is 10 billion times dimmer than the sun, and scientists expect they will have to cope with similar contrast ratios to spot Earthlike planets. Researchers are looking for ways to block out the light of the planet's host star while preserving the light reflected off the planet, says NASA's Hudgins.

Right now, scientists and technologists are looking at two competing concepts:

• A **coronagraph** in which starlight would be filtered out by an arrangement of optics and light stops inside the telescope. Coronagraphs were originally developed to expose the sun's corona, but they have potential for planet hunting too.

• A petal-shaped **starshade** meters across that would be positioned 50,000 kilometers in front of a telescope to control diffraction and block light from a specific star. The result would be a very dark shadow, like a solar eclipse, because "the shape of the petals, when seen from far away, creates a softer edge that causes less bending of light waves," Hudgins says.

The coronagraph approach would be demonstrated in space starting in 2024, provided NASA chooses to build a new flagship astronomy spacecraft with an unwieldy name: the Wide-Field Infrared Survey Telescope-Astrophysics Focused Telescope Assets, or WFIRST-AFTA. The initial proposal for this telescope called for a 1.5-meter mirror, which meant there would have been no room for a coronagraph. All that changed in 2012 when NASA announced that the spy satellite developers at the National Reconnaissance Office had donated two spare telescopes for scientific research. If WFIRST-AFTA is built, it would be centered on a 2.4-meter diameter mirror – the same size as the Hubble's primary mirror – culled from one of the NRO telescopes. There's now plenty of room behind the primary mirror to install a coronagraph, and scientists almost can't believe their good fortune: "It's 2.4 meters. It exists. I've seen it. I've almost touched it," NASA's Wes Traub, the chief scientist for the Exoplanet Exploration Program at JPL, told an audience at AIAA's Space Forum. WFIRST-AFTA would demonstrate the coronagraph technique on large planets, but "it's probably not going to see Earths, unless we're incredibly lucky," Traub cautioned. "You don't have the angular resolution. You can't get as close to the star as the habitable zone, and you're not going to collect enough light from a planet that's the size of the Earth."

As for the starshade, tests have been conducted in a lab at Princeton University and by Northrop Grumman in the Nevada desert. The potential advantage of starshades is that they block starlight before it can be diffracted by a telescope's optics. But testing a starshade on the ground is difficult, because in space it would work in tandem with a telescope positioned thousands of kilometers away, something that can't be easily simulated on Earth. A team of scientists is defining a possible starshade space mission, nicknamed Exo-S with the S standing for starshade. Another mission is under study, tentatively called Exo-C, for coronagraph. These are backup concepts in case NASA or Congress decides not to pursue a large flagship astrophysics mission like WFIRST-AFTA.

Of course, the desire to image an Earth 2.0 begs the question: How might human beings reach a far-off planet? The closest star to Earth is Alpha Centauri, and that's 4.3 light-years, or 26.5 trillion miles, away. To put that into perspective, it would take explorers on a conventional spacecraft 165,000 years to reach that solar system. Undaunted, Ricker of MIT suggests that humanity's best bet for reaching Earth 2.0 could be to launch an unmanned probe with some advanced, still-to-be invented propulsion technology. As a thought experiment, he imagines a probe that can travel one-tenth the speed of light to a planet 10 light years away. "It would take the probe a century to get there, and then it would start transmitting [images] back, so in 110 years, you would know" what the planet and its native flora and fauna looked like, he says.

Voyager left our solar system in 2012 and has lasted for nearly 37 years. This future spacecraft would have to do even better, and the people who launch it would definitely not be the same people receiving its transmissions from the vicinity of an alien world.

"It's no different from the way it was when the cathedrals were being built in the Middle Ages," Ricker says. "It took several generations. Perhaps this is our version of a cathedral."

Collateral Damage

Impacts of Russia-Ukrainian conflict extend beyond the here and now

ANALYSIS
by Anatoly Zak

NASA

Artist's rendering of the U.S. Space Launch System. Its completion would put NASA back in the astronaut-launching business.

Russian Vice Prime-Minister Dmitry Rogozin created a stir in April by Tweeting in Russian that astronauts might need to use a trampoline to get to the International Space Station. In the U.S., most analysis of the potential fallout from the Ukrainian crisis has focused on NASA's dependence on Russian Soyuz capsules to deliver astronauts to the station, or on the Russian-supplied engines that help propel the Atlas 5 and Antares rockets. The reality is that so far the Ukraine crisis has not had any real-world impacts in those areas.

Underappreciated is the impact on a slew of lesser-known joint space projects:

Human spaceflight

In October, before the Ukraine crisis boiled over, Russian space officials held a closed-door strategy meeting. Manned spaceflight chief Aleksei Krasnov promised to strike a deal with station partners in two or three years on joint manned missions beyond Earth orbit, according to a transcript. An international manned outpost was discussed that would be deployed in one of the Lagrange points, where gravitational fields of the Earth and the moon cancel each other out. A facility at the L2 Lagrange point behind the moon would be a most convenient way station for exploration. According to Krasnov, this program could eventually afford annual or biannual expeditions to the moon, flights to asteroids and even expeditions to Mars.

In one view, all these ambitious dreams went out of the window when Russia annexed Crimea in September. Even if Moscow does not deliver on its threat to leave NASA with a trampoline to reach the station, the talk of a new Cold War could ruin the appetite for future cooperation on both sides. Some Russia watchers expect Vladimir Putin to remain in power for life, raising the possibility that renewed Russian-American ties in space might have to wait for at least a generation.

Others still hope that the station partners can weather the storm. A former official from the International Space Exploration Coordination Group, which was created by 14 space agencies to chart joint plans in space, said that Russia and the West would have no choice but to cooperate with each other. He said any major post-station agreement on human missions beyond the Earth's orbit is likely five or six years off. The latest efforts by the station partners to certify the outpost to operate in orbit as late as 2028 could buy time for tensions over the Ukraine to be resolved.

In the meantime, the U.S. is working on the Orion crew spacecraft and the Space Launch System that would send Orion into deep space. NASA would be independent again in its ability to carry astronauts into space. Under a strategy adopted by the U.S. long before the Ukrainian crisis, any cooperation between the U.S. and Russia must be of a complementary rather than dependent nature. NASA would avoid Russian hardware in the critical path to the program's ultimate goal.

Russia's own next-generation spacecraft for flying cosmonauts beyond Earth

Boeing

Artist's concept of a manned outpost at the L2 Lagrange point. Author Anatoly Zak says the international partnerships envisioned to make such projects affordable are now threatened by the Russian-Ukrainian crisis.

orbit is now several years behind the American effort, suggesting there could be a role reversal by the end of the decade.

Russian-Ukrainian super heavy launcher

Multi-national or not, any major expansion of the manned space program into deep space would require the development of a super-heavy launcher capable of sending a manned spacecraft beyond Earth orbit. In the U.S., the problem is being addressed with the Space Launch System, which is to be capable of delivering 85 tons into low Earth orbit. Such a payload mass would be enough to send a six-seat Orion spacecraft toward the moon or to the Lagrange points.

Roskosmos promised to build its own super-heavy rocket, soliciting bids from its domestic industry for the most suitable design. This ambitious proposal had attracted the interest of the Ukrainian space industry.

In August 2013, Ukraine's main space firm — KB Yuzhnoe design bureau, the developer of the Zenit rocket and the first stage of the U.S. Antares launcher — went to the Moscow Air and Space Show with a scale model of a super-heavy rocket. The Ukrainian bid had powerful supporters in Russia, including the nation's chief manned spacecraft contractor, RKK Energia. The first stages of the super rocket would be built at KB Yuzhnoe's huge rocket factory in Dnepropetrovsk in Eastern Ukraine. Russian authorities had been skeptical about letting Ukraine participate in the super-heavy rocket project, but by the end of 2013, the prospects of Ukraine turning to the European Union for an economic agreement prompted Russia to act. The Kremlin offered Kiev an alternative, which included space cooperation. An agreement was inked by the two sides in January 2014 guaranteeing Ukraine a role in the development of the Russian super-heavy launcher, Valery Mutiyan, the Ukrainian envoy to Russia told a business publication, Birzhevoi Lider.

Just weeks later, the Russian-Ukrainian economic ties collapsed with the overthrow of the Ukrainian President Viktor Yanukovych and the subsequent Russian annexation of Crimea.

End of the Zenit rocket?

The crisis threatens current launch systems operated by two countries, first of all the Zenit. Ukraine has supplied the Zenit for the Russian federal space program and for the struggling Sea Launch venture, which uses a converted oil platform deployed in the Pacific Ocean near the Equator to launch commercial satellites. The crisis in Ukraine could be the last nail in the Zenit's coffin. In July, the head of the Kazakh space agency, Talgat Musabaev, told the Interfax-AVN news agency that plans for launching commercial missions on Zenit from Baikonur had to be scrapped.

In the meantime, KB Yuzhnoe's factory struggled to come up with cash to pay its subcontractors in Russia who supplied components for the Zenit. In a telephone interview, a representative of the Yuzhnoe production association, Anatoly Karmanov, denied reports in the Moscow-based Izvestiya daily that the work at the plant had been tak-

(Continued on page 43)

PREPARING FOR THE ERA OF

Six unmanned aircraft test sites are being set up around the country, just as Congress directed the FAA to do. Establishment of the sites is producing professional tension between umanned aircraft developers, who want to fly now, and FAA officials, who say their regulatory processes are defined by laws and driven by safety experience. Debra Werner looks at whether this divide can be bridged.

by Debra Werner

Minutes after FAA Administrator Michael Huerta declared Alaska's unmanned aircraft test site open for business, a 1.4-kilogram Aeryon Scout quadcopter began patrolling the skies over the Fairbanks Large Animal Research Station to capture images of grazing caribou. The same day, May 5, scientists in North Dakota used a 1.65-kilogram Draganflyer X4-ES quadcopter to survey crops and evaluate soil conditions. These were the first of thousands of flights expected during the next five years at six test sites selected by the FAA in December. The flights will help the agency figure out when and how to allow un-

Draganfly Innovations

The Draganflyer X4-ES. The aircraft has been surveying crops and evaluating soil conditions at the North Dakota test site.

