February 2015

AEROSPACE AMERICA

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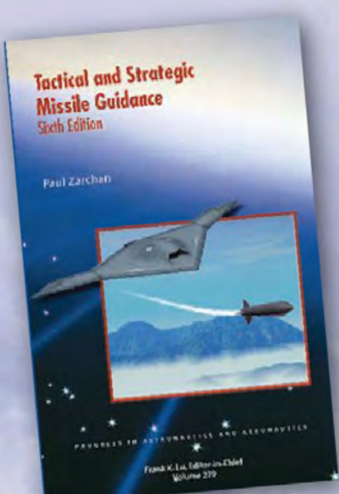

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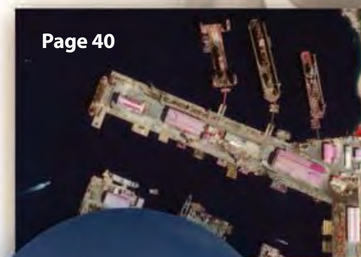

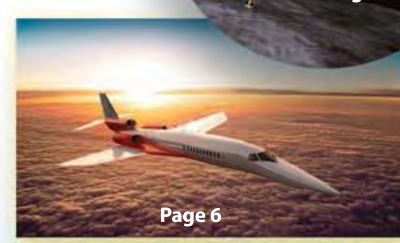

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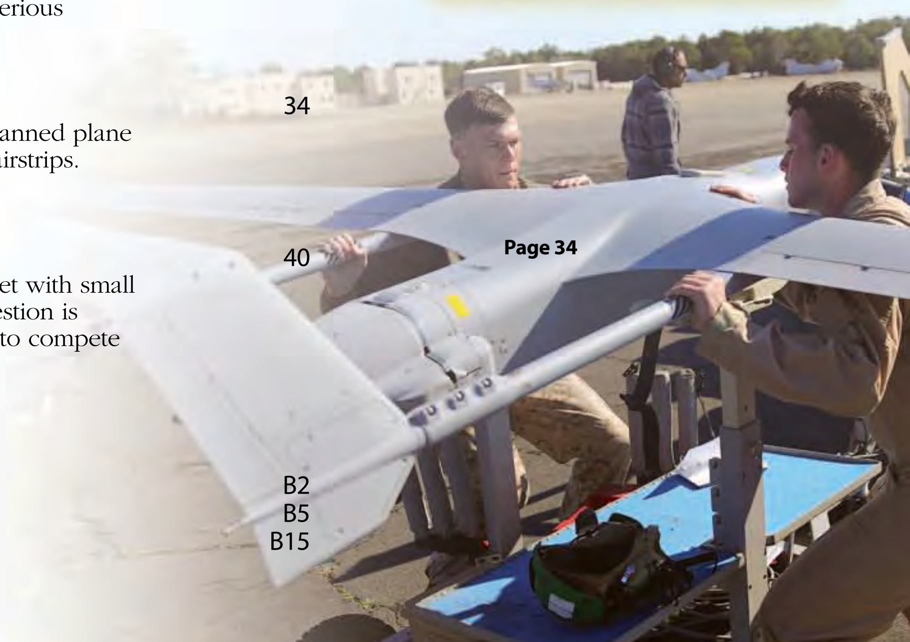

ON THE COVER

737-800 airliners at Boeing Field, Washington. Image credit: Boeing

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AIAA
Shaping the Future of Aerospace

Editor's Notebook

Being exceptional

The arrival of a new Congress seems likely to spark a fresh look at NASA's raison d'être. There could be a temptation to focus the agency's efforts more than ever on a single core mission: Getting humans into deep space.

My view is this would be a big mistake, and here's why.

Human space flight once symbolized America's view of itself as exceptional, but it is now a tool, not an end unto itself. Human missions must contribute to NASA's often-unspoken overarching reason for being: To apply the nation's aerospace brainpower toward helping humanity reach its full potential.

People will define that potential differently, but I see it as living on a clean, sustainable, largely peaceful planet inhabited by people who are highly mobile and knowledgeable about their place in the cosmos. In the far future, the potential could include leaving Earth, but this should not be because we've ruined the place. It should be because pioneering is in our DNA.

Astronauts can do lots of things to contribute to that full potential, but they can't do it all. They can't build clean flying planes, supersonic transports or software to manage air traffic more efficiently. They can't survey the solar system, grab a piece of an asteroid, swim under Europa's ice or look back toward the Big Bang. That work will require unmanned probes and space telescopes.

All elements of NASA's portfolio must compete with each other based on their costs and likely contributions to human progress. Human missions should not be weighted more heavily just because they involve astronauts. Proposals must be judged by the knowledge they would produce, the problems they could solve and the economic value they might bring.

Would the human spaceflight endeavor crumble under such a metric? I don't think so. There are likely to be valuable missions that can only be done by humans working in situ, probably together with robots. These missions can't be so expensive, however, that NASA can't afford to do anything else. Costs will need to be controlled and the U.S. will need to pace itself. Done wrong, human space flight could end up undercutting NASA's core mission of contributing to human progress.

On the question of economic value, not every space mission has to promise a tangible output, such as minerals from asteroids or pharmaceuticals developed in space, in order to have value. We're living in the information age, which means knowledge has been democratized. There's a vast and growing market for it. Our smartphones and tablets are only as valuable as the amazing photos, news articles and conversations that course through them. There is no longer such a thing as knowledge for the sake of knowledge. Information is now a commodity and it has economic value. NASA makes important contributions to this new economy.

We in the U.S. can't just call ourselves exceptional. We have to actually be exceptional if we want to stake that claim. This will mean continuing NASA's numerous contributions to human progress, part of which is a vigorous human space flight program. It won't be easy, but this is no time to let up.

Ben Iannotta
Editor-in-Chief

Simpler planetary defense

The article "Planetary Defense" [January, page 32] seems to have ignored one very effective strategy for asteroid deflection. This is simply to attach a good-sized thruster to the asteroid and with a scheme to do a little attitude control or fire the thruster at given times so the asteroid could be moved off path. This, if sized and done correctly, would not only deter it from hitting the Earth on its next orbit but also be able to eventually shift its orbit to be a non-NEO asteroid. This is a major problem with most of the schemes considered in the article in that a small deflection may be good for the next orbit of the asteroid but does not allow for succeeding orbits that then could be just as dangerous to the Earth. A major advantage of the thruster control system is that we can see the early results and make adjustments for more effective use. Other schemes use a 'one shot' attempt with unknowable results. A thruster control system could be used at various times in the future and would apply to mid-size asteroids.

However, most schemes considered in this article utilize technologies pretty much at hand whereas the thruster control scheme needs more technology development. But asteroid collision is not a near-term problem — it is a long-term problem and we have time to develop whatever technology is called for. And even with a thruster control system, we would want a backup and a secondary backup proven scheme to reduce the risk of a thruster malfunction and a short timetable. So, the schemes identified in the article are good for backup considerations. One major consideration of the thruster control system is how to put it in place. Technologies need to be developed for a manned mission to do this. This could also push automation systems to reduce the high cost of manned missions. Asteroids have very small gravity so the cost is mainly long duration manned flight and tools they need.

These new technologies would be needed for future Moon and Mars missions, so these new developments would have continuing use. In the longer term more automation could be developed so that eventually the installation of a thruster control system could be done with automated robotics — further enhancing needed technologies in Mars exploration and eventual settlement. The fuel to use and structure installation would also be new technologies to develop, which would also have application for other missions.

And, yes, a dedicated Planetary Defense Agency — as you suggest in the January editorial — may be needed to work with NASA to put in place an effective system that reduces impact risks. Unfortunately it may take a devastating hit to bring enough concern to have action beyond NASA's ARM activity. Until then, perhaps a study can be done.

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More air travel options

The article "Revolutionizing Air Travel" by Philip Butterworth-Hayes in Aerospace America, January 2015, was interesting. I am glad to see that some effort into improving air travel with refueling, in-flight transfer, and feeder-cruiser aircraft in the Recreate study. I was surprised, however, that the article did not mention the benefit of replacing multiple flights, and I hope the Recreate study has not overlooked this benefit.

Consider 3 flights: San Diego to Denver, Phoenix to Kansas City, and Denver to Indianapolis. With in-flight payload transfer (cargo or passengers), the flight leaving San Diego can carry payload to all 3 destinations. As a result, the airplane can be larger, the flights more frequent, and smaller airports can be served. Adding flights from Kansas City to Columbus, Indianapolis to New York, and Columbus to Boston multiplies the benefits. Also, non-stop flights across the country can be completed with airplanes designed for much shorter range.

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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.

Correction

An article in the January issue about near-Earth objects, "Planetary Defense," misstated the size of a meteoroid that exploded over Chelyabinsk, Russia, in February 2013. It was 17 to 20 meters in diameter.

Appreciation

Jim Harford

Jim Harford, the pioneering leader of AIAA from 1964 to 1988, died in December at age 90. Former colleague Jerry Grey describes how Harford used his strong personality and professional friendships to elevate AIAA into one of the country's leading technical societies.

When James J. Harford became executive secretary of the American Rocket Society in 1953, his staff consisted of two: himself and the former executive secretary, the redoubtable Agnes "Billie" Slade.

Over the next years, Jim would lead the transformation of ARS and the Institute of the Aeronautical Sciences into the nation's leading professional forum for engineers and technologists working in the aerospace domain.

Jim's first mission was to build both his staff and the society membership from about 2,500, many of whom were science-fiction aficionados, but with a solid core of real rocket engineers and scientists.

I got to know Jim in the mid-1950s when I was a professor of aerospace engineering at Princeton. We lived on adjacent streets bordering Princeton's Lake Carnegie, where on Saturdays we watched the university's crew race those of the other Ivy League colleges. My own association with ARS was as a member and contributor of technical papers to its journal Jet Propulsion. Through Jim's urging, I later joined several technical committees, and at his request I agreed to chair the ARS 1961 Space Flight Report to the Nation.

This was the first major ARS project to breach what had been a firewall restricting professional societies solely to matters of science or technology. Jim organized a grand exhibition of rockets and their technologies at the New York Coliseum, and I assembled several blue-ribbon panels to present ongoing space programs and achievements in nontechnical terms. One of Jim's greatest contributions to the success of this landmark event was to secure Vice President Lyndon Johnson as the banquet speaker.

When ARS merged with the Institute of the Aeronautical Sciences in 1963 to create AIAA, Jim agreed to have Paul Johnston, his counterpart at IAS, serve as chief executive until Paul's planned retirement 18 months later, when Jim took over.

Then began a period of truly spectacular growth for AIAA, not just in membership and staff, but most importantly, in scope. Of all Jim's achievements during this time, there are three that stand out. First and foremost was building on the 1961 Space Flight Report to create AIAA's Public Policy program, one side effect of which was moving the AIAA headquarters from New York to Washington. Jim's second major accomplishment was to bring AIAA strongly into the international scene, and the third was the creation of this magazine, Aerospace America.

I was directly involved in these activities with Jim. One of his astute perceptions was that the lack of technical expertise among his staff members was hindering their ability to communicate effectively with the AIAA members who ran the technical committees, wrote the technical papers and organized the technical meetings. So in 1969 he invited me to join his staff as administrator of technical activities, which I agreed to do on a two-day-per-week basis. (I had previously been elected to two terms as AIAA vice president, publications.)