Researchers from the University of Alaska Fairbanks fly an unmanned Aeryon Scout quadcopter to collect images and data as part of the FAA's campaign to determine how small unmanned aircraft can be integrated in the national airspace.

University of Alaska Fairbanks

manned aircraft to share the skies with piloted planes.

The new test sites are in Alaska, Nevada, New York, North Dakota, Texas and Virginia. The site directors are advertising unique features of their operations — varied climates, proximity to water and access to local experts — as a way of attracting customers eager to test unmanned aircraft, components, software and ground systems.

Those attributes, however, might not be enough. Customers will only show up if the sites can do what Congress hoped they would do under the FAA Modernization and Reform Act of 2012: Streamline the unmanned aircraft testing process and guide customers toward commercial operations and all the economic benefits these would mean for the U.S. The jury is still out about how fast or even whether that can be achieved.

"The hope is that the test sites will become trusted extensions of the FAA, with substantial decision-making authority," says John Langford, chairman and chief executive of Aurora Flight Sciences, Manassas, Va. "If the FAA doesn't do that, the whole idea won't work, in my opinion. If it just adds bureaucracy, it's not going to be in anybody's interest."

FAA officials say they will give the test sites the authority to approve airframes and flight plans, but this will take time. Initially, each site needs to obtain a Certificate of

FAA STRUGGLES TO CONTROL SMALL DRONE ROLLOUTS

Even though General Atomics Aeronautical Systems, manufacturer of the U.S. Air Force MQ-1 Predator, has its own testing facilities in the desert North of Los Angeles, company officials are closely following the FAA's action to establish unmanned aircraft test sites.

"The sites represents advancement in all the work that needs to be done to integrate unmanned aircraft in the national airspace system," says Scott Dann, director of strategic development for San Diego-based General Atomics. The tests sites, he says, will enable the kind of research the FAA will need to prove "beyond a shadow of a doubt that these things are safe and able to integrate into the national airspace." Dann chaired an FAA advisory rulemaking committee from 2011 to 2014 on integrating unmanned aircraft into U.S. airspace.

That process will not be speedy. It often takes federal agencies seven to 10 years to finalize significant rules like the one the FAA plans to release in draft form by the end of the year. The draft will describe the safety features that aircraft weighing 25 kilograms or less would need to have and the tests they would need to pass to fly in the national airspace. The industry will get to comment on the proposed rule. FAA officials are quick to point out that many of the steps they must follow to issue new regulations are defined by federal statute, making it impossible for the agency to move quickly.

Agency officials also are keenly aware the rules could have a huge impact on passengers and crew of 87,000 daily aircraft flights in the United States. "The FAA is aware of the strong precedents that will be set in whatever it does and is proceeding cautiously, too cautiously," says John Langford, chairman and chief executive of Aurora Flight Sciences. "It needs to lean further forward, because the rest of the world is moving forward and the lack of sensible operating procedures and regulations is creating a vacuum that is encouraging scofflaws."

Thousands of unauthorized commercial unmanned aircraft flights are taking place annually in the United States without FAA authorization, industry officials say. Real estate firms advertise their ability to use unmanned quadcopters to gather aerial images of property, and farmers rely on remotely controlled aircraft to survey fields.

The FAA has neither the manpower nor the authority to search for this type of illegal activity. It only finds out about unauthorized flights when pilots report them. "We usually get about three reports a quarter," Elizabeth Soltys, FAA UAS test site program manager, said in June at the AIAA Aviation Forum in Atlanta. "Between March and June of this year, the agency received 18 reports."

Although the agency has not studied why those reports are increasing, Soltys said her personal view was that people did not know that a March decision by a National Transportation Safety Board administrative law judge who said the agency had failed to establish any rules for small unmanned aircraft was stayed pending appeal. The original ruling received far more media attention than the stay, she said.

Until that decision is reached and the FAA issues final rules on small unmanned aircraft, the agency plans to approve commercial flights on a case-by-case basis. In June, the FAA approved the first commercial operations over land when it gave energy giant BP permission to use AeroVironment's hand-launched, battery powered Puma AE to monitor pipelines, equipment and roads near Prudhoe Bay, Alaska. In September 2013, the FAA authorized ConocoPhillips to use Insitu ScanEagles, which weigh about 20 kilograms and have a 3.1-meter wingspan, over Alaska's Arctic waters to survey ice and whale activity.

Filmmakers, farmers, geospatial mapping firms and energy companies are petitioning the FAA for permission to conduct limited, low-risk unmanned aircraft operations under a provision of the FAA Modernization and Reform Act of 2012, known as Section 333. The agency is reviewing those applications, but had not issued any decisions as of August 1.

Until some of this plays out, it will be hard for a U.S. commercial unmanned aircraft industry to develop, because companies can't predict how and when commercial flights will be allowed in the United States. "At the end of the day, a business case has to be made, risk capital has to be raised and there has to be a desire by somebody to venture into this new territory," Dann says.

Waiver or Authorization — COA — the document that provides any public agency with permission to conduct unmanned aircraft activities in the United States. To obtain a COA, test sites have to tell the FAA what vehicle they intend to fly, when and where, whether it will be within sight of the operator and whether it will be accompanied by a chase plane, according to Elizabeth Soltys, FAA Unmanned Aircraft Systems test sites program manager. Soltys was speaking in June at the AIAA Aviation Forum in Atlanta.

The process for obtaining COAs is more arduous for the test sites than for most public agencies seeking to conduct research flights. "What will come with that, we hope, is that we will grant [the test sites] more freedom or latitude," Soltys said. "Test sites are working with us to show their safety acumen. We will watch some trials of their operations. We hope eventually test sites will not have to apply airframe by airframe to conduct operations."

Test site operators are eager to acquire that flexibility, both to help the fledgling industry develop and to attract business to pay for their operations. Congress did not provide any money for the test sites, which it created in the FAA Modernization and Reform Act of 2012. That legislation also prohibits the sites from charging customers to fly. The sites receive no FAA funds.

WHO WILL PAY

Test site directors, who turned to their state legislatures for millions of dollars in economic development funds, plan to pay for ongoing work by charging customers for their role in planning, supporting and conducting the tests, and analyzing the results. "We can charge them for the labor it takes to review test plans and...support and observe operations," says Ro Bailey, a retired Air Force brigadier general and now deputy director for the Alaska Center for Unmanned Aircraft Systems Integration. "That's how we would expect to financially survive this."

Each state earmarked funding to establish its test site. North Dakota's legislature is providing approximately $2 million a year. "You hear a lot about oil in North Dakota because it just surpassed agriculture as our biggest industry," Robert Becklund, executive director of the Northern Plains Unmanned Aircraft Systems Test Site.

None of the test site directors can tell prospective customers how much test

The Test Sites

Northern Plains Unmanned Aircraft Systems Test Site
Headquarters: Grand Forks, N.D.
Key partners: University of North Dakota, North Dakota State Univ.
Research: UAS airworthiness essential data, high reliability link technology and human factors research.

Northeast UAS Airspace Integration Research Alliance
Headquarters: New York's Griffiss International Airport.
Key Partners: Massachusetts Institute of Technology, Draper Laboratory, State University of New York.
Research: Test and evaluation, verification and validation. Sense and avoid. Integrating UAS into the congested northeast airspace.

State of Nevada
Headquarters: Nevada Institute for Autonomous Systems, Las Vegas.
Key Partners: University of Nevada, Reno; University of Nevada, Las Vegas and Desert Research Institute.
Research: UAS standards and operations. Operator standards and certification requirements. Air traffic control procedures and the introduction of UAS.

Mid-Atlantic Aviation Partnership
Headquarters: Virginia Tech
Key Partners: States of Virginia, Maryland and New Jersey.
Research: UAS failure mode testing. Operational and technical risks areas.

Alaska Center for Unmanned Aircraft Systems Integration
Headquarters: University of Alaska, Fairbanks.
Key Partners: States of Hawaii and Oregon.
Research: Standards for unmanned aircraft categories, state monitoring and navigation. Safety standards for UAS operations.

Lone Star UAS Center of Excellence and Innovation
Headquarters: Corpus Christi.
Key Partners: Texas A&M University; University of Texas; Southwest Research Institute.
Research: System safety requirements for UAS vehicles and operations. Protocols and procedures for airworthiness testing.

Source: FAA

flights will cost, because they haven't finished developing flight planning guides and testing procedures. Once these are completed, they will then have to be reviewed and approved by the FAA. Each test site must figure out how it will deal with various issues that might occur during testing, such as loss of communications between an unmanned aircraft and its ground systems. Aircraft will need embedded software to ensure a predictable reaction to losing that link. Then, multiple tests will be needed to prove the software performs as expected. "That is not necessarily a fast process," Bailey says.

WINNING APPROVAL

For now, test site directors are asking each of their prospective customers to prepare a detailed description of their testing goals, the type of flights they want to conduct, their budgets and schedules, says Thomas Wilczek, aerospace and defense industry liaison for the Nevada Governor's Office of Economic Development. Once customers provide that information, Wilczek is confident Nevada's team can provide whatever kind of testing a customer seeks. "Our sites offer different types of testing protocols and different types of data capture because they've done that work for federal agencies," Wilczek says. "On the flip side, I have sites that are more appropriate for the low-cost user who just needs a place to fly."

"The hope is that the test sites will become trusted extensions of the FAA, with substantial decision-making authority."

JOHN LANGFORD, CEO, AURORA FLIGHT SCIENCES

Before the FAA sites were established, aircraft developers often scrambled to find places to fly. This is because commercial businesses cannot conduct legal unmanned aircraft flights in the United States unless they are working with a government agency. Area-I, a small Georgia company focused on unmanned aerial system re-

Aurora Flight Sciences

The optionally piloted Centaur from Aurora Flight Sciences. Company officials say its large size complicates the process of obtaining permission to fly it unpiloted.

search and development, formed a partnership with Middle Georgia State College. The college obtained four FAA COAs, allowing it to conduct research using Area-I's aircraft, computers and guidance systems. "We have been fortunate," says Nicholas Alley, Area-I chief executive. "We had support from the state of Georgia which allowed us to obtain with minimal cost and effort FAA COAs to fly our platforms."

> **"If the FAA gave preferential treatment at test sites and a small business owner could show up, demonstrate his platform was airworthy and safe and carry out tests, small companies would relocate near those areas."**
>
> **NICHOLAS ALLEY, CHIEF EXECUTIVE OF THE COMPANY AREA-I**

Aurora Flight Sciences and other larger unmanned aircraft developers often conduct flight tests on government ranges as part of NASA, Department of Defense or Department of Energy programs. "The government sites are either provided to us as part of our government contracts, or we pay a daily fee to use them," Langford says.

If the test sites can help streamline the time-consuming and labor-intensive process of winning FAA approval to conduct test flights, company executives say they would be eager to begin using them. Aurora Flight Sciences is seeking permission to fly its Centaur optionally piloted aircraft with a 13.4-meter wingspan at the Virginia site. "Because it's a large airplane, getting permission is more complicated than for some of the dinky hobby tests that some of the other test sites have done," Langford says. "Flying a small quadrotor is not in my opinion a legitimate unmanned aircraft test."

BANKING ON A TECH BOOM

Even developers of small unmanned aircraft struggle to find places to test their designs. "If the FAA gave preferential treatment at test sites and a small business owner could show up, demonstrate his platform was airworthy and safe and carry out tests, small companies would relocate near those areas," Alley says. "It would make sense for any type of entity that has to fly a lot. The states could have a small tech boom around their sites."

The states are banking on that. They hope the new test sites will bring in people, jobs and advanced technology. "You hear a lot about oil in North Dakota, but agriculture is still our biggest industry," Becklund says. North Dakota is eager to use unmanned aircraft to help farmers and ranchers assess the health of crops and keep tabs on livestock.

Nevada's leaders see the test sites as a long-term investment. Nevada Gov. Brian Sandoval recently led a trade mission to Montreal to see how that city became the world's third largest aerospace development center. "You can build a Bombardier large fuselage executive jet, and all the parts of the entire supply chain exist within the Montreal area," Wilczek says. "But it took 30 years to develop that infrastructure."

Congress directed the FAA to operate the test sites until at least February 2017, but test site directors hope to be in business much longer. "We have been told the FAA plans to request an extension to give us the full five years and permission to continue unmanned system tests beyond that magic date, because it sees value to having six locations where tests can continue," Bailey says. "New unmanned systems are going to be coming online all the time, and having the ability to do testing at various locations is worthwhile."

ing place only two days a week. However, Karmanov would not comment about the possible demise of the Zenit.

About 50 percent of all components for the Zenit were coming from Russia, and without Russian orders the Zenit had no chance to survive, deputy director of the National Space Agency of Ukraine, NKAU, Eduard Kuznetsov, told me.

The end of Zenit would be a huge loss for both sides. It would spell the end of the Russian-controlled Sea Launch venture, while the Moscow-based NPO Energomash would lose the only customer for its most powerful rocket engine, the RD-171, which propels the Zenit's first stage.

Not surprisingly, some Russian officials called for building the new production line for the Zenit inside Russia and transferring the Sea Launch floating platform from its current homeport in Long Beach, Calif., to Russia's Pacific coast. Skeptics said that the cost of such moves would kill any commercial viability of the Sea Launch for years to come.

Turning to Europe

The departure of the Zenit from Ukraine would leave KB Yuzhnoe's production arm to build the first stage of the Antares, which is based on the Zenit but uses a different Russian-built engine. In addition, KB Yuzhnoe builds the RD-869 engine for the fourth stage of the European Vega rocket introduced in 2012 for launching small satellites. By the middle of this year, the Ukrainian company had delivered four of these engines to the Vega's prime contractor — Avio of Rome, Italy. At the time of the Crimean showdown, two more propulsion systems for Vega were in production in Ukraine and a contract for up to a total of 16 units was in the works, industry sources said.

In 2012, the European Space Agency adopted a strategy of phasing out the Ukrainian hardware and replacing it with a domestically built system, even though the Vega would still need Ukrainian engines as late as 2020.

"We are trying to retain this position and maybe even expand [our participation in the Vega project] by proposing something else for this vehicle," NKAU's Kuznetsov said. According to Kuznetsov, KB Yuzhnoe was working on new lightweight composite materials, which could replace traditional alloys in the Vega's components.

Ukrainian involvement in European space projects has been hampered by the country's failed bid to join the European Space Agency. The cash-strapped Ukrainian government was not able to pony up its required entrance fee, estimated at around €5 million. Now, a breakup with Russia is providing fresh impetus for Ukraine's economy to link up with Europe's.

"Today, NKAU is ready to join ESA at least as an associated member," Kuznetsov said, adding that such an agreement could be signed in 2015 if ESA were to provide a discount.

In the meantime, KB Yuzhnoe is actively looking for new customers in the aerospace industry around the world who could fill the void left by the Russian-Ukrainian split.

Russian ICBMs

An irony of the conflict between Russia and Ukraine is that experts from Ukraine still conduct periodic maintenance of Russia's nuclear-armed SS-18 ICBMs. These rockets were built at KB Yuzhnoe's factory in Dnepropetrovsk. In the post-Soviet period, 20 such boosters were converted into Dnepr space launchers and fired with a peaceful mission to deliver commercial satellites into orbit. The joint Russian-Ukrainian team launched the latest Dnepr rocket on June 19, in the midst of the crisis, even though three days earlier the newly elected Ukrainian president, Petr Poroshenko, had ordered an end to all military cooperation between Ukraine and Russia. Still, as of July, NKAU had not received any instructions to discontinue servicing work on the Russian ICBMs, Kuznetsov told Aerospace America.

The Zenit and Dnepr are the product of deep ties between the Russian and Ukrainian industries, and cutting those ties would have enormous economic impact. According to the Kommersant daily, Roskosmos estimated the price tag for breaking up with Ukraine at 3.5 billion rubles — $96.6 million — just this year, and at 33 billion rubles — $911 million — by 2018. The agency's proposal for replacing Ukrainian-made components currently in use across the Russian space and rocket industry listed 56 different items, including electronics and chemicals.

Other fallout from the Ukrainian crisis

The annexation of Crimea by Russia left Ukraine without a major ground control station on the peninsula, requiring a new facility — currently under construction — on mainland Ukraine. The loss of the Crimean ground station also contributed to the grounding of Lybid, the Ukrainian communications satellite, built in Russia and slated to launch on a Zenit.

(Continued from page 37)

The Zenit rocket, long used for launches by Russia, is built by KB Yuzhnoe in Ukraine. Tensions between the two countries could lead to the rocket's demise.

Out of the

25 Years Ago, September 1989

Sept. 4 The Air Force launches a Titan 34D, the last Titan 3 in its inventory, from Cape Canaveral, Fla. The rocket carries a secret military payload. NASA, Astronautics and Aeronautics, 1986-1990, Page 231.

Sept. 5 Japan's National Space Development Agency launches its GMS-4 weather satellite into orbit from an N-1 launch vehicle. NASA, Astronautics and Aeronautics, 1986-1990, Page 231.

Sept. 6 The Soviet Union sends two cosmonauts into orbit in a Soyuz TM-8 capsule using a Proton booster. Cosmonauts Alexander S. Viktorenko and Alexander A. Serebrov rendezvous with the then-unmanned Mir space station and dock with it on Sept. 8. NASA, Astronautics and Aeronautics, 1986-1990, Page 231.

Sept. 25 NASA launches the F-8 satellite, the last in the Navy's Fleet Satellite Communications series, into geosynchronous orbit on an Atlas-Centaur rocket at Cape Canaveral. NASA, Astronautics and Aeronautics, 1986-1990, Page 232.

50 Years Ago, September 1964

Sept. 3 X-15 rocket research aircraft No. 3, piloted by Milton O. Thompson, attains an altitude of 77,000 feet and a record speed of Mach 5.37, or 3,545 mph. This will not be the aircraft's fastest speed, however — on Oct. 3, 1967, it will fly at Mach 6.7, or 4,520 mph, piloted by Pete Knight. D. Jenkins, "X-15," Pages 637, 659-461.

Sept. 3 The British Aircraft BAC 1-11 Viscount short-range jet airliner makes its first passenger flight. Flight International, Sept. 10, 1964, Page 447.

Sept. 3 Three NASA astronauts — Edwin A. "Buzz" Aldrin, David R. Scott and Elliott M. See Jr. — start a training program for Project Apollo, flying in Lockheed Shooting Star T-33 trainer airplanes. To simulate approaches to the lunar surface, the astronauts send their planes into dives from altitudes of 15,000 feet toward large, rugged lava flows in southern Idaho. The Houston Post, Sept. 3, 1964.

Sept. 4 The Orbiting Geophysical Observatory — OGO 1 — is launched by an Atlas-Agena-B rocket from Cape Kennedy. The very large, 1,073-pound satellite, known as a space bus, carries 20 experiments and will conduct several of them simultaneously in space. This is the first in a series of six important satellites used between 1964 and 1972 to study the Earth's magnetosphere. New York Times, Sept. 6, 1964, Page 26; OGO 1 file, National Air and Space Museum.

Sept. 14 The U.S. aviation industry marks the 25th anniversary of the flight of the VS-300, the nation's first practical helicopter. Piloting the 1939 flight at Bridgeport, Conn., was the aircraft's designer, Igor Sikorsky. Aviation Week hails the flight as the beginning of the vertical takeoff and landing industry. Aviation Week, Oct. 5, 1964, Page 11.

Sept. 17 NASA Marshall Space Flight Center director Robert R. Gilruth announces that astronaut M. Scott Carpenter will serve as his executive assistant, calling the job a "convalescent assignment," since Carpenter still has minor injuries from a motorbike accident. Washington Evening Star, Sept. 18, 1964.