But then a major national aerospace issue arose: Should the U.S. support the development of a commercial supersonic transport, or SST? Arguments pro and con abounded — on feasibility, performance, environmental impact, economics — but were often based on flawed data or analyses. Jim felt that this was one area in which the AIAA membership possessed all the expertise needed to make a proper decision, so he decided to form a new AIAA department — Public Policy — to provide a framework able to address this and similar national issues. He asked me to be the staff administrator of the new department, and then proposed it to the AIAA Board of Directors. Not surprisingly, there was opposition initially by board members, many of whom were employed by aerospace corporations, NASA and the Department of Defense — agencies and companies that did not necessarily welcome an outside organization poking its nose into matters affecting their lifebloods. There was concern that an AIAA study might provoke antagonism among board members employed by companies competing for contracts.

Nevertheless, the Public Policy

department was created in 1970; the first AIAA vice president for public policy was Richard DeLauer, who in the Reagan years became undersecretary of defense for research and engineering under Caspar Weinberger. DeLauer often disagreed with the defense secretary and was chief architect of a controversial plan to speed up development of the Strategic Defense Initiative.

The mantra of the new Public Policy department was made very clear (and persists to this day) — "Inform, but do not persuade." That is, provide the information needed to make decisions, but do not lobby.

The first assessment by the new department, "The Supersonic Transport: A Factual Basis for Decision," published March 1, 1971, was generated by a team of AIAA members who represented all the relevant disciplines. It was presented at a congressional hearing by then-AIAA President Holt Ashley and me. This set up a precedent for dozens of future appearances before congressional committees and key administration offices such as the Office of Management and Budget and the Office of Science and Technology Policy. Teams of AIAA members, selected and organized by the Public Policy department, would meet in intensive two- or three-day workshops to generate assessment papers on major aerospace issues and respond to invitations to present them to appropriate government bodies.

To facilitate communications with government staffs, Jim set up a Washington office staffed by Johann Benson and Patricia Jefferson, whose main function was to get AIAA assessments and position papers into the right hands and obtain invitations to present them. This highly successful operation subsequently motivated the decision to move AIAA headquarters from New York to Washington, which was managed so expertly by Jim.

Another new AIAA function that Jim pioneered was to set up a group within Public Policy to acquaint non-aerospace industries with aerospace technologies that could be useful to them. Led by Jim's brother Tom Harford, this group brought representatives of major industries, such as the pharmaceutical and energy sectors, to NASA centers, where they gained hands-on familiarity with a broad range of technological capabilities.

One of the more interesting of these efforts led Jim into his long-term involvement with the international aerospace community. Tom and AIAA's director of international activities, Mireille Gerard, received an invitation from the Soviet Union's Ministry of Civil Aviation to acquaint the Soviets with U.S. air traffic control technologies — too many Aeroflot planes were involved in accidents. Although this was during the peak of the Cold War, a number of U.S. companies responded favorably to the prospect of a big new market, so AIAA set up and conducted a technical symposium and exhibit in Moscow.

Jim managed the whole operation, which involved a large delegation of AIAA staff as well as the relevant corporate members. A humorous incident occurred during our initial Moscow visit, when Jim, Tom, Larry Craner (AIAA exhibit manager), Mireille and I were being assigned our rooms at the enormous Rossiya Hotel. Jim objected to being assigned a double room with me. "I snore," he said. "I'm willing to pay extra for a single." Without batting an eye, the hotel clerk said, "Sorry. These are the only rooms available." Jim was incredulous. He looked from the corner desk down two halls, each over a hundred meters long. Not a soul in sight. (It was February, in Moscow!). But the clerk was adamant. "No rooms available," he insisted. We later guessed that the assigned rooms were the only ones the Soviets had bugged.

Jim's extensive contact with the Soviets developed further over the years via the congresses of the International Astronautical Federation, of which the AIAA was the U.S. voting member. His jovial, open mien was favorably received by the Soviets, even the KGB operatives who always accompanied their scientists to the IAF congresses. They liked his back-slapping style and respected the steel fist inside it. His good relations with the Soviets led to his learning Russian and eventually to his multiyear effort writing the definitive book on the early Soviet space program, "Korolev: How One Man Masterminded the Soviet Drive to Beat America to the Moon," published in 1997.

Jim and Mireille Gerard also negotiated two month-long visits to mainland China, shortly after the end of Mao's Cultural Revolution, when China's aerospace infrastructure was in shambles. By invitation of AIAA's counterpart Chinese society, two groups of about 20 AIAA members each visited key space and aeronautics facilities in 1979 and 1980 to "exchange mutually interesting information." Jim accompanied the first group, led by satellite communications pioneer Burt Edelson, to visit space facilities. The second group, covering aeronautics, was co-led by Norm Augustine, later elected an AIAA president.

Jim's decision to convert AIAA's staid magazine Astronautics and Aeronautics, or A&A, into a vibrant, broader-based instrument was a key factor in AIAA's development. He asked me to set it up, as publisher. A&A had relied wholly on articles contributed by AIAA members (engineers or scientists), was circulated only to AIAA members and only half-heartedly solicited advertising. It was more like a technical journal than a magazine. We picked the new title, Aerospace America, created a whole new design, extended circulation to the entire aerospace community (not just AIAA members), began to hire professional writers, expanded the advertising effort and incorporated the AIAA Bulletin into the magazine. Later, a digital version was introduced.

Jim Harford's cheerful good nature was an excellent cover for a remarkably astute management capability, and it is in good part due to him that AIAA is today such a strong and vibrant organization.

Jerry Grey is Aerospace America's editor at large.

UK, France study a single unmanned combat air vehicle

The U.K. and France, which have each been developing an unmanned combat air vehicle demonstrator, have agreed to pool their efforts and seek a single UCAV to serve both countries. The next step is a two-year feasibility, and in the meantime, both nations will continue their own UCAV program — the U.K. with its Taranis and France with the Neuron, which is being developed with cooperation from Italy, Greece, Spain, Sweden and Switzerland.

Taranis in flight.

BAE Systems

The French and U.K. governments awarded a £120 million ($191 million) contract in November to six companies — three French, three British — for a study into the feasibility of a Future Combat Air System to replace the Eurofighter Typhoons and Dassault Rafales in service in both countries. BAE Systems and Dassault have begun work on design of the air vehicle, Rolls-Royce and Safran/Snecma are studying engine options, and Selex ES and Thales are designing the electronics and avionics for an aircraft that could go into service around 2030. The contract follows a 2012 award to develop a demonstration program proposal.

While the Anglo-French study will bring together elements of both Taranis and Neuron, the industry partners could find it difficult to accommodate competing industrial and political interests so that work can move from the two-year study phase to a flying demonstrator.

"The two sides have slightly different interests," said Doug Barrie, senior fellow for military aerospace at the International Institute for Strategic Studies in London. "The U.K. has been largely concerned with technological issues. It has had a low-observable signature management research program underway since the late 1980s, which has evolved from inhabited to uninhabited platforms and from passive to active low-observable technologies. For the French much of their focus in this area has been on developing European industrial collaboration, something the U.K. is far less keen on."

Among the potentially contentious technical issues are how autonomous the vehicle should be and how it should work alongside manned aircraft. The Future Combat Air System concept will include new types of sensors, internal weapons carriage, air-to-air refueling and a low-frequency satellite communications system.

Neuron test flight.

Dassault Aviation

Political and economic issues could be even more problematic. Both governments recognize the need to retain national design expertise in advanced military aircraft technologies, in danger of waning following the end of development of the Eurofighter Typhoon and Dassault Rafale. But both governments are also under intense financial pressure and it is not yet clear whether an Anglo-French UCAV would be a better economic option than France developing its own solution — with support from European partners — or the U.K. deciding to team with the U.S.

Taranis has undergone two series of flight tests since August 2013. Ground-based tests aimed at refining design elements such as low observability, systems integration, control infrastructure and full autonomy are underway.

The Taranis industry team is led by BAE Systems and includes Rolls-Royce, the Systems Division of GE Aviation and QinetiQ, working alongside Ministry of Defense military staff.

Neuron development is led by Dassault Aviation and includes Alenia Aermacchi, Hellenic Aerospace Industry, Airbus Military, Saab and RUAG.

Meanwhile the U.K. government announced in July that the General Atomics Aeronautical Systems MQ-9 Reaper will fulfill the initial capability for a deep and persistent armed intelligence, surveillance and reconnaissance capability from 2018, one of the roles that Taranis, or its Anglo-French competitor, will be designed to fill in 2030.

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Supersonic business jet market: Boom or bust?

Airbus is teaming with Aerion to produce the AS2 supersonic business jet, shown in this artist's concept.

Several aircraft manufacturers are betting there is a market for civil supersonic air travel, but noise regulations could make it a tough sell.

In September, Airbus said it would collaborate with Aerion on the development of a supersonic business jet. Aerion, founded in 2002, is building the AS2, a 12-passenger jet the company says will have a top speed of Mach 1.6. Airbus's Defence and Space Division will provide technical and certification support to the project, and will assign engineers to Aerion's engineering center in Reno, Nevada.

"This agreement accomplishes two major objectives," Aerion Chief Executive Officer Doug Nichols said in an email. "It provides validation from the industry leader in aerospace innovation and it decisively kicks the program into high gear. Each company will benefit. Aerion moves quickly toward building a supersonic jet and Airbus Group gains exclusive access to more than a decade of successful research and proprietary high-performance aircraft technology."

The AS2 would cruise at Mach 1.4 over the sea. Over land in the U.S. it would cruise at Mach 0.95. Since 1973, due to concerns about sonic booms, civil supersonic flights have been forbidden over the U.S. European and many other countries allow supersonic flights over land, but they do not permit disturbances caused by sonic booms. Over those areas the AS2 would fly just below the speed of sound. The company says it is developing flight methods that would allow the plane to fly at up to Mach 1.2 while preventing a sonic boom from reaching the ground.

Gulfstream is another manufacturer doing research into supersonic aircraft. But the company says civil supersonic jets only make sense if they are permitted to exceed Mach 1 over land as well as sea. Gulfstream is researching ways to mitigate sonic booms and has spoken with FAA officials about relaxing the ban on supersonic flights, according to Steve Cass, the company's vice president of technical marketing and communications.

Despite the hurdles, the manufacturers believe there is a need for speed.

Gulfstream's G650, which entered service in December 2012, has a top speed of Mach 0.92.

"The feedback we have had is that most operators use the Mach 0.9 capability," Cass said. "Over the course of a year flying at Mach 0.9 rather than the traditional Mach 0.8 can generate savings of at least 50 flight hours. That's a significant value of time saving for passengers."

It also saves on crew and maintenance costs and preserves the aircraft's residual value, which is based on the number of hours flown, Cass said.

Aerion says the AS2 will cut six hours from some long-range flights. It expects the jet to enter service in 2021.

The supersonic speed advantages will be appealing to business-jet operators, according to a 2014 study by Rolland Vincent Associates, a Plano, Texas, aviation consulting firm.