Sept. 18 The Saturn SA-7, the seventh in a series of Saturn 1 flight-test launch vehicles for Project Apollo, lifts off, carrying a boilerplate Apollo Command and Service Module into a low Earth orbit. This payload later reenters the atmosphere and apparently disintegrates over the Indian Ocean during the craft's 59th orbit. The flight thereby demonstrates the reliability of the two-stage Saturn 1's propulsion system as well as its guidance and flight control systems. The Saturn 1 uses eight H-1 engines for the first stage and six RL-10s for the second. Aviation Week, Sept. 28, 1964, Page 27.

Sept. 21 The North American six-engine Mach-3 XB-70A Valkyrie, prototype of the B-70 nuclear-armed, deep-penetration strategic bomber, makes its first flight from Palmdale to Edwards Air Force Base, Calif., beginning its extensive flight test program even though the B-70 program was recently canceled. Aviation Week, Sept. 28, 1964, Page 23.

Sept. 27 British Aircraft's TSR.2 low-level strike-reconnaissance aircraft, the first of 20 pre-production models, makes its first flight, at Boscombe Down in Wiltshire, England. The plane is scheduled for Royal Air Force service. However, in a controversial decision, the aircraft program is scrapped the following year because of rising costs and inter-service rivalry over Britain's future defense needs. Aviation

Past

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

Week, Oct. 5, 1964, Pages 22-23, and Oct. 12, 1964, Pages 62-63; Flight International, Oct. 8, 1964, Pages 637-640; British Aircraft Corp. TSR.2 file, National Air and Space Museum.

Sept. 29 The first flight of the Ling Temco-Vought XC-142A four-engine tilt-wing vertical/short takeoff and landing tri-service transport aircraft takes place. The wing is elevated 10 degrees for takeoff and then lowered to a horizontal position. The plane reaches an altitude of 10,000 feet. The landing is made at 72 mph and uses only 1,000 feet of runway. Aviation Week, Oct. 5, 1964, Page 27, and Oct. 12, 1964, Page 27.

75 Years Ago, September 1939

Sept. 1 The first major air battle of World War II begins around 7 am in Poland when a German bomber group of some 70 He-111 and Do-17 aircraft on the way to bomb Warsaw is intercepted by about 30 Polish P-11 and P-7 fighters from the Pursuit Brigade. The invading force disperses and drops the bombs on the fields near Nieporet in northern Poland. The Poles claim six victories with three losses of their own. Cynk, J.,"History of the Polish Air Force 1918-1968."

Sept. 2 Frank Fuller Jr. becomes the first to win the transcontinental Bendix Trophy Race twice, for the fastest time from Burbank, Calif., to Bendix, N.J. He also breaks his own record. Elapsed flight time in his stripped-down Seversky pursuit plane—a modified P-35—is 9 hours 2 minutes 5 seconds. Aircraft Year Book, 1940, Page 434.

Sept. 14 The Vought-Sikorsky VS-300 helicopter makes its first tethered flight. The craft has a single main rotor. M.J.H. Taylor and D. Mondey, Milestones of Flight, Page 127.

Sept. 15 Famed aviatrix Jacqueline Cochran sets a new international speed record of 305.9 mph for a 1,000-kilometer closed course, flying a Seversky AP-9 racer. The previous record of 254 mph was set by Helene Boucher of France. Aircraft Year Book, 1940, Page 435.

Sept. 17 German submarines torpedo Britain's HMS Courageous, which becomes the first aircraft carrier sunk by enemy action during World War II. Flight, Sept. 21, 1939, Page 256.

Sept. 21 Lockheed's 18 Lodestar civil transport, a successor to the Lockheed 14, makes its inaugural flight at the company's plant in Burbank, Calif. The 14 lacked sufficient cabin space for economical operations over short routes, and the Lodestar provides a cabin 24 feet 6 inches long, compared with 19 feet for the Model 14. Both planes have the same span and identical loaded weight, but the Lodestar carries 14 passengers and crew, vs. 10 for the older model, and can cruise for 1,150 miles. The Aeroplane, Nov. 2, 1939, Page 548.

Sept. 25 Col. Nicola de Mauro of Italy sets a new world altitude record for seaplanes when he flies his Caproni 161 to 44,429 feet at Vigna di Valle, Italy. Powering the plane is a single Piaggio XI RC 100 engine. The former record was set in 1929 by the U.S. Navy's Apollo Soucek. Aircraft Year Book, 1940, p. 435.

Sept. 26 Warsaw falls to the Germans after 21 days of siege. The city endured repeated air raids by about 200 planes dropping explosive and incendiary bombs. Especially effective were the incessant Junkers Ju.87 dive bomber attacks. The Aeroplane, Oct. 5, 1939, p. 419.

100 Years Ago, September 1914

Sept. 8 Capt. Peter Nesterov, an Imperial Russian Army pilot and the first person ever to perform a loop in an aircraft, dies in combat when he deliberately rams his Morane Type M into an Austrian aircraft flown by Lt. Baron von Rosenthal. It is believed to be the first recorded air-to-air victory of World War I. A. van Hoorebeeck, La Conquete de L'Air, Page 109.

Career Opportunities

Faculty Opening

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The Department of Aeronautics and Astronautics at Stanford University invites applications for a tenuretrack faculty position at the Assistant or untenured Associate Professor level.

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Stanford University is an equal opportunity employer and is committed to increasing the diversity of its faculty. It welcomes nominations of and applications from women, members of minority groups, protected veterans and individuals with disabilities, as well as from others who would bring additional dimensions to the university's research, teaching, and clinical missions.

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For more information: www.me.mtu.edu

THE UNIVERSITY OF ALABAMA

DEPARTMENT OF AEROSPACE ENGINEERING AND MECHANICS

FACULTY POSITION IN SPACE AND ASTRONAUTICS

The Department of Aerospace Engineering & Mechanics at The University of Alabama invites applications for a tenure-track faculty position in areas related to space and astronautics. While all applications will be considered, highest priority will be given to candidates with expertise in guidance, navigation, and control (GNC). It is anticipated that the successful candidate will join the faculty at the rank of tenure-track Assistant Professor, although exceptional candidates may be considered for higher rank depending upon experience and qualifications.

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The University of Alabama is located on a beautiful 1,168 acre residential campus in Tuscaloosa, a dynamic and resilient community of over 150,000. The Tuscaloosa community provides rich cultural, educational, and athletic activities for a broad range of lifestyles. With technology-oriented government/industrial research centers (including the U.S. Army's Redstone Arsenal and the NASA Marshall Space Flight Center) in north Alabama and a growing aviation industrial sector (including Airbus aircraft manufacturing & engineering centers) in south Alabama, The University of Alabama is centrally located in Alabama's north-south aerospace corridor.

Applicants must have an earned doctorate degree in aerospace engineering or a closely related field. Applicants are to submit: a letter of application, a detailed CV, statement of teaching & research interests, and contact information for at least three professional references. Successful applicants are expected to develop a strong externally-funded research program, demonstrate a commitment to excellence in teaching & mentoring of students, and provide service to the profession, university, college of engineering and AE&M department. All application materials must be submitted via The University of Alabama's employment website (https://facultyjobs.ua.edu, requisition number 0808972). Review of applications will begin immediately and will continue until the position is filled. Inquiries should be addressed to Dr. John Baker, Department of Aerospace Engineering & Mechanics, Box 870280, The University of Alabama, Tuscaloosa, AL 35487-0280 or sent by e-mail to john.baker@eng.ua.edu.

Qualified women and minorities are encouraged to apply. The University of Alabama is an equal opportunity, affirmative action, Title IX, Section 504, ADA employer. Salary will be competitive and commensurate with experience level.

AIAA Bulletin

In 2010, the AIAA Delaware Section and ATK hosted the above female students from Bohemia Manor Middle School at ATK's Elkton Facility as part of the Introduce a Girl to Engineering Day (IGED), which takes place during National Engineers Week. Breanne Sutton, analyst at ATK and the Delaware Section Chair, was able to follow up with some of these students at the Bohemia Manor High School Scholarship banquet in June. Full story on page **B9**.

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Addresses for Technical Committees and Section Chairs can be found on the AIAA Web site at **http://www.aiaa.org**.

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

Event & Course Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
2014			
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)	
20–23 Oct†	**International Telemetering Conference USA**	San Diego, CA (Contact: Lena Moran, 951.219.4817, info@telemetry.org, www.telemetry.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)	
23–24 Oct†	**Joint Conference on Satellite Communications (JC-SAT 2014)**	Busan, Korea (Contact: Satoshi Imata, +81 80 6744 6252, sat_ac-sec@mail.ieice.org, www.ieice.org/cs/sat/jpn/purpose_e.html)	
24–25 Oct†	**combustionLAB and fluidsLAB Workshops**	Pasadena, CA (Dr. Francis P. Chiaramonte, 202.358.0693, francis.p.chiaramonte@nasa.gov, http://icpi.nasaprs.com/cflab-info)	
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			
3–4 Jan	**Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-On Training Using CIFER®**	Kissimmee, FL	
3–4 Jan	**Third International Workshop on High-Order CFD Methods**	Kissimmee, FL	
4 Jan	**Introduction to Integrated Computational Materials Engineering (ICME)**	Kissimmee, FL	
5–9 Jan	**AIAA SciTech 2015 (AIAA Science and Technology Forum and Exposition)** **Featuring:** **23rd AIAA/ASME/AHS Adaptive Structures Conference** **53rd AIAA Aerospace Sciences Meeting** **AIAA Atmospheric Flight Mechanics Conference** **AIAA Infotech@Aerospace Conference** **2nd AIAA Spacecraft Structures Conference** **AIAA Guidance, Navigation, and Control Conference** **AIAA Modeling and Simulation Technologies Conference** **17th AIAA Non-Deterministic Approaches Conference** **56th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **8th Symposium on Space Resource Utilization** **33rd ASME Wind Energy Symposium**	Kissimmee, FL	**2 Jun 14**
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	

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
11 Mar	**AIAA Congressional Visits Day**	Washington, DC	
25–27 Mar†	**3rd Int. Conference on Buckling and Postbuckling Behaviour of Composite Laminated Shell Structures with DESICOS Workshop**	Braunschweig, Germany (Contact: Richard Degenhardt, +49 531 295 3059, Richard.degenhardt@dlr.de, www.desicos.eu	
30 Mar–2 Apr	**23rd AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar**	Daytona Beach, FL	**30 Sep 14**
13–15 Apr†	**EuroGNC 2015, 3rd CEAS Specialist Conference on Guidance, Navigation and Control**	Toulouse, France (Contact: Daniel Alazard, +33 (0)5 61 33 80 94, alazard@isae.fr, w3.onera.fr/eurognc2015)	
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	
6–9 Jul	**20th AIAA International Space Planes and Hypersonic Systems and Technology Conference**	Glasgow, Scotland	
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.).

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

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– John O'Leary, Vice President and General Manager, Airbus Americas Engineering
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—Edgar G. Waggoner, Program Director—Integrated Aviation Systems, Aeronautics Research Mission Directorate, NASA Headquarters
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AIAA Balloon Systems Conference
AIAA Complex Aerospace Systems Exchange (CASE)
22nd AIAA Computational Fluid Dynamics Conference
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From the Corner Office

TELLING THE AEROSPACE STORY – OUR COLLECTIVE IMPERATIVE

Jim Albaugh, AIAA President

The great communicator Marshall McLuhan theorized that "the medium is the message," and what better medium than aerospace to convey the message that science and engineering are important to our world, that creativity and imagination are still alive? Who hasn't paused to look up at an airplane soaring overhead? Or gathered around a radio, TV, or computer to witness historic events made possible by our work? Who did not feel something give way in their hearts when they witnessed the Challenger or Columbia disasters? Aerospace is a common touchstone of creation, imagination, and inspiration. It represents individuals coming together to make the world more connected, safer, and prosperous. Aerospace is a pretty great medium.

Despite the aerospace community's achievements, if you look through recent headlines, you find that our achievements are not as clearly recognized as they could be. Some believe that space exploration is no longer important; more of our young professionals are exiting the aerospace profession because they do not see a long-term, unifying vision for future exploration efforts; and one need only look at coverage of recent aviation disasters to see a dearth of scientific and engineering knowledge in the mainstream media. However, the truth is our community's commitment to space exploration is still strong; the space sector is thriving with government and private sector firms creating new technology and projects to advance exploration of the universe—creating opportunities in nearly every field of endeavor; and people from all walks of life still look skyward to watch airplanes soar. However, the very fact that both the general public, as well as some within our own industry, think the opposite is troubling—it means we have a great medium, but the message is being lost in translation.

When the public names things our community created, the two things often cited are Tang and Velcro, fine products to be sure, but neither originated in our community. Their constant citing, however, points to a need for us to improve our messaging about things we did create, and which have transformed life as we know it. Imagine if carpenters sent thank-you cards to us for our invention of cordless tools originally meant to help astronauts work in environments where extension cords wouldn't. Consumers might be interested to know that we helped develop the air scoops and foils now used on commercial trucks that improve gas mileage, thus helping keep product prices down by eliminating even higher fuel charges. There are so many things we could tell people—it was our community that developed the GPS system that got them home safely and quickly; that it was aerospace professionals who invented the micro-surgical tools that give patients a fighting chance in complex surgeries; that it was our collection of engineers and designers who created the portable breathing apparatus that firefighters use when saving lives. Superior sunglasses, stronger and more flexible artificial limbs, LEDs, freeze-dried food—these things, and countless more—are all things *WE* created and gave to the world. But because our messages are not told well enough, in the end, it seems it is often back to Tang and Velcro.

So, how do we use our remarkable medium to share our message more effectively? The answer lies in a unified voice and commitment on behalf of our community to communicate our message more succinctly, more coherently, and more consistently. We need to start speaking to the public in less technical terms and we need to find ways to start engaging them at their level, in newspapers, online, and on TV rather than primarily through technical- and science-focused mediums. The aerospace community is a tight-knit and specialized one. Sometimes we get caught up in our work and feel so comfortable in our knowledge of the industry and related events that we just assume the rest of the world understands what we do when instead they may be confused, nervous, or skeptical. We can be better at explaining what we do to the general public, conveying the message of our work in simpler, easier to understand language. We can consistently refute stubbornly ingrained myths; we can offer the media our expert analysis and then deliver it in convivial and accessible ways. We can train teachers to talk about STEM subjects in ways that will engage and encourage their students to consider STEM careers, inspiring them to want to know more, do more, and discover more. And when schools consider slashing STEM budgets, we can engage their leaders and explain why it is a shortsighted, bad idea. There is a lot we can and must do.

Who can do this? Our entire community can. "Aerospace professional" is a term that includes everyone in our community—not just engineers and scientists. Each of us has the power to start making these changes now. We can rethink our messages; we can correct errors and misconceptions; and we can find ways to explain what we do that are both non-technical and engaging. We must also find new ways to inspire non-technical students to join our community as well. A thriving aerospace community needs not only engineers and scientists, of course, but also electricians, writers, accountants, machinists, and many other professionals to continue transforming our world. If a young person is fascinated by flight and space, but thinks that all the jobs in the aerospace industry require advanced math and science degrees, we've lost. AIAA can play a huge role in this by leading the charge by first shifting the paradigm of how we talk about aerospace—by providing forums for the exchange of ideas, by developing "best practices," and by providing training on public engagement. By all means, AIAA must continue working with lawmakers help them understand what our industry needs to thrive. And that must go beyond simply urging them to give us more money; it involves helping them establish a clear vision for future exploration efforts, and enlisting them as allies in our efforts to help the public more fully understand our efforts.

What we do matters. We bring the world closer together: our discoveries illuminate our universe, inspire us to keep striving to learn more and to imagine, design, create, and accomplish seemingly impossible things. But we will have a harder time succeeding if the public understand doesn't understand why and how our efforts enrich everyone's lives. If we can't find ways to inspire the next generation, as well as current professionals, to stay in our community or rally public support for our work, we will find doing what we do harder and more challenging than it already is. We must come together to rethink how we communicate our message to ensure that the public hear it clearly. Nobody else will do this for us. It is our collective imperative as aerospace professionals, and we must begin at once.

Correction: In the July-August issue, page **B5**, in the article "Steltzner Awarded Inaugural Brill Lectureship," **Dr. Adam Steltzner's** name was misspelled. We regret this error.

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.

DATE SET FOR CONGRESSIONAL VISITS DAY 2015

AIAA's 18th annual Congressional Visits Day (CVD) program will be held Wednesday, 11 March, on Capitol Hill. CVD is AIAA's premier grassroots congressional advocacy program, allowing members a chance to engage in a day of discussions with congressional decision makers and their staffs about issues that affect the entire aerospace community. Participation allows you to become an effective advocate for the community and provides attendees with a "behind the scenes" look at how Capitol Hill works. If you have an interest in the future of aerospace and public policy, AIAA CVD 2015 is the program for you.

"AIAA's CVD program is a valuable experience that I would hope every AIAA member would take part in at least once," said AIAA Executive Director Sandra Magnus. "Our efforts help representatives of both parties understand the importance of our community to the economic prosperity and national security of our nation, and what they can do to ensure sound decision making for the future of aerospace. CVD only works if you get involved, so I am hoping to see on March 11th in Washington, DC."

Registration for CVD will open in early September, and a schedule of events will be posted to the AIAA website at that time. If you have questions about AIAA CVD 2015, contact Duane Hyland at duaneh@aiaa.org or 703.264.7558.

LIAISONS TO THE AIAA BOARD OF DIRECTORS

The AIAA Board of Directors, Student and Young Professional Liaisons were instituted in January 2004, at the request of the AIAA Board of Directors through the AIAA Strategic Plan. The AIAA Strategic Plan tasked AIAA to establish a liaison position on the Board of Directors for Student Members and Young Professionals. These positions are to be non-voting Board of Directors positions, lasting two years in duration.

Liaisons will travel to attend Board of Directors meetings in January (SciTech forum), May (Washington, DC, Board Meetings), and August (meeting TBD) each year. Their travel will be covered by AIAA for these trips.

The term for the next cycle will be May 2015–May 2017. Students applying for the Student Liaison position must be students during the entire term. Application packages for the positions are due in October. A first review will be done in the fall; interviews will be held with first-round candidates from November through January; and final decisions will be announced in early spring.

For eligibility criteria and how to apply, visit AIAA's Young Professional Liaison page, or AIAA's Student Liaison page. If you have any questions, please contact Stephen Brock, stephenb@aiaa.org, 703.264.7536

KRIMIGIS WINS AIAA 2014 JAMES A. VAN ALLEN SPACE ENVIRONMENTS AWARD

Stamatios M. "Tom" Krimigis, an AIAA Fellow, and emeritus head, Space Department, Johns Hopkins University Applied Physics Laboratory (JHU/APU), Laurel, Md., has won the AIAA 2014 James A. Van Allen Space Environments Award. Dr. Krimigis received the award at the AIAA Mid-Atlantic Section 2014 Awards Banquet on 10 June 2014, in Baltimore, MD.

The James A. 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, credited with the early discovery of the Earth's "Van Allen Radiation Belts." Krimigis is being honored "for pioneering studies of the radiation environment around all solar system planets and of interplanetary charge particles from Mercury to the local interstellar medium."