"Our research suggests that there is a market for about 600 Aerion supersonic business jets over a 20-year period, based on our surveys and one-on-one meetings with large cabin owners and operators," said Rollie Vincent, the firm's president, in an email.

The firm forecasts that 40 percent of those sales will be in North America; Europe and Asia Pacific will account for 20 percent each; 10 percent will be in Middle East; and 10 percent will be in the rest of the world.

"Purchasers are intrigued by the potential for much faster mission times and are interested in range and cabin comfort," Vincent said. "Price will be an inhibitor to some, as will the inability to fly over land at supersonic speeds. There will be a strong first-mover advantage for the original equipment manufacturer, and customers are more than ready for this technology to be available."

A 2011 analysis by the German Aerospace Center (DLR) is not as optimistic. Noting that a supersonic business jet would be "the ultimate status symbol," the report says an annual demand of about 20 aircraft "does not seem unrealistic today and even less so for the future. Nevertheless, a sufficient demand is neither certain nor verifiable."

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Virgin Galactic moves forward with space tourism plans

The Virgin Galactic WhiteKnightTwo aircraft carries the SpaceShipTwo space plane during a test flight.

Virgin Galactic

After a fatal test flight failure that destroyed its suborbital space plane in October, Virgin Galactic is continuing toward its goal of building a space tourism business.

George T. Whitesides, chief executive officer of Virgin Galactic and The Spaceship Company, told an AIAA audience that the accident that destroyed SpaceShipTwo and took the life of copilot Michael Alsbury was "the toughest thing we could undergo," but "we are turning the corner and looking toward the future — our team and investors remain committed to the goal of opening space for all."

George T. Whitesides

AIAA

Work on a second SpaceShipTwo is underway, Whitesides said. The Spaceship Company, the Virgin-owned manufacturer, is "two-thirds done on the systems, and while we have a lot of work to do, 'weight on wheels' is now in sight," he said.

The current build will factor in any recommendations from the National Transportation Safety Board stemming from its investigation of the accident, Whitesides said. In initial findings, investigators determined that, shortly after SpaceShipTwo was released from its carrier plane, Alsbury prematurely unlocked the twin tail booms, which were designed to rotate upward and slow the vehicle. The booms rotated after being unlocked, even though a separate command was supposed to be necessary to move them, and aerodynamic forces tore the craft apart. Pilot Peter Siebold was thrown clear of the damaged craft and survived.

Construction of a third space plane will begin later this year, Whitesides said.

"We want to give our engineers a chance to learn as they go through the vehicles," he said. "We want to build them quickly but we want to build in lessons from One and Two into Three."

The company is also proceeding with development of the LauncherOne small-satellite launch vehicle, which, like SpaceShipTwo, would be deployed from the WhiteKnightTwo dual-fuselage jet aircraft. Using a two-stage liquid oxygen RP-1 engine, LauncherOne "is designed to have the lowest discrete cost of any U.S. [launch] vehicle," Whitesides said.

Discussing the role of risk in developing new aerospace systems, Whitesides said "many of the public and press seemed to misunderstand the nature of testing. We test to understand and improve new systems. Failure is not fortunate, and in our case tragic, but it's part of the deal."

Minimizing risks means putting together diverse teams, he said, with a liberal sprinkling of "graybeards who have a sense of where and when it's OK to take risks."

If the risks are often great, so are the potential benefits.

"Understanding space is crucial to save our planet, to solve its greatest challenges, and bringing people into space will help connect people to the Earth in ways not possible now," Whitesides said. "We will also see advances in vehicles, which are the key to the solar system. We are undeterred in our commitment to these goals. We have another spaceship at hand and we are hard at work on LauncherOne. And we will succeed."

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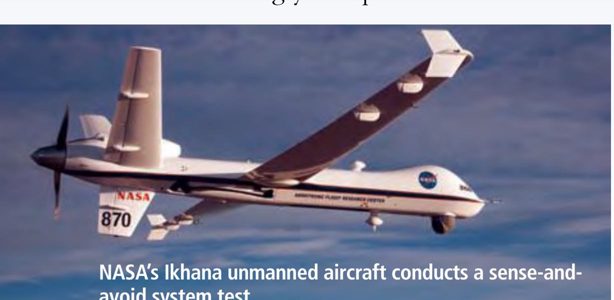
NASA sees an autonomous future for aviation

The next 20 years will see operations in the increasingly complex National Airspace System relying more heavily on autonomous systems — in cockpits, in air traffic control towers and on board unmanned aircraft.



NASA's Ikhana unmanned aircraft conducts a sense-and-avoid system test.

NASA

Assured autonomy, as NASA calls it, will allow operations that would otherwise exceed the limits of human cognitive performance, said John Cavolowsky, director of the Airspace Operations and Safety Program at NASA's Aeronautics Research Mission Directorate.

"Autonomy overcomes the limits and enables performance that will exceed our abilities," he said. "We know this from the history of technology."

Autonomous aircraft could be certified for operations in the NAS by 2035, said Doug Rohn, director of the Transformative Aeronautics Concepts Program at the mission directorate.

Over the next two years, NASA

Engineers urged to hone business skills

If aerospace engineers hope to keep up with ever-increasing demands for innovation within tight budgets, they'll need to acquire some new tools: business acumen and negotiation skills.

An industrywide "push for innovation" is creating a demand for "technical advancement in a hurry, wherever you're at," said Andy White, director of the University of Tennessee's Aerospace & Defense Business Institute, adding that engineers are being "asked to do it with business savvy and more limited resources than [ever] before."

"Today in the acquisition environment, the game has changed," said Bobby Smart, the Air Force's deputy assistant secretary for acquisition integration. Driving the change, he said, are the "budget pressures that we in the Pentagon are living with today," which means "managing cost is really paramount."

Smart said that while engineers may have great technical expertise, many lack the "business knowledge aspect of managing a program." Acquiring that "savviness," he said, would help engineers understand their colleagues on the business side — "their motivation, why they negotiated the way they did, and have a better appreciation for how to live in this changing environment and work with our industry partners."

Agreeing that "the world has changed," Jeff Babione, vice president and deputy general manager of Lockheed Martin's Joint Strike Fighter Program, said, "industry recognizes the pressure sequestration and … the geopolitical environment has put on our primary customer, the Department of Defense." In response, the company has moved toward pursuing innovation "to solve what necessarily wasn't a technical issue, but now is an affordability or cost issue."

In this new world, finance must be a common language, said Alex Miller, director of the Consortium for Social Enterprise Effectiveness at the Haslam College of Business.

"It turns out that we've got a lot of engineers who have major responsibilities for cost and financial performance who don't really have a very good understanding of what it is that drives financial performance and cost," Miller said.

Engineering principles are "black and white," said NASA Associate Administrator Robert Lightfoot. "The applications of those principles are where it becomes gray, and that's where you have to have a little of this business acumen."

Lightfoot said the engineers who make good program project managers are usually good systems engineers — "the people who can see across a broad spectrum."

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will continue an "intense schedule" of work and testing in the effort to integrate unmanned aircraft in the U.S. civil airspace, said Ed Waggoner, director of the agency's Integrated Aviation Systems Program.

"We finished human in the loop, finished initial flight tests, and we are making good progress toward the roadmap's goal," he said.

The work includes studying whether unmanned aircraft could perform specific operations on their own, such as monitoring forest fires and precision agriculture tasks.

In addition to such practical applications, the quest for autonomous aircraft dovetails with NASA's mission to conduct basic and applied aeronautics research, said Jay Dryer, director of the Advanced Air Vehicles Program at the Aeronautics Research Mission Directorate. **Duane Hyland**
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SciTech 2015

"It turns out that we've got a lot of engineers who have major responsibilities for cost and financial performance who don't really have a very good understanding of what it is that drives financial performance and cost."

Alex Miller, University of Tennessee's Haslam College of Business

"NASA sees working with its international partners as a way to reduce risks and solve pressing technology problems to make Mars exploration a reality by 2024."

David Miller, NASA's chief technologist

"Improving diversity in the aerospace community, and closing the existing educational achievement gap between whites and minorities, would boost the American economy by $2.3 trillion dollars by 2050."

Wesley Harris, Massachusetts Institute of Technology

"This technology has an opportunity to really transform not only the way we manufacture parts, but the way we design parts."

Mark Shaw, GE Aviation, on additive manufacturing or 3-D printing

"[If designers run] every single test via computational fluid dynamics to avoid wind tunnel use, you end up expending as much power as you would using the wind tunnel."

Robert Gregg, Boeing Flight Sciences

Report: Webb telescope schedule faces risks

Work on the James Webb Space Telescope is on schedule and on budget, NASA reports, but the Government Accountability Office said there is little margin for error in the program as it nears its scheduled 2018 launch.

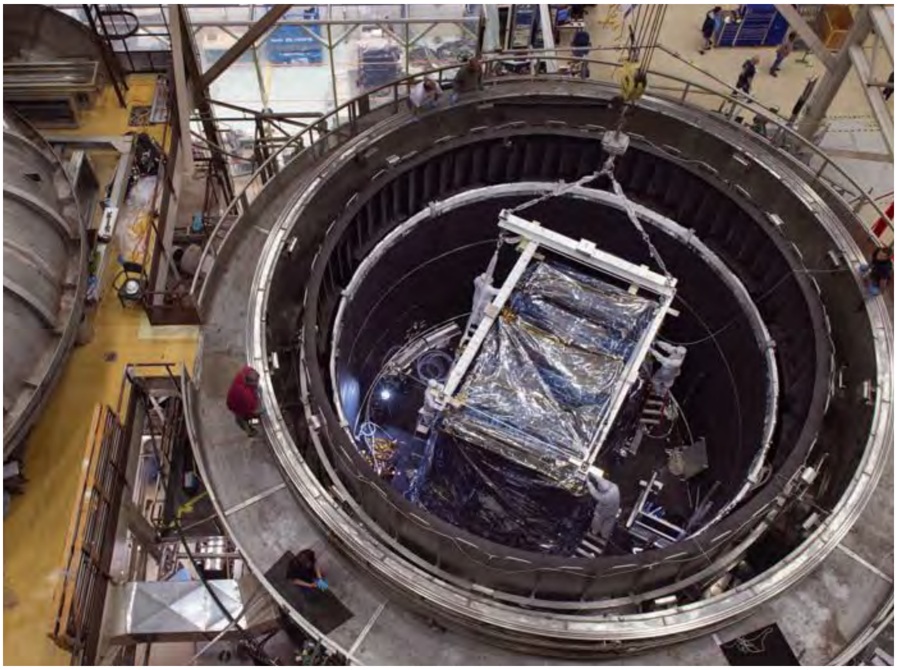
In 2014, delays caused reductions in the schedule reserves for elements and major subsystems of the telescope, GAO said in a December report. A schedule reserve is the extra time built in to a schedule to allow for unanticipated technical problems.

A "critical path" for a program is determined by the element or subsystem with the least amount of schedule reserve, GAO said. For the Webb project, the current critical path is 11 months, down from 14 months in 2013.

"Any delay to an activity that is on the critical path will reduce schedule reserve for the whole project, and could ultimately impact the overall project schedule," GAO said.