Dr. Krimigis has made several important contributions to our understanding of the radiation environments of planets within our solar system. Working with Professor James Van Allen, Krimigis determined that Earth's magnetosphere contains helium in abundance compared to protons, allowing investigators to determine that the helium was not interplanetary in origin, but rather from the Earth's ionosphere. Krimigis furthered his work in this area, leading the Active Magnetosphere Particle Tracer Explorer (AMPTE) program, a collaborative U.S.–German–British program that created the first man-made comet in space in 1984. Krimigis' other accomplishments include placing an upper limit on the intrinsic dipole magnet moment of Venus; collaborating on the creation of the MErcury Surface, Space ENvironment, GEochemistry, and Ranging mission (MESSENGER); serving as principal investigator for the Low Energy Charged Particle (LECP) experiment on Voyagers 1 and 2—which discovered that the plasma physics of Jupiter and Saturn are quite different than that of Earth; and serving as the principal investigator for the Cassini mission to Saturn and Titan, where instruments of his invention are returning neutral ion images of Saturn's magnetosphere as well as in-situ measurements of electrons and ion composition.

Dr. Krimigis holding his medal and Dr. Ralph McNutt of APL holding the certificate at the awards banquet.

Krimigis' other honors include the 2004 Lifetime Achievement Award from JHU/APU; the Committee on Space Research's 2002 Space Science Award; the Smithsonian Institution's 2002 Trophy for Achievement; and three *Aviation Week and Space Technology* "Laurels in Space" awards—in 1996 and 2001, for the Near Earth Asteroid Rendezvous (NEAR) mission and in 2001, for the New Horizons mission. Krimigis is a Fellow of the American Physical Society, American Geophysical Union, and the American Association for the Advancement of Science.

For more information about the James A. Van Allen Space Environments Award or the AIAA Honors and Award program, please contact Carol Stewart at carols@aiaa.org or at 703.264.7623.

MEMBERSHIP ANNIVERSARIES

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

40-Year Anniversaries

Mark D Maughmer	Central Pennsylvania
Michael M Micci	Central Pennsylvania
James E Carter	Connecticut
David F Stroberg	Connecticut
Robert L Calloway	Hampton Roads
Peter F Covell	Hampton Roads
Delma C Freeman	Hampton Roads
Peter A Gnoffo	Hampton Roads
Robert M Hall	Hampton Roads
Jerry R Newsom	Hampton Roads
James C Townsend	Hampton Roads
Bernard Kaufman	Mid-Atlantic
Frank J Regan	Mid-Atlantic
Michael A Solly	Mid-Atlantic
GaryJ Batie	National Capital
Robert A Brodowski	National Capital
Ronald K Browning	National Capital
John W Clark	National Capital
Vance D Coffman	National Capital
Mary F Dominiak	National Capital
Richard C Gentz	National Capital
Joseph D Gillerlain	National Capital
Carl H Hubert	National Capital
Jeff R Loren	National Capital
Richard M Obermann	National Capital
Louis Pollack	National Capital
Gary G Presuhn	National Capital
Edward W Stinnett	National Capital
John B Walsh	National Capital
James D Wilson	National Capital
Kevin L Zondervan	National Capital
John F Egan	New England
Donald Fifield	New England
Burton D Figler	New England
Herbert M Kosstrin	New England
William Z Lemnios	New England
Petrus A Spierings	New England
Ramani Mani	Northeastern New York
Doyle D Knight	Northern New Jersey
Harry E Plumblee	Atlanta
Eric Steinberg	Atlanta
Benton L Walker	Atlanta
Alan M Lovelace	Cape Canaveral
Thurman D McCay	Cape Canaveral
Keith A Ex	Central Florida
Raphael T Haftka	Central Florida
Charles R McClinton	Central Florida
Anthony M Rossetti	Central Florida
Thomas M Devanney	Greater Huntsville
Michael D Griffin	Greater Huntsville
John R Knox	Greater Huntsville
Charles R LaMar	Greater Huntsville
Ronald I Miller	Greater Huntsville
Sarat C Praharaj	Greater Huntsville
David J Schultz	Greater Huntsville
Clyde L Ware	Greater Huntsville
Lawrence E Lijewski	Northwest Florida
Daniel P Mazzeo	Northwest Florida
George S Dulikravich	Palm Beach
Eduardo L Elizondo	Palm Beach
Dale Bradley	Tennessee
William D Jackson	Tennessee
Timothy W Swafford	Tennessee
Richard J Freuler	Columbus
Harwood A Hegna	Dayton/Cincinnati
Lanson J Hudson	Dayton/Cincinnati
Fred H Krause	Dayton/Cincinnati
Thomas P Severyn	Dayton/Cincinnati
James M Snead	Dayton/Cincinnati
Bruce K Walker	Dayton/Cincinnati
James F Coakley	Illinois
Mark R Lawson	Illinois
Robert C Nelson	Indiana
Subrata Sengupta	Michigan
Edward J Sichterman	Michigan
Eric J Daiber	Northern Ohio
Woodrow Whitlow	Northern Ohio
Andrew B Cox	Albuquerque
Malcolm L Holcomb	Albuquerque
John C Rich	Albuquerque
John J Russell	Albuquerque
James H Strickland	Albuquerque
William Vega	Albuquerque
Dallas G Ives	Houston
Dan Yee	Houston
Carroll S Kirkpatrick	North Texas
Baxter R Mullins	North Texas
Donald T Ward	North Texas
Walton E Williamson	North Texas
George W Botbyl	Southwest Texas
Michael L Slack	Southwest Texas
Russell M Cummings	Rocky Mountain
Douglas E Hutchinson	Rocky Mountain
Paul Migliore	Rocky Mountain
Garret N Vanderplaats	Rocky Mountain
James F Cain	St. Louis
Edward A Eiswirth	St. Louis
David A Peters	St. Louis
James A Warren	St. Louis
Gary P White	St. Louis
William L Garrard	Twin Cities
Gary L Hartmann	Twin Cities
David J Whalen	Twin Cities
Arthur A Winquist	Wichita
Dean E Davis	Antelope Valley
Paul J Reukauf	Antelope Valley
Philip A Donatelli	Los Angeles-Las Vegas
Tony C Lin	Los Angeles-Las Vegas
Jerry L Lockenour	Los Angeles-Las Vegas
Joel A Storch	Los Angeles-Las Vegas
I-Shih Chang	Orange County
Stephen John Dwyer	Orange County
John L Fletcher	Orange County
Louis H Kurkjian	Orange County
Charles S MacGillivray	Orange County
Bill P Olson	Orange County
Richard L Tischner	Orange County
Edward A Zadorozny	Orange County
Frederick W Bowen	Pacific Northwest
Michael J Dunn	Pacific Northwest
Jerry L Lundry	Pacific Northwest
Peter M Morton	Pacific Northwest
James P Noblitt	Pacific Northwest
Stephen W Paris	Pacific Northwest
Kwok-On Tong	Pacific Northwest
Melvin J Bulman	Sacramento
Trevor C Sorensen	San Fernando Pacific
Robert E Berry	San Francisco
Dallas G Denery	San Francisco
Heinz Erzberger	San Francisco
Ferdinand Hendriks	San Francisco
Michael L Knaebel	San Francisco
Blair G McLachlan	San Francisco
William J Miklos	San Francisco
George P Sloup	San Francisco
Josette R Bellan	San Gabriel Valley
John W Barainca	Utah
Burton H Holaday	Vandenberg
Karl F Doherr	International
Colin A Franklin	International
Peter C Hughes	International
Alain Dupas	International
Jean-Pierre Taran	International
Karl F Doherr	International
Reza Eslami	International
Aviv Rosen	International
Asher Sigal	International
Norihiro Goto	International
Masafumi Miyazawa	International
Susumu Toda	International
Francois C Frochaux	International
Chienchang Lin	International
Geoffrey M Lilley	International

50-Year Anniversaries

Walter M Presz	Connecticut
Charles H Marston	Greater Philadelphia
William A Wood	Greater Philadelphia
Melvin S Anderson	Hampton Roads
E Leon Morrisette	Hampton Roads
R Clayton Rogers	Hampton Roads
Martin H Woodle	Long Island
William J Breedlove	National Capital
Archie Gold	National Capital
Tse-Fou Zien	National Capital
Andrew J Breuder	New England
Leslie E Matson	New England
Charles R Hoover	Niagara Frontier
Howard M Brilliant	Northeastern New York
George F Wiggers	Northeastern New York
Peter W Conrad	Northern New Jersey
Joel A Strasser	Southern New Jersey
Arthur Slotkin	Atlanta
Ronnie Radford	Cape Canaveral
Charles Henderson	Carolina
Robert Kappler	Carolina
Alfred Morrison	Central Florida
Robert Ryan	Greater Huntsville
T. Veziroglu	Palm Beach
William Kimzey	Tennessee
Robert Rhodes	Tennessee
Frederick Shope	Tennessee
C. Stroud	Tennessee
Hermann Viets	Wisconsin
Donald E Nash	Albuquerque
Carl W Peterson	Albuquerque
Ronald W Marshall	North Texas
Carl G Stolberg	North Texas
Joe B Webb	North Texas
Vernon R Jackson	Iowa
James D Porter	Rocky Mountain
Norman E Conley	Wichita
James E Randolph	Wichita
George T Upton	Wichita
L. J Ehernberger	Antelope Valley
Franklin B Mead	Antelope Valley
Andrew H Mactavish	Los Angeles-Las Vegas
Peter R Schultz	Los Angeles-Las Vegas
Douglas N Smyth	Los Angeles-Las Vegas
James E Kinnu	Orange County
James A Martin	Orange County
Robert A Curnutt	Pacific Northwest
Avtar S Mahal	Pacific Northwest
Curtis N Orsborn	Pacific Northwest
A. V Viswanathan	Pacific Northwest
C James Dorrenbacher	San Diego
Thomas Y Palmer	San Diego
Richard H Petersen	San Diego
Victor Lyman	San Fernando Pacific
Vaughn W Abbott	San Francisco
John W Overall	San Francisco
Henry Rie	San Francisco
Robert Thornquist	San Francisco
J. W Young	San Francisco
Ewald Heer	San Gabriel Valley
Alfred R Zieger	San Gabriel Valley
William L Shields	Tucson
John A Kentfield	International
Sannu Molder	International
Chul Park	International