Although an 11-month reserve exceeds the standards of NASA's Goddard Space Flight Center, which is managing the program, GAO said maintaining an adequate time reserve is important because the telescope is "one of NASA's most complex and expensive projects, at an anticipated cost of $8.8 billion."

In 2011 Goddard factored in additional schedule reserve for the Webb program and has no plans to adjust it, NASA spokewoman Felicia Chou said in an email. For most projects three years from launch, the recommended reserve is seven months, she said. Because the Webb project requires lengthy cryogenic tests, "in 2011 we re-baselined the project to carry additional schedule margin," she said. "That plan would have us carrying about 9.5 months of margin at this stage in development. Currently, we are carrying 11 months of funded schedule margin and thus, have even more than the 2011 re-baseline plan."



NASA

The James Webb Space Telescope's science instrument module undergoes cryogenic vacuum testing at NASA's Goddard Space Flight Center in Maryland in 2014.

Named for a former NASA administrator who oversaw the Apollo moon program, Webb is intended to search for Earth-like planets and increase knowledge of how the universe was formed. Equipped with a 6.5-meter-diameter primary mirror and orbiting 1 million miles from Earth, it is designed to be 100 times more sensitive than the Hubble Space Telescope, which has occupied low-Earth orbit since 1990.

2015 highlights for the project, NASA said, include beginning assembly of the optical telescope element, which will serve as the observatory's eyes, and conducting vibration tests of the four-instrument science module, which will detect light from distant galaxies. The telescope assembly and vibration tests take place at NASA's Goddard Space Flight Center in Maryland.

The telescope will comprise 18 hexagonal mirrors made of beryllium metal coated with gold to capture faint infrared light. Goddard has been preparing for the assembly process with a prototype telescope.

The vibration tests of the science instrument module will simulate the rigors of launch. The module has already undergone cryogenic vacuum tests to ensure it can withstand the frigid temperatures of deep space.

Other major activities for Webb this year include continued construction of the spacecraft bus and the tennis-court-sized sunshield at prime contractor Northrop Grumman's facilities in California, and tweaking equipment that will be used to test the mated telescope and science instrument module at NASA's Johnson Space Center in Houston.

Webb is scheduled to lift off in October 2018 aboard an Ariane 5 rocket from the European Spaceport in French Guiana.

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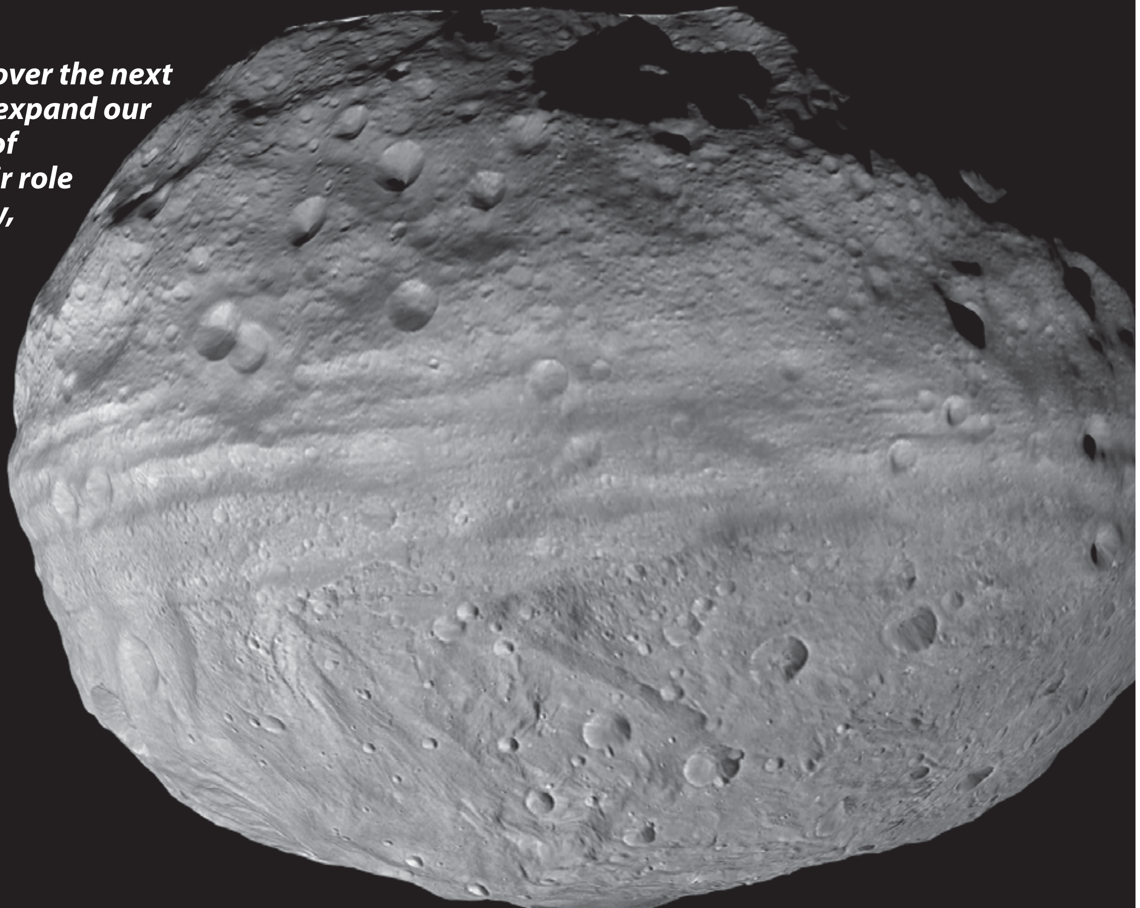
NASA

Asteroids in the crosshairs



Space missions over the next 10 years aim to expand our understanding of asteroids — their role in Earth's history, the potential treasure they hold, how we might avert a catastrophic collision. Astronaut Tom Jones looks at plans to pry secrets from asteroids, including Ceres in March.

Vesta, the third largest object in the asteroid belt, was photographed in 2011 by the Dawn spacecraft. Dawn departed Vesta in September 2012 and is set to rendezvous with the largest asteroid in the solar system, Ceres, in March.

They hold mineral wealth estimated to be in the trillions of dollars. They preserve the environmental and chemical conditions prevailing at the dawn of the solar system. It's likely they delivered the water that filled the young Earth's oceans. Only in the last 50 years did we learn that these orbital orphans have repeatedly altered the evolutionary course of life on Earth — and absent action we take in space, will do so again.

They are the asteroids, and for the next decade they will come under intense scrutiny. Three exploration craft will venture to asteroids by 2024, testing anchoring and sampling techniques, gathering ancient or even pre-solar organic material, prospecting for potential space resources, and demonstrating how we might nudge a future rogue asteroid from a collision course with Earth.

NASA's Science Mission Directorate is currently running two robotic exploration missions to asteroids. They are Dawn, which is deep into a decade-long mission to the main asteroid belt between the orbits of Mars and Jupiter, and the Origins Spectral Interpretation Resource Identification Security Regolith Explorer, or OSIRIS-REx, slated for launch in 2016.

Vesta revealed

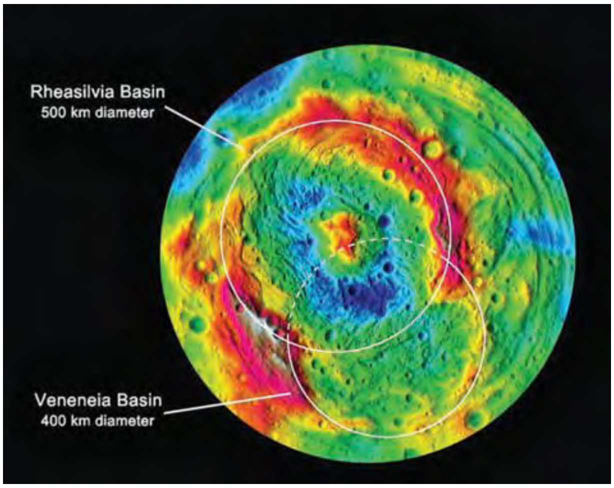
Dawn conducted an intense, 14-month scrutiny of main belt asteroid 4 Vesta. Before it left Vesta in September 2012, the ion-propelled probe revealed the asteroid as a complex mini-world, its rough, varied terrain more similar to the Moon, Mercury and the outer planet satellites than the battered, inactive surfaces of most asteroids.

As seen in a geologic map released by Dawn's science team in November, the most prominent feature on Vesta is a giant impact basin, Rheasilvia, 500 kilometers across and 19 kilometers deep. Rheasilvia dominates the entire southern hemisphere; the impact that formed it excavated 1 percent of Vesta's volume and ejected large fragments into solar orbit, while carpeting Vesta's surface with debris. The survival of these fragments from the collision, up to 10 kilometers across and compositionally linked to Vesta, indicates the impact occurred as late as 1 billion years ago.

Dawn's orbital gravity data and detailed mapping of Vesta's impact basins suggest that the asteroid, which is 525 kilometers in diameter, has a crust about 10 kilometers thick, a rocky mantle (like Earth's) and a nickel-iron core about 220 kilometers across. Vesta underwent intense early heating and was large enough to have differentiated: Molten, dense metals sank to the core, while lighter silicate minerals separated into mantle and crust.

Dawn's cameras revealed localized, pitted terrain where dark material seems to have been freshly exposed at the surface. Dawn's instruments identified the material as water-bearing silicate minerals, like those found in carbonaceous chondrite meteorites. Dawn also spotted sinuous gullies on the walls of several young craters, ending in fan-shaped deposits on the crater floors. Could the water and gullies be related?

Chris Russell, the mission's principal investigator, told me in an email exchange that evidence for water erosion on Vesta's airless surface is the mission's most surprising discovery:



A topographic map of the asteroid Vesta generated with data from the Dawn spacecraft shows two large impact basins in the southern hemisphere. Rheasilvia, the largest impact basin, was formed about 1 billion years ago, and Veneneia is at least 2 billion years old. In the map, red indicates higher areas and blue lower areas.

"Because we expected that Vesta had once been almost completely melted, and because it is very small, [we thought] it would be very dry. But when we looked at several of the more recent large craters, we found evidence for gullies with interconnecting networks that looked like they had once carried flowing water down the crater walls. There were the expected deposits of material at the end of the gullies, as you might have on earth at the end of a river — like a delta. There was evidence on the crater floors of the floor once being wet."

The fresh-looking gullies, says Russell, suggest that even today one might find ice under the surface, like terrestrial permafrost, releasing meltwater when a small asteroid strikes the surface. To be sure, water flowing on a once-molten, airless asteroid is a controversial proposition that Dawn scientists are still debating.

Vesta was once thought to be a rare protoplanet — the building blocks for larger worlds like Earth — that survived the chaotic formation of the early solar system and 4.5 billion years of subsequent collisions. But Dawn's revelation of Vesta's multiple giant impacts, prominent shock-induced grooves and debris deposits suggest that it is probably a composite body — blasted, shattered and then reassembled to include fragments of colliding asteroids.

Russell admits that "our early ideas about Vesta were too simplistic." He says a "sophisticated process" appears to drive formation and evolution of small planets. "Perhaps then the biggest surprise was how much Vesta resembled her larger brothers and sisters, including Earth."