60-Year Anniversaries

John J Horan	Connecticut
David C Howe	Connecticut
Raymond G Bertles	Greater Philadelphia
Irving P Magasiny	Greater Philadelphia
Jon R Geer	Hampton Roads
Edward J Deutsch	Long Island
Arthur G Buckingham	Mid-Atlantic
Richard E Walters	Mid-Atlantic
Ali B Cambel	National Capital
John H Grover	National Capital
Ray F Siewert	National Capital
Emerson W Smith	National Capital
Vincent A Grosso	New England
Douglas W Linder	New England
John E Miller	New England
Hartwell F Calcote	Northern New Jersey
Arnold J Kelly	Northern New Jersey
Edmund A Shereika	Northern New Jersey
Roelof L Schuiling	Cape Canaveral
William B Cross	Carolina
Robert W Dunning	Central Florida
William J Escher	Greater Huntsville
Claude S Sarphie	Greater Huntsville
James T Clay	Northwest Florida
Wendell S Norman	Tennessee
H. M Davis	Dayton/Cincinnati
Frank L Oppenheimer	Dayton/Cincinnati
Emanuel J Stringas	Dayton/Cincinnati
Robert E Miller	Illinois
James C Butler	Indiana
Herbert H Dobbs	Michigan
Ronald M Gabel	Northern Ohio
Roger E Tate	Albuquerque
Joseph G Thibodaux	Houston
Arnold P Breeden	North Texas
Charles H Herty	North Texas
Sol Love	North Texas
Roy R Priest	North Texas
Robert V Glowczwski	Southwest Texas
Wilfred L De Rocher	Rocky Mountain
Marty A Ferman	St. Louis
Charles A Scolatti	St. Louis
Edward H Roberts	Wichita
Stephen Starch	Wichita
Robert M. L Baker	Los Angeles-Las Vegas
Joseph R Di Camillo	Los Angeles-Las Vegas
Eugene G Haberman	Los Angeles-Las Vegas
Kalle Kaups	Los Angeles-Las Vegas
Tobenette Holtz	Orange County
Robert M Bridgforth	Pacific Northwest
Richard G Merritt	Pacific Northwest
Ted C Nark	Pacific Northwest
Daniel J O'Brien	Pacific Northwest
Walter Spangenberg	Pacific Northwest
Greg R Johnston	Phoenix
Richard E Kuhn	San Diego
Lionel G Wilson	San Diego
Robert P Egermeier	San Fernando Pacific
Henry R Graf	San Fernando Pacific
George M Suzuki	San Fernando Pacific
Jason J Moses	San Francisco
Victor L Peterson	San Francisco
William J Schatz	San Francisco
Daniel M Tellep	San Francisco
Myron Tygar	San Francisco
John M Bozajian	San Gabriel Valley
Paul W Hoekstra	Utah
Bruce A Reese	Utah
Edgar Benditzky	Vandenberg
John E King	Vandenberg
Edwin F Perlman	International

70-Year Anniversaries

Richard G Stutz	Connecticut
James R Polski	Greater Philadelphia
William Bihrle	Long Island
Leon H Schindel	Long Island
Alfred R Deptula	National Capital
Marvin I Haar	National Capital
John R Meyer	National Capital
John E Stevens	National Capital
Robert A Summers	New England
Robert G Loewy	Atlanta
N. C Witbeck	Northwest Florida
Hubert I Flomenhoft	Palm Beach
Gordon Rosenthal	Palm Beach
Mark V Morkovin	Illinois
George M Palmer	Indiana
H A Richardson	Wichita
Louis B Gratzer	Pacific Northwest
Edward O Dickerson	San Fernando Pacific
David Altman	San Francisco
Robert L Nelson	San Francisco

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

INTRODUCE A GIRL TO ENGINEERING EVENTS SPURRING LONG-TERM INTEREST IN STEM

Since 2005, the AIAA Delaware Section and ATK have been hosting female students from Bohemia Manor Middle School at ATK's Elkton Facility as part of the Introduce a Girl to Engineering Day (IGED), which takes place the Thursday of National Engineers Week. Seventy-eight girls have participated in the program since its inception. The program is truly unique among the various STEM Outreach programs hosted by ATK and AIAA. Because the participation is limited to a small number, the girls are able to visit the engineers at their desks, participate in a design activity, have a tour and hopefully witness a rocket motor firing, and then have pizza with the engineers.

For the first time in the history of the program, the Delaware Section was able to receive feedback on the impact that Introduce a Girl to Engineering Day is having on the students. Breanne Sutton, analyst at ATK and the Delaware Section Chair, had the opportunity to meet with 7 of the 8 participants from IGED 2010 at the Bohemia Manor High School Scholarship banquet in June. Over half the 2010 participants are pursuing a STEM degree, such as Biology, Bio-Engineering, Robotics Engineering, and Accounting. Many of the girls received scholarships to their colleges.When asked if IGED influenced their educational decisions, we received the following replies:

> "Before going to ATK, I had never considered being an engineer. IGED made me realize engineering would be perfect for me. Not only would I be able to put my love of math and science to use, but I would also get to work with my hands."
>
> "Ever since ATK, I knew I wanted to be an engineer."

2010 IGED participants at their Scholarship Ceremony in June 2014.

> "This event increased and sparked my interests in science and helped me to see the STEM careers first hand, helping me to come to the decision to major in Biology"

Additionally, the girls walked away with a staggering amount of scholarships during their award ceremonies. Ms. Sutton, who took over IGED in 2008 from its Delaware section originator Tim Dominick, described the girls as "Rock Stars": "I am completely blown away by how accomplished all of these women have become. I am very excited for their future and so moved to hear the impact that our program is having" she said. The AIAA Delaware section has always hoped that the event was accomplishing its goal of introducing female students to engineering and STEM. Now we have the feedback that it is.

OBITUARIES

AIAA Senior Member Gegg Died in January

Steven G. Gegg died 16 January 2014. He was 53 years old.

Dr. Gegg earned a B.S. in Mechanical Engineering from the University of Missouri, Columbia in 1982, earned his M.A. in Mechanical Engineering from Stanford University in 1983, and later his PhD. from Iowa State in 1989. He worked at Rolls-Royce for 30 years, first as a Mechanical Engineer and then served as the Chief of Turbine Aerodynamics. He was a Rolls-Royce Associate Fellow. Dr. Gegg was also a member of ASME.

AIAA Senior Member Drake Died in February

James Madison Drake passed away on 3 February 2014.

Mr. Drake received a Bachelor of Science in Aerospace Engineering from Virginia Polytechnic Institute & State University in 1971, and a Master of Science degree in Aerospace Engineering from Georgia Institute of Technology in 1977. From 1982 to 1992, he oversaw the construction of the external tank for the space shuttle (tanks ET 2-17) for the Department of Defense (DSAS), NASA Michoud Assembly Facility in New Orleans.

He also worked as a professional engineer with the Department of Energy and a systems engineer in the Systems/Analysis Division in support of operations and maintenance of the Strategic Petroleum Reserve.

AIAA Associate Fellow Bezdek Died in June

William J. "Bill" Bezdek, 66, died on 12 June 2014.

Mr. Bezdek worked for more than 44-years at McDonnell-Douglas Corporation (MDC)/Boeing in Modeling and Simulation in St. Louis and was a Boeing Technical Fellow. He worked with systems engineers, avionics and networking engineers to use reconfigurable prototype simulators as part of requirements development and real-time distributed networked simulations. He helped put together the capability to allow flight hardware (live), simulated aircraft (virtual), and computer-generated (constructive) models to operate on a real-time distributed network.

Mr. Bezdek held several positions for the International Council of Systems Engineering (INCOSE) Midwest Gateway Chapter, including president, treasurer and program chairperson. He was the General Chair for the AIAA Modeling and Simulation (M&S) Conference and Chairman of the AIAA M&S Technical Committee (2005–2007). He was also the President of the Missouri Society of Professional Engineers St. Louis Chapter (2012–2013). Mr. Bezdek was also an adjunct professor at Washington University in St. Louis.

AIAA Associate Fellow Osder Died in June

Stephen S. Osder, age 89, died on 29 June 2014.

Mr. Osder received a B.S. in Electrical Engineering from City College of New York in 1948 and his MSE in Electrical Engineering from Johns Hopkins University in 1951. During a career of over 50 years, Mr. Osder made contributions to automatic flight control, digital avionics systems, and sensors for aircraft, spacecraft, missiles, and helicopters.

He was Chief Scientist and Department manager for flight controls and avionics technology at McDonnell Douglas/Boeing from 1985 to 1995, including the position of corporate fellow. During this period, he made individual contributions as well as led the groups responsible for development of advanced fly-by-wire flight control systems, advanced fire control systems for rotorcraft, new avionics architecture concepts, and advanced navigation technology for those aircraft. Prior to joining McDonnell Douglas in 1985, he was Director of Research and Development for Sperry Flight Systems, now Honeywell.

After his retirement from Boeing Helicopters in 1995 (where he had been principle control system designer for new experimental aircraft), Mr. Osder was an independent consultant and led advanced technology activity in the guidance, navigation, and control areas for major aerospace companies. He worked on guidance and control of an experimental unmanned VTOL vehicle while a consultant to Boeing.

He was an Associate Editor of AIAA's *Journal of Guidance, Control, and Dynamics* from the journal's founding in 1978 to 2005. He published more than 40 papers and held 24 patents on flight control systems and devices, fault tolerant computers, automatic landing, navigation and guidance sensors and systems. He also authored textbook chapters on these subjects. Besides being an AIAA Associate Fellow, he was also a member of IEEE and AHS. He has served on NASA's Aeronautical Advisory Committee, various National Academy of Sciences and NASA Advisory panels, gave AIAA courses in avionics and controls and seminars on these subjects at Stanford University, University of Washington, Arizona State University, and the Naval Postgraduate School.

AIAA Fellow Ordway Died in July

Frederick I. Ordway III, 87, died on 1 July 2014.

Mr. Ordway's involvement with AIAA began in 1941, when at the age of 13, he joined the American Rocket Society—one of AIAA's two predecessor organizations. He remained actively involved with AIAA throughout his entire life, and was a member of the History Technical Committee at the time of his death.