On to Ceres

The Dawn team is now intent on a rendezvous with the solar system's largest asteroid, the 950-kilometer-diameter dwarf planet 1 Ceres, in March. By mid-March, Dawn will be some 75,000 kilometers from Ceres, and its framing camera is already seeing Ceres more clearly than the best Hubble images.

Ceres is thought to be composed of rock and ice with a rocky core. Hydrated minerals and frost have been detected on its surface by Earth-based telescopes. Lucy McFadden, a physical scientist at Goddard Space Flight Center and a Dawn co-investigator, tells me that Ceres's water-rich composition could mean lots of surprises: "Will we see traces of recent liquid water flows, as on Vesta? Will eruptions from the wa-

NASA

OSIRIS-REx, shown in an artist's rendering, will extend an arm to collect up to 2 kilograms of regolith from the near-Earth asteroid Bennu and return the sample to Earth.

ter-rich mantle have resurfaced parts of Ceres?"

She hopes that Dawn will be able to map surface vents that might be the source of water vapor detected by the Herschel space telescope in early 2014. "We would like to find those sources, but it won't be easy. Other spacecraft have had a big challenge identifying the source of vapor jets streaming from a comet's surface," she says.

The past few months of Dawn's approach to Ceres have been anything but routine. On Sept. 11, the spacecraft sustained a pair of radiation-induced single event upsets that shut down its ion engines and affected attitude control. For 95 hours, Dawn was unable to thrust toward its Ceres rendezvous, but the team recovered the spacecraft from safe mode, redesigned its capture trajectory and resumed thrusting.

Marc Rayman, Dawn's chief engineer and mission director, tells me via email that "the team did an outstanding job with a very challenging situation. We resolved both [anomalies] and returned to routine ion thrusting in four days. The mission is, to a large extent, entirely unaffected. That's part of the beauty of ion propulsion."

Following a looping approach toward Ceres after its March capture, Dawn should reach its initial, 13,500-kilometer mapping orbit by April 23. Rayman said Dawn's systems are healthy and ready for action at Ceres, but — and this is a significant "but" — two of Dawn's four reaction wheels have failed; these provide the primary means to point the spacecraft.

"For many missions, losing two could have dire consequences, but we have been able to devise plans that will allow us to complete all Ceres objectives regardless of the health of the wheels. That is, we are not even dependent on the two remaining wheels. We have what I like to call a zero-reaction-wheel plan," says Rayman.

Chris Russell, the Dawn principal investigator, is eager to dig into Ceres's mysteries: "We have very little knowledge of what to expect. There are no meteorites that came from Ceres to guide our thinking. Everything will be a surprise.... [The] moons of Saturn can help our thinking process, but none is a good analog for Ceres."

Timely experience

Japan launched its Hayabusa 2 probe on Dec. 3. Its target is near-Earth asteroid 1999 JU3, a dark, C-type object, thought to be similar to carbonaceous chondrite meteorites; it appears to harbor water-bearing silicate minerals. In 2018, after mapping the asteroid, the probe, whose name in Japanese means falcon, will deliver four small landers and fire a penetrator to gouge a crater and expose fresh bedrock.

Samples will be collected by touching down briefly at three locations, firing tantalum bullets into the surface to blast debris upward into separate collection chambers. Hayabusa 2 will depart the asteroid in 2019 and a re-entry capsule will deliver the samples to Earth in 2020.

NASA meanwhile is pressing ahead on its own asteroid sample return mission, OSIRIS-REx, slated for launch in September 2016. The mission is designed to explore the 500-meter-diameter near-Earth asteroid Bennu. A dark, possibly water-bearing asteroid, Bennu's spectral similarity to carbonaceous chondrite meteorites suggests it may preserve grains that predate the solar system's formation. After a mapping phase in 2018, OSIRIS-REx will descend for a touch-and-go landing using its pogo-stick-like sampler arm. When the arm's sampler head touches the surface, a jet of pure nitrogen will fluidize and push at least 60 grams of regolith into the sample chamber. Surface contact pads on the arm's exterior will also collect fine-grained material at touchdown to supplement up to three gas-driven sampling attempts.

OSIRIS-REx could gather up to 2 kilograms of the asteroid for return in 2023. NASA and the Japan Aerospace Exploration Agency have agreed to exchange samples from their respective missions, enhancing the study of these two objects, which may have formed in different regions of the asteroid belt.

Results from these ambitious asteroid missions will open a promising frontier in our space exploration future. Dawn, Hayabusa 2 and OSIRIS-REx should teach us how to identify water-rich objects in the inner solar system, boosting prospects for eventual use of that invaluable resource. Extensive robotic operations around asteroids will improve our chances of warding off a rogue Earth-impactor and pave the way for complex astronaut operations on small bodies like the Martian moons Phobos and Deimos.

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Video from GEO

A team led by Ball Aerospace figured out how to generate images by diffracting light through thin membranes of plastic. Someday, a 20-meter-diameter telescope made this way could look down from geosynchronous orbit to track vehicles or into space to characterize the atmosphere of exoplanets. Will scientists or the Pentagon adopt the technology? Ben Iannotta looks at the breakthroughs and challenges of the MOIRE program, short for Membrane Optic Imager Real-time Exploitation.

Engineers at Ball Aerospace had good reason to root for a dry summer along Colorado's front range in 2014. Inside a non-humidity-controlled room dubbed "the hangar," they had erected a set of six translucent plastic membranes held taut by aluminum frames. Their plan was to project a previously acquired image of Earth onto this membrane, a diffractive optical element, as if the element were looking down on Earth from geosynchronous orbit. The goal was to prove that a picture could be generated by a set of optics and a detector located 27 meters away. In space, these aft optics would be supported behind the primary element by a set of booms.

Generating images by diffracting light through membranes was a radical idea, and one that the Ball team began exploring for the Defense Advanced Research Projects Agency in 2010 under a program called MOIRE, for Membrane Optic Imager Real-time Exploitation.

Spy satellites typically look at Earth or peer into the cosmos by collecting light with carefully shaped and polished mirrors. This light is reflected onto a set of optics and detectors. The catch is that the mirrors must be supported by structures to keep them aligned and focused. The resulting mass is one factor limiting the size of apertures that can be launched by rockets. Using plastic membranes just 20 microns thick would open entirely new space telescope applications, Ball officials say. They're also careful not to oversell the technology. Because diffraction patterns must be tuned to narrow bands of wavelengths, a telescope made with plastic membranes will never replace the glass or metal variety. DARPA's main reason for supporting the research was the possibility that it could lead to a telescope large enough to produce black-and-white videos of vehicles moving across Earth's surface from geosynchronous orbit 35,000 kilometers above Earth. Unlike low-Earth-orbit satellites, such a spacecraft could stare continuously.

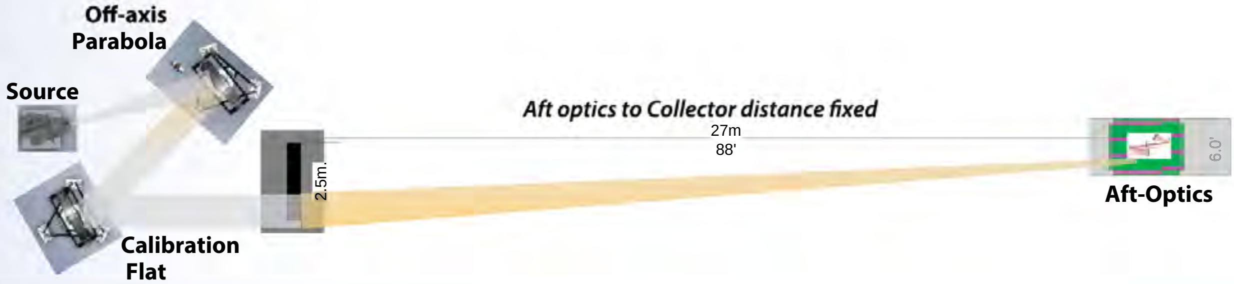
The membranes had one potential Achilles' heel in the ground demonstration at Ball. The hangar was not a vacuum chamber, and so the optics would be exposed to humidity. That was a problem, because engineers knew the material was prone to absorbing water.

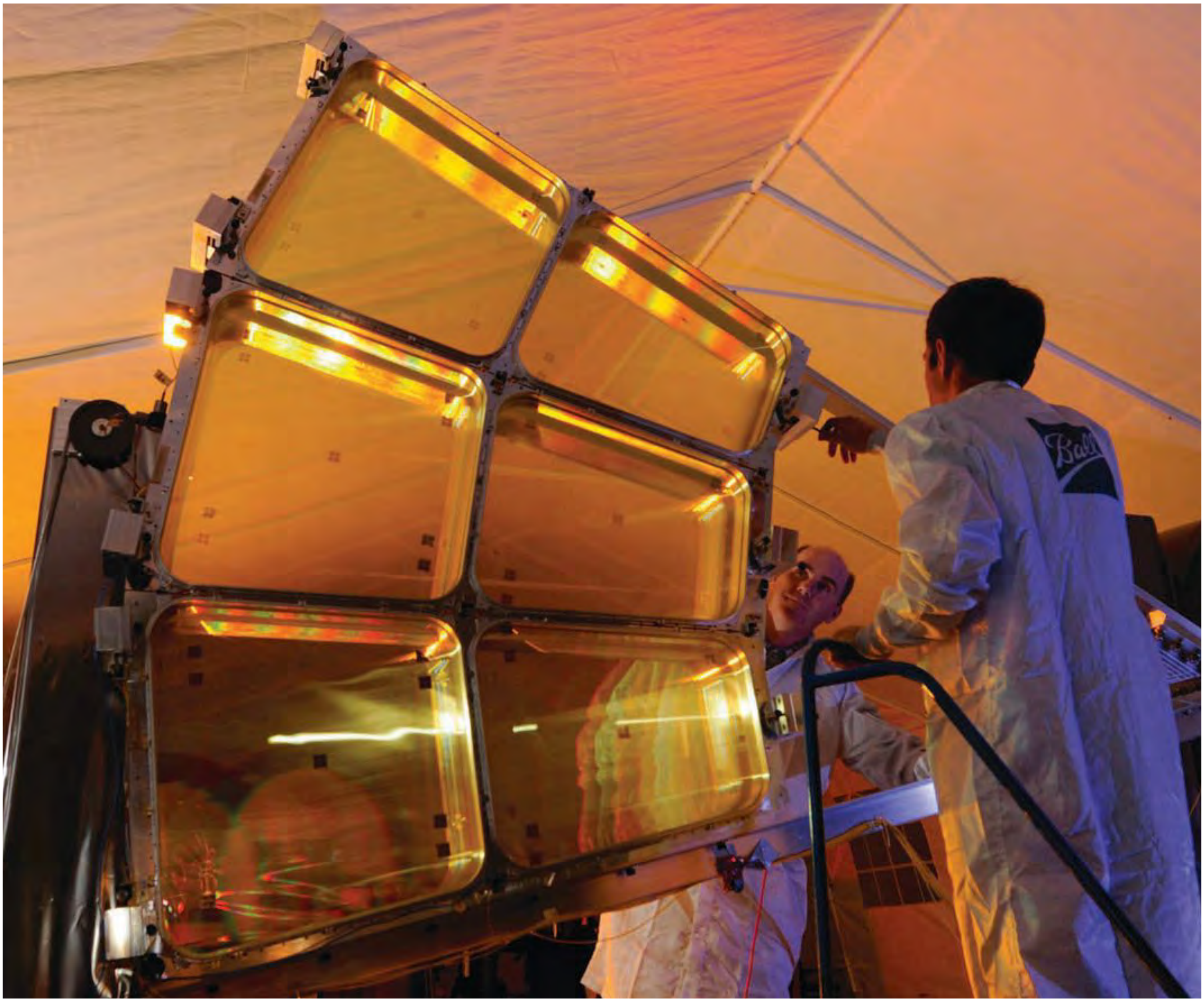
Sure enough, when they projected still images acquired by a WorldView satellite onto the membranes, the image quality was degraded by atmospheric turbulence inside the hangar and by the water absorption.

The images came through less

Simulating the view from geosynchronous orbit

The MOIRE program culminated with a 2014 test inside a Ball Aerospace facility in Boulder, Colorado. The source below projected a previously acquired image of Earth through a lens made of membranes to simulate the lens looking down from geosynchronous orbit. The Aft-Optics produced images.





Ball Aerospace

For a test of lightweight optical technology, Ball Aerospace engineers erected a set of six 20-micron-thick diffractive optical elements on a frame to represent one-eighth of a 5-meter-diameter membrane telescope.

clearly than hoped, but they came through. The team is upbeat about the achievement. "We put [the membranes] together with the aft optics. We actually built the camera end, the detector end, and we got images out," says Ball's Jeanette Domber, a deployable structures expert and the company's MOIRE program manager. "I'm not aware of anybody else who's done that with an end-to-end telescope that has a membrane primary," she adds.

DARPA, per its usual process, supported the technology development and has now moved on. Ball is trying to find a government agency or scientific organization to pick up the technology, help refine it, and ultimately launch a membrane telescope into space. Ball officials say such a telescope could be used for anything from monitoring methane in Earth's atmosphere to characterizing the atmospheres of exoplanets to receiving scientific data beamed back optically from deep space.

"We've been talking with a number of folks, and there's definitely a lot of interest in the technology," says planetary astronomer Makenzie Lystrup, who is in charge of Ball's business development for the MOIRE technology. "I think it's just a matter of figuring out how to transition" the technology.

The objectives of such a spacecraft would probably be specific, given the narrow band.

"Because you have the large aperture, and a good angular resolution, you might be able to look at maybe a specific planet that [the Kepler Space Telescope] has identified and try to characterize the atmosphere, or just look and see if there's water there," Domber says.

An early challenge for the MOIRE team was to find the right material for the membranes. They had to support the diffractive patterns etched into them without deforming.

"Since the spacing of the diffractive edges sets the operational wavelength, any change in those dimensions due to thermal effects [on the membranes] changes the operating wavelength, defocusing the image," Domber says. "We chose [the Novastrat polyimide] because we can tailor the properties of it, specifically the coefficient of thermal expansion to be what we want it to be for the entire system to work properly."

Novastrat was supplied by NeXolve Corp. of Huntsville, Ala.

Another key factor was the etching process, whose development was led by Lawrence Livermore National Lab in California. Before the MOIRE program, the state-of-the-art diffractive etching process was an entirely different approach also pioneered by Livermore. Under a program called Eyeglass, Livermore figured out how to draw diffraction patterns onto glass by controlling a liquid etchant through fluctuations or gradients in surface tension, called the Marangoni effect. In 2002, the Eyeglass team built a 5-meter-diameter diffractive prototype lens made of 72 segments for optical testing, according to a report on the project.

There was a big architectural challenge for the Eyeglass team, though. Their diffraction patterns resulted in long focal lengths, too long for even deployable booms to accommodate. The Eyeglass telescope concept therefore called for launching two discrete spacecraft separated by a few kilometers, with one spacecraft carrying the primary collection element.

"When most people hear that you're looking at a diffractive system for imaging, this is the system that they're thinking about," Domber says. "We were able to come up with a design that you could fit on a single spacecraft and in optical terms is relatively fast in comparison."

The key was the new etching technique devised at Livermore, which allowed for finer diffraction patterns and shorter focal lengths. Using a master pattern, an ion tool etches complex patterns into photoresist material applied to the membranes. "That same glass master is used to make a bunch of membranes with this pattern on it over and over again, which is why it's cheaper — or one of the reasons why it's cheaper — compared to polishing a glass optics," Domber says. "About 1 to 2 microns of material is etched away from the surface, and that's what creates the diffractive pattern on the membrane."

Finer patterns meant shorter focal lengths. Instead of the primary element being kilometers away from the focal plane, it would be 50 meters away, supported by three foldable, deployable booms devised by ATK.

A 50-meter boom and 20-meter membrane telescope — the size DARPA wants someday for video — is still too big to fit inside a rocket shroud. So, the MOIRE team came up with a concept to fold up the booms and membrane segments, and rely largely on their stored energy to deploy them.

"Once the launch locks are released, because of the strain energy in the system, [the primary] wants to deploy to a flat state," Domber explains.

The booms also want to be in their deployed state, she says. Inside the rocket, "they compact down into a footprint less than 2-feet tall and they're going to deploy out 160 feet," she says. They're deployed with the aid of a motor and lanyard. Once in place, "they're very stiff. They have good thermal properties. They can carry cabling with them, and they're very reliable," she adds.

If all goes as Ball hopes, the MOIRE team will get to prove this technology in space.

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Marking 100 Years of American flight research

NACA to NASA

Compiled by Edward Goldstein

About a decade after the Wright brothers' flight, Americans were losing aviation ground to British, French and German aeronautical laboratories. The Europeans were leapfrogging the progress of the United States through a mix of government and private funding, and inspiration provided by the Great War, which erupted in 1914. The Smithsonian Institution's regents recommended in February 1915 that Congress establish a National Advisory Committee for Aeronautics, based largely on the similarly named British organization.

On March 3, 1915, Congress acted, setting aside funds in the Naval Appropriations Act for a new organization that would "supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions."

From a modest $5,000 allocation by Congress, NACA emerged as the pacesetter for practical civil and military aviation research and provided the foundations for the U.S. space program.

1915
The first meeting of the National Advisory Committee for Aeronautics.

This early history is sometimes overshadowed by NASA's space triumphs following its founding in 1958 and absorption of NACA, but in March, NASA will recognize its aeronautical roots and ongoing research by celebrating the 100th anniversary of the organization that spawned it.

In its day, NACA attracted some of the nation's brightest thinkers and boldest doers. There was engineer Richard Whitcomb, who helped pioneer supersonic flight; and Maxime Faget, who eventually would conceive development of the one-person spacecraft used in Project Mercury; and there were of course daring test pilots like Neil Armstrong.

NACA encouraged its engineering staff to take on esoteric projects, and as a result they basked in the glow of five Collier Trophies. "NACA nuts" was the term bemused neighbors of NACA's first facility, the Langley Memorial Aeronautical Laboratory in Hampton, Virginia, used for the researchers they encountered. NACA would go on to establish the model for productive government-industry partnerships and lay the geographic template for today's NASA. Pioneering wind tunnel research was done at the Langley lab, now NASA's Langley Research Center, and at NACA Ames Aeronautical Lab, now NASA's Ames Research Center. Propulsion and icing studies were done at the NACA Flight Propulsion Research Lab near Cleveland, now NASA's John H. Glenn Research Center. High-speed aircraft testing was done at the NACA Muroc Flight Test Unit at Edwards Air Force Base, California, now NASA's Neil A. Armstrong Flight Research Center. Research and testing at these sites made passenger flight safer and more efficient and contributed to U.S. air power dominance in World War II.

Today a few surviving members of the NACA team gather occasionally for reunions in the cities that housed the NACA centers.

Birth of the black box — This 1933 memo cleared the way for NACA's V-G — velocity-gravity — recorder to be installed on commercial aircraft. During flight, a stylus would etch a pattern on a small piece of glass that had been coated with soot by holding it over an oil lamp. The pattern showed changes in acceleration and deceleration and the speeds at which they occurred. The recording could span hundreds of hours of flight time. The device was developed as a research tool but also proved useful in some accident investigations. U.S. aviation regulators used V-G recordings to establish the design criterion of 55-feet per second "effective gust velocity," leading to safer airplane designs.

From NACA
To LMAL

Washington, D. C.,
April 5, 1933.

Subject: Research authorization on study of load and load distribution on commercial type airplanes.

Reference: LMAL letter, March 15, EWM.DD, paragraph 2.

APR 7

1. Consideration has been given to the question of reference as to the suitability of continuing to charge to Research Authorization No. 287 the work on the study of load factors and gusts on commercial airplanes in actual transport operation by the use of the N.A.C.A. V-G recorder.

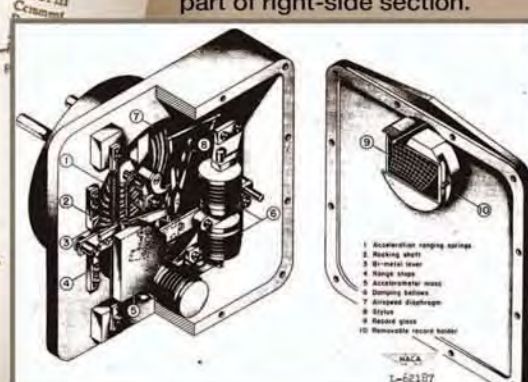
2. In view of the fact that the work the Committee is actually doing on this problem at the present time comes within the scope of the title and purpose of the investigation as stated in the research authorization, it is believed unnecessary to request a new authorization or an extension of No. 287 to cover the very different procedure being followed in conducting the investigation. Since it was not possible at Langley Field with the Fairchild cabin monoplane to obtain information regarding the load factor on commercial airplanes under the varying conditions encountered in actual operation, approval was given by this office, as within the scope of administrative discretion, to the extension of the procedure to airplanes in operation in commercial air transport and the study of accelerometer and V-G recorder records obtained in such operation.

G. W. Lewis,
Director of
Aeronautical Research.

CW/NW

Langley Memorial Aeronautical Lab in Virginia, now known as NASA's Langley Research Center.

Cutaway drawing of a V-G recorder. The device, which measures 4.5-by-4.5-by-2.75 inches, includes a soot-coated recording glass on the upper part of right-side section.



George W. Lewis wasn't shy about exercising "administrative discretion" to advance technology. Here, he uses it to get an early data recorder onto commercial planes. NASA's Ohio field center carried his name until 1999, when it was renamed the Glenn Research Center at Lewis Field.

High-level attention

Visiting NACA facilities became a way for a succession of U.S. presidents to signal to voters and business leaders that they were determined to keep the country on the cutting edge of aviation development. NACA was founded in 1915 during the administration of President Woodrow Wilson with funds from Congress, and led the country's aviation research until the administration of President Dwight D. Eisenhower. NACA was absorbed into a new agency, the National Aeronautics and Space Administration, in 1958.