After graduating with a degree in geosciences from Harvard University in 1949, Mr. Ordway did graduate work at the Sorbonne and other institutions abroad. He was an early employee of Reaction Motors, Inc. (RMI) of New Jersey, a pioneering American liquid propellant rocket, before he moved to Republic Aviation, Inc.

A 1955 meeting with legendary rocket pioneer Wernher von Braun led to them become friends and to Mr. Ordway joining von Braun's rocket team in Huntsville, AL. He worked with von Braun until 1967, when on the advice of AIAA Honorary Fellow and notable science fiction writer Arthur C. Clarke, director Stanley Kubric hired Mr. Ordway to be a technical advisor for *2001: A Space Odyssey*. He helped develop basic concepts and designs for several of the spacecraft in the movie.

After completing his work on the film, he became a professor at the University of Alabama in Huntsville, before heading to Washington, DC, in 1974 to become a special assistant to Robert Seamans, the first Director of the Energy Research and Development Agency, now the Department of Energy (DOE).

Mr. Ordway had written numerous books on space travel, some with Wernher von Braun, and also published over 350 articles. His authored and coauthored works included *Basic Astronautics: An Introduction to Space Science, Engineering, and Medicine* (1962), *Dividends from Space* (1972), *The Rocket's Red Glare: An Illustrated History of Rocketry* (1976), and *Visions of Space Flight* (2001). In 1974, Mr. Ordway won AIAA's Pendray Aerospace Literature Award "For many contributions to the literature in recording the history and publicizing the benefits of the space program."

Mr. Ordway was also involved with the American Astronautical Society and the International Astronautical Federation, and served on the Board of Governors of the National Space Society, which presented Ordway with its 2012 National Space Society Space Pioneer Award for a Lifetime of Service to the Space Community. Ordway also received the Arthur C. Clarke Foundation's Arthur C. Clarke Award for Lifetime Achievement in 2013.

AIAA Associate Fellow Gaubatz died in July

William A. (Bill) Gaubatz, 81, died on 5 July 2014.

Dr. Gaubatz attended Purdue University through the Air Force ROTC program and obtained his PhD in Mechanical and Aeronautical Engineering. After obtaining his PhD, the Air Force sent him to Edwards Air Force Base where he discovered a lifetime passion for the air and space industry while working with and supporting rocket test pilots in their efforts. After finishing active service, he spent 40 years in the Air Force Reserves. He taught night classes for many years at Vandenberg AFB as well as classes overseas at the AFB in Wiesbaden, Germany, and summer classes in the Air Force training facility in San Diego.

In 1966, Dr. Gaubatz joined McDonnell Douglas (now Boeing) first in Santa Monica and then in Huntington Beach, CA. He originated and managed the development of the Delta Clipper reusable spaceplane system concept. He was responsible for the Delta Clipper Experimental programs (DC-X and DC-XA) that proved through flight that aircraft-like operations could be routinely achieved for spaceplanes. The efforts that he and his team made had major impacts on U.S. space programs and policy and on initiating today's fledgling Personal Spaceflight industry.

After retiring, Dr. Gaubatz helped found Universal Space Lines, Inc., where he served as president of SpaceClipper International (SCI) with the long-term goals of establishing an international network of spaceports and connecting Spaceway routes for routine, safe flights by the general public to and from and through space. He led studies for the SpaceClipper vertical take-off and landing (VTOL) commercial spaceplane and fostered the concept for incremental development of the new reusable systems. Dr. Gaubatz contributed to pioneering efforts for investigating the physiological and psychological system requirements for public space travel and space tourism and participated in early development activities leading to the formation of the Southwest Regional Spaceport in New Mexico. He was a cofounder of SpaceAvailable LLC and served as its president.

Dr. Gaubatz was a charter member of the X-Prize Committee, participating as a judge in many competitions and served as the EVP for the X-Prize Foundation. He was the founder and co-chair of the annual International Symposium for Personal Spaceflight (ISPS), chairman of the Space Tourism Society, and a member of the International Academy of Astronautics, the International Institute of Space Law (ISSL), and the Board of Directors of Space Frontier Foundation. Dr. Gaubatz authored numerous papers and articles, including the inaugural Ansett Lecture for the SafeSkies Conference, Australia.

AIAA Fellow Ragan Died in July

Ralph R. Ragan died on 15 July 2014. He was 90 years old.

Mr. Ragan attended the University of Missouri in 1941, and became a member of the Naval Reserve. After two years he was transferred to Iowa State University, joining the V-12 program there and receiving his B.S. degree in electrical engineering. Later, as one of the "90-Day Wonders" of that time, he was trained and commissioned at the U.S. Naval Academy. Mr. Ragan then earned his M.S. in aeronautics MIT. In the 1950s and 1960s he worked at the MIT Instrumentation Laboratory in Cambridge, where he was Director of Development of the Polaris Fleet Ballistic Missile Inertial Guidance Program (under the direction of the Navy) and then, Deputy Director of the laboratory in charge of operations for Apollo Guidance, Navigation and Control (directed by NASA). Mr. Ragan retired from Draper Labs in 1987.

On 20 July 1969, Mr. Ragan was in the control room of the Johnson Manned Spacecraft Center, when the Apollo program culminated in man's first lunar landing. His NASA Public Service Award attests to the successful completion of this long-term program. In addition to his work at MIT, Ragan was also editor-in-chief of AIAA's *Journal of Spacecraft and Rockets* and AIAA vice president of publications.

AIAA Fellow Schwinghamer Died in July

Robert J. Schwinghamer Jr., 86, died on 28 July.

Mr. Schwinghamer received his BS in Electrical Engineering from Purdue University in 1950, attended Massachusetts Institute of Technology in 1968 and received his Master's in Business from Sloan School.

Mr. Schwinghamer entered federal service in 1957 with a U.S. Army agency as a member of the Dr. Wernher von Braun rocket research and development team. He transferred with that team to the NASA Marshall Space Flight Center (MSFC) when it was formed in 1960. He made a number of far reaching and lasting technical contributions to the Saturn-Apollo Program, including pioneering the use of intense transient magnetic fields for forming aerospace materials. He also invented the magnetomotive hammer, which continues to exceed expectations when applied to the difficult metal working problems of large tanks and is still considered to represent the leading edge of magnetomotive forming. Mr. Schwinghamer developed a solar shield to provide temperature control and retain the habitable environment in the Skylab interior when the micrometeroid shield malfunctioned and caused overheating inside Skylab. When the Space Shuttle was on the pad for its first launch in 1981, the external tank thermal protection material came loose and its quality for flight became highly questionable. Mr. Schwinghamer was charged with investigating the thermal protection material and finding an immediate solution for bonding the deficient materials at the launch pad.

In the aftermath of the Challenger accident, Mr. Schwinghamer headed the MSFC investigation of the solid rocket motor failure. His team continued testing of the o-ring materials, seeking the best possible material for the redesigned solid rocket motor.

In 1996, he headed the MSFC team assigned to the overall NASA Tethered Satellite Failure Investigating Team. His team deduced the failure mode and reproduced the tether material failure in extensive laboratory tests. Also, in 1996, the National Transportation Safety Board (NTSB) requested NASA assistance in the investigation of the TWA-800 disaster. Extensive analysis and testing of materials from TWA-800 was done by a NSFC team, headed by Mr. Schwinghamer. NTSB Chairman Jim Hall praised the MSFC Team and Mr. Schwinghamer for the professionalism, cooperation, and their timely contribution to the investigation.

Mr. Schwinghamer retired from the position of Associate Director Technical of NASA Marshall Space Flight Center in January 1991. After retirement, he served as an aerospace consultant for NASA, consulting on 14 reviews and investigations. Over his long career, he was the author or coauthor of over 50 technical papers and held 12 U.S. and 7 foreign patents.

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

CALL FOR NOMINATIONS

Nominations are being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 October**. Any AIAA member in good standing may serve as a nominator and are urged to read award guidelines to view nominee eligibility and other requirements. AIAA members may submit nominations online or download a nomination form after logging into www.aiaa.org. For more information, contact Carol Stewart, Manager, AIAA Honors & Awards, carols@aiaa.org or 703.264.7623.

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 is the highest honor AIAA bestows for notable achievement in the field of astronautics.

International Cooperation Award recognizes 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.

Dryden Lectureship in Research 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 honors 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.

von Kármán Lectureship in Astronautics recognizes an individual who has performed notably and distinguished himself technically in the field of astronautics.

Wright Brothers Lectureship in Aeronautics 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 honors meritorious achievement in the applied aerodynamics field, recognizing notable contributions in the development, application, and evaluation of aerodynamic concepts & 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 honors 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 given to an individual member of AIAA who has made a recent significant contribution that is worthy of national recognition. Submit nominations to your AIAA Regional Director.

F. E. Newbold V/STOL Award honors 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 that 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 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 honors an individual's 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 given for outstanding contributions and achievements in the advancement of free flight balloon systems or related technologies. (Presented odd years)

Piper General Aviation Award honors 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 recognizes the person(s) judged to have contributed most outstandingly during the recent past toward achieving compatible relationships between airports and/or heliports and adjacent environments.

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 recognizes 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. (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.

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www.aiaa-scitech.org

3–4 January 2015

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

Instructor: Dr. Mark B. Tischler

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

Key Topics

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

Who should attend:

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

3–4 January 2015

Third International Workshop on High-Order CFD Methods

Workshop Organizer: H. T. Huynh

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

Workshop Objectives

- To provide an open and impartial forum for evaluating the status of high-order methods (order of accuracy > 2) in solving a wide range of flow problems
- To assess the performance of high-order methods through comparison to production 2nd order CFD codes widely used in the aerospace industry with well-defined metrics
- To identify pacing items in high-order methods needing additional research and development in order to proliferate in the CFD community

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

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

4 January 2015

Introduction to Integrated Computational Materials Engineering (ICME)

Instructor: Dr. Vasisht Venkatesh

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

Key Topics

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

Who should attend:

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