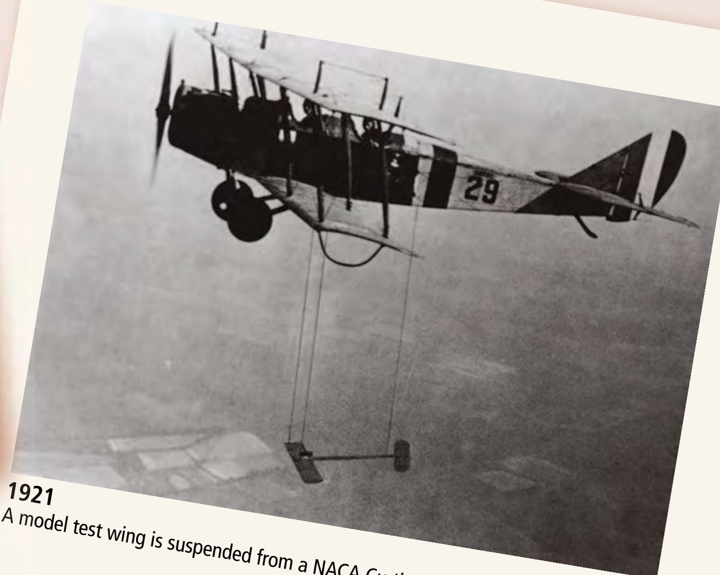
1929
On the south lawn of the White House, President Herbert Hoover, at left, presents the 1929 Collier Trophy to NACA Chairman Joseph Ames and members of a team that developed a low-drag streamlined cowling for aircraft engines. The trophy is named for aviator and publisher Robert J. Collier.

1940
President Franklin D. Roosevelt, in the rear seat, visits NACA's Langley Memorial Aeronautical Lab in Virginia. Back when NACA was proposed by the Smithsonian Institute and Congress in 1915, Roosevelt was acting secretary of the Navy. He wrote to the chairman of the House Committee on Naval Affairs to say he "heartily [endorsed] the principle" on which the NACA legislation was based.

1946
The recently victorious Supreme Allied Commander General Dwight D. Eisenhower gives a vigorous thanks to the staff of the Aircraft Engine Research Lab in Cleveland for improving the performance of U.S. military aircraft during World War II. In the background is lab Director Edward Sharp.

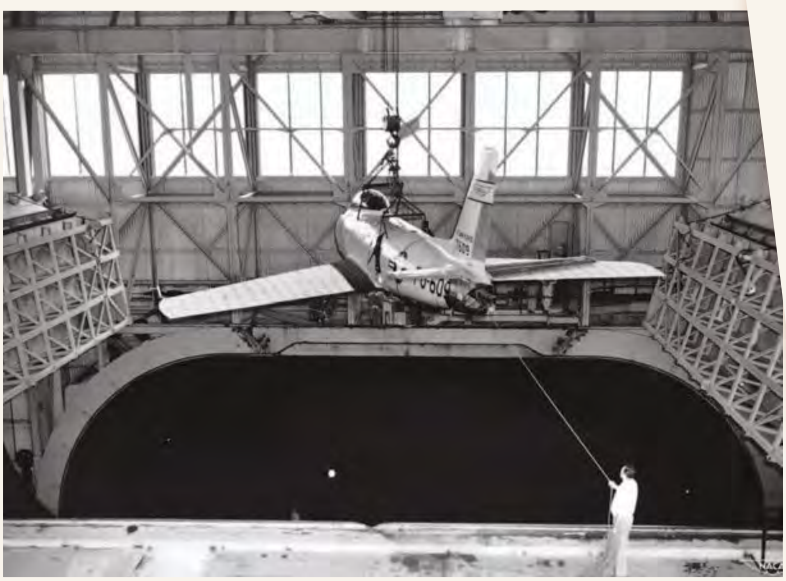
1946
President Harry Truman presented aviation's Collier Trophy to Lewis Rodert, chief of the Flight Research Branch at the Aircraft Engine Research Lab in Cleveland, for his work in thermal de-icing systems for aircraft. The engine lab was eventually renamed the Lewis Fight Propulsion Lab, after NACA's first executive director, George W. Lewis.

1949
A technician works on the Analog Computing Machine at the Lewis Flight Propulsion Laboratory in Ohio.



1921
A model test wing is suspended from a NACA Curtiss JN-4 "Jenny."

NACA research through the years



1954
An F-86 aircraft is lowered into the 40x80 Foot Full Scale Wind Tunnel at the NACA Ames Aeronautical Laboratory at Moffett Field, California.

1927
Elton W. Miller, chief of aerodynamics at Langley Memorial Aeronautical Laboratory, stands in the Propeller Research Tunnel during studies on a Sperry M-1 Messenger, the first full-scale plane tested in the tunnel.

1922
The Variable Density Tunnel, the world's first pressurized wind tunnel, arrives by rail from the Newport News Shipbuilding and Dry Dock Co. for installation at Langley Memorial Aeronautical Laboratory.

1949
A researcher stands by with a fire extinguisher during research on the effect of twin-jet exhausts inclined toward the ground at the Lewis Flight Propulsion Laboratory. The lab was studying how certain engine installations could decrease an aircraft's takeoff distance.

NASA photos

Sharp intelligence, tight budget

*With the U.S. trying to understand events and hunt enemies from Afghanistan to the Middle East to Africa, the demand for the Air Force's airborne video feeds, still photos and eavesdropping collections has not diminished. Gone are the days when the Air Force could satisfy troops and intelligence analysts with the surge in intelligence dollars that came during the heights of the wars in Iraq and Afghanistan. This budget season, it will be up to Lt. Gen. Robert P. Otto, an F-15 pilot who also flew training flights in the U-2, to fight for the service's ISR priorities in an entirely different spending climate. **Ben Iannotta** spoke to Otto by phone about his visions for Predators, Reapers, Global Hawks and U-2s.*

What does it mean to be the Air Force's senior intelligence officer?

When we get together with the intelligence community, the senior intelligence officer represents the Air Force. Often, because we have less money than we had last year, it's: "Here's how these cuts are likely gonna affect us." It's the first opportunity for us to hear the impact and either mount a defense or accept the cuts.

How do you go about understanding the technologies in these really sophisticated aircraft?

I rely very heavily on the acquisition community and the Air Force Research Lab. The chief might say, "Hey, if we had hypersonics then we could compress the decision cycles of an adversary." And then we would rely on AFRL and the acquisition community to tell us how hard and expensive it would be. We can put that in the right bin: Something that we can look at on our 20-year horizon, or something we can look at on our five-year horizon.

What are some of the innovations that you've seen or that you'd like to see in ISR?

From a collection standpoint, what we have is a tremendous set of platforms that work in a permissive environment, and what we would like to do is develop the capability to work with penetrating ISR in a non-permissive environment.

You mean getting a plane over contested or through contested airspace?

Yes, but then we have to analyze what they collect. How do we turn the information into intelligence? Targeting would be another aspect. Today, we think kinetic: Drop a bomb. In the future, why wouldn't we have an integrated, cross-domain, high-capacity capability for targeting? Maybe the best opportunity would be through cyberspace. Whether it's our collection platforms or whether it's the exploitation or dissemination, right now our equipment is proprietary or hierarchical, and we would like to get to open architectures, cloud architectures and more plug and play, so that we can integrate new technologies more quickly.

Does that mean including on the airframe?

The airframe too. As we look at future airframes, why wouldn't we want a universal adaptor that we could put various sensors on? The builder knows in an open architecture, "OK, here's what I need the software to be able to interact with." The first time we try it, there's a high likelihood it's going to work, and we don't have high integration costs. [With] a universal payload adaptor, the same platform might be able to carry a variety of sensors.

Could you adapt existing aircraft to do that, like the Predators, Reapers, Global Hawks?

The [MQ-9] Reaper is certainly better than the Predator, because the Reaper has the ability to carry external stores to a much greater degree. The MQ-9 could have pods that would allow us — and we're doing that now — [to equip it for] full-motion video, wide-area sensors.

Meaning Gorgon Stare?

Right, Gorgon Stare. It's something we're looking at for the RQ-4 [Global Hawk] to have a universal payload adaptor. It's much harder to reverse engineer or certainly more expensive than to build it in as we're creating a new weapon system.

Can you get me up to speed on where the RQ-4 Global Hawks are as far as upgrades? Early on there was criticism that the engine was

U.S. Air Force Lt. Gen. Robert P. Otto, the service's deputy chief of staff for intelligence, surveillance and reconnaissance

Interview by Ben Iannotta

underpowered to get up over thunderstorms; it didn't have de-icing capability; and the sensors didn't have the range of the U-2.

We are interested in improving the sensors. Do we try to port over the sensors from the U-2 or do we buy a new sensor to work within the Global Hawk. We've got a pretty good plan on the signals intelligence side. It's the EO/IR [electro-optical/infrared camera] side that needs the work. Also the U-2 has the Optical Bar Camera, and so we would need the capability to meet the treaty obligations and port that over to the RQ-4 as well. [NOTE: *U-2's Optical Bar Camera produces "unalterable" hard copy photos for the State Department for treaty verification purposes, according to the camera's maker, UTC Aerospace Systems.*] And then the RQ-4, it will need some improvements like see-and-avoid radar to operate broadly.

The U-2 operates where commercial aircraft operate, but you couldn't do that right now with the RQ-4 Global Hawks?

That's right, and the RQ-4 also doesn't get above 60,000 feet for much of its sortie. Unless we come up with a different due regard solution, the RQ-4 is flying within controlled airspace typically, and so we need the ability to see and avoid.

Wouldn't you have to have the Optical Bar Camera solved before you retire the U-2s?

Ideally that's what we'd like to do. That's what we're trying to analyze right now: How long do we need to keep the U-2s? How long can we afford to keep the U-2s? One option would be to come up with an Optical Bar Camera or similar capability for

U.S. Air Force

the RQ-4. Another option would be to keep the U-2 until we have another technology fielded for the RQ-4. Another option would be take a look at the existing sensors on the RQ-4 and see if that could meet the requirements. The fourth would be a capability that meets the Optical Bar Camera treaty requirements on a different platform, like a biz jet or something.

What's the status of the plan to retire the U-2?

The latest is at the end of FY16 [fiscal 2016]. The U-2 should be around at least that long, and then we are looking at whether that's too soon or whether there are some other options. That came out in the NDAA [National Defense Authorization Act] from FY15. That's the plan right now, and we're in work to prepare [for that]. OK, that's a known, and now what's doable?

Having flown the U-2, how do you feel about retiring them?

The Air Force's position has always been that the two platforms are complementary. The RQ-4 provides unmatched range and endurance, and the U-2 has 60 percent more payload capacity and flies higher, 30 percent faster, better against a higher range of threats. But in a situation where we can only afford one, which is where we are with sequestration, we're going to make the Global Hawk the platform of the future.

How does the relative lack of U.S. troops on the ground in places like Africa, Afghanistan and the Middle East affect the kinds of aircraft and sensors you fly?

The AOR [area of responsibility] influences the kind of range that we need. In Africa, where we don't have that many operating locations and it's such a large continent, we find ourselves looking towards longer range platforms. The MQ-9 ER — extended range [Reaper] — is a platform that will be better suited for Africa than the regular MQ-9 or an MQ-1. There's a synergistic effect to having multiple ISR platforms, and we can't look at them in isolation. We get tremendous information from signals intelligence that helps us narrow our focus; we get tremendous capability from GMTI — the ground moving target indicator; tremendous information from EO/IR — [NOTE: *still cameras that take visible and infrared photos*] that helps us narrow our focus. Once we know where to look, full-motion video comes into play, but those are kind of soda straw sensors. You can end up looking in the wrong place. Where we have troops on the ground, that brings in human intelligence; it brings in ground sensors that the ground forces have; it brings in liaison with partner nations. There certainly is additional information that is available if we have forces on the ground. But there's lots of places where we don't have that and we're still able to do good work. It may not be as efficient.

How is the MQ-9 ER working for you?

We haven't rolled that one out yet, but the acquisition community is telling us that we should get an extra up to seven hours of endurance from that platform. The quick versions that we field will not have the anti-ice. So we did have to make some choices in order to field that capability.

Are you still measuring how much collection you're doing by measuring CAPs — combat air patrols?

We are, yes. The biggest problem we have with the medium-altitude fleet is we only have 55 CAPs worth of people, but we're flying 65 CAPs. So we're crushing our people in terms of their work hours and denied opportunities and so on.

Can you get at that problem through multi-aircraft control?

Not with the current airplanes, current technology. That's something that could help in the future, but in the near term, we've been surging essentially since 2007 in the MQ-1, MQ-9 business. We need to come off the surge in order to reset.

On GMTI, are you looking at doing that from unmanned planes or still Joint STARS [Boeing 707 radar planes]?

It could be both. We could do that off of the Block 40 [Global Hawks]. We could do that off of the Joint STARS. It could be a podded capability off of an MQ-9.

So the Block 40 Global Hawks are still going forward then?

Yes.

Joint STARS, for bookkeeping purposes, is not an ISR platform.

That's correct. GMTI, just the way the Air Force is organized, falls into a C2 [command and control] portfolio under the A3 [Air Force command, control and communications staff], not the A2 [intelligence staff]. I don't care who's responsible. We're doing exploitation of GMTI right now out of our distributed ground systems. They're looking at the dots — shifts in radar frequency that indicate movement — and doing immediate warfighter support.

How important is radar stealth for your missions going forward? You don't have that now in the medium altitude, right?

Right. When you think about penetrating ISR, you are thinking about some kind of stealth capability moving forward.

Given their stealth, do you think F-35s will be useful for ISR?

I do, and we might even rely on some of the partners to advance that initially. I know the United Kingdom is very interested. The F-35 is going to be a Hoover vacuum cleaner.

I thought airships, finally, were going to become a widespread, important ISR platform. Why do you think airships never seem to pan out?

It was a timing issue, honestly. Right at the time when the technology was starting to mature, when we could have taken airships to the area of operations, the money was starting to dry up. And so on very limited budgets, do you go with what you know works or do you then experiment on some of these technology demonstrators? The sums of money that we're talking about were significant enough that we just didn't have room in the budget to do everything that we wanted to do.

Would full-motion video be handy from high altitude, even space?

I think it can be. The improvements of the optics are that you can be effective from space with full-motion video. It depends on what mission you're trying to do. Are you trying to track large vehicles or are you trying to track people? I don't think you're going to track people from space.

Global Hawk and U-2 don't have full-motion video or even motion imagery, right?

That's right.

Are you in mourning over the [MC-12] Liberty planes going to the Army?

No, I'm celebrating that we're keeping the MC-12 in service. I'm less strident that it has to be the Air Force. We've got a really good cooperative relationship with the Army facilitating that transfer.

Are you aiming for either multispectral or hyperspectral capability on Global Hawks, since that's going to be the platform for the future?

I see that in the future for Global Hawk.

There was the SPIRITT — Spectral Infrared Remote Imaging Transition Testbed — experiment on the U-2. Something like that?

I think it's at least multispectral, possibly hyperspectral.

Hyperspectral was for a single use in Afghanistan, a single intelligence need.

The combat requirement was driven for a particular need, but with hyperspectral you can characterize different things that we're looking for. So, it has a fair amount of flexibility in application.

Does the U-2 now have SPIRITT on it or was that just an experiment?

We still have the sensor. It's not flying right now on the U-2.

I've totally piled on so I'm going to stop now.

Ben, it's been great chatting with you.

A maddening, costly problem

By Debra Werner

On Sept. 11, 2010, a Bombardier Dash 8 Q400 operated by British regional carrier Flybe was cleared to prepare for landing at Exeter International Airport when one of the plane's two input/output processors stopped working. Instead of reporting the aircraft's speed and altitude, the pilot's primary flight display showed only white dashes.

When the pilot tried to restart his display, he inadvertently disarmed the autopilot system's approach mode. The pilot then handed control to the co-pilot, whose display was functioning, shortly before a "caution, terrain" alarm sounded, followed by a "terrain, terrain, pull up" warning. The aircraft was 700 feet from the ground when the co-pilot began a steep ascent, returned the plane to its proper approach and landed safely. The incident is described in a June 2012 bulletin published by the U.K. Air Accidents Investigation Branch.

It was not the first time, or the last, that particular aircraft had trouble with the input/output processor, a key component of the avionics computer. A month before the incident and six times during the subsequent month, flight crews reported warning

In 2012, the U.S. Defense Department found it was spending $2 billion a year removing line replaceable units from its fleet of aircraft that subsequently showed no fault found during testing.

U.S. Air Force

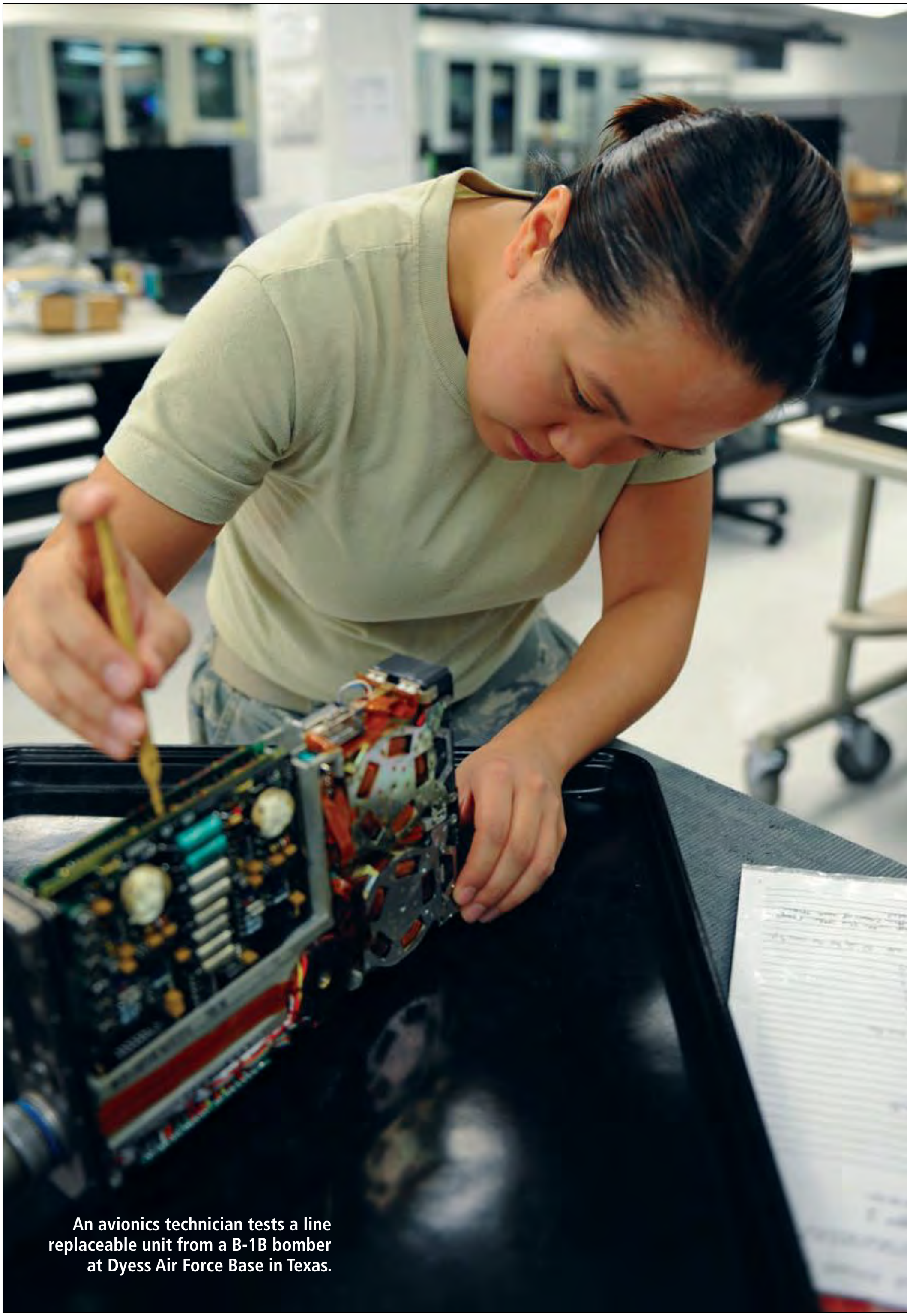
Maintenance personnel routinely pull suspicious parts from aircraft, only to discover that they test just fine in the lab. Air crews and managers are left to scratch their collective heads about the true origins of what looked like a part failure in mid-flight. Instances of no fault found are wasteful and potentially dangerous, which is why the industry has grown more serious about addressing the problem. Debra Werner explains.

lights indicating the processor had failed. During ground testing, however, technicians could not identify any problems and the aircraft continued flying with the same component, until it was returned to the vendor after the eighth failure indication.

The episode was an example of a phenomenon known as no fault found, or NFF, which occurs when a part is suspected of being faulty but subsequent testing turns up no problems. NFF is a potentially dangerous problem, as the Exeter case proves, and it is expensive due to the cost of diagnosing failures and replacing parts that in some cases are not faulty. In recent months, industry groups, including AIAA, have redoubled efforts to define the precise cost of NFF and address it through a multipronged approach of data gathering, testing, teamwork and communication among flight crews, engineers, maintenance technicians, aircraft manufacturers and industry suppliers.

The NFF problem has been known for some time. In a 1997 study, the Air Transport Association of America (now Airlines for America) estimated that commercial airlines spent $100,000 per airliner per year on the problem. Today that's probably closer to $185,000 per commercial airliner, says Giles Huby, who chairs a working group on the no-fault-found issue for the ADS Group, a U.K. aerospace, defense and security industries trade association. In 2012, the U.S. Defense Department said it was spending $2 billion annually removing line replaceable units — components designed to be easily replaced — that subsequently showed no fault found during depot testing.

The expense comes from packing, shipping and tracking parts that are thought to be faulty. Maintenance experts say they will never be able to eliminate instances of


An avionics technician tests a line replaceable unit from a B-1B bomber at Dyess Air Force Base in Texas.

U.S. Air Force

no fault found, but they are confident the scope of the problem can be reduced.

Assessing the cost

Huby's $185,000 figure is but a rough estimate. Many commercial and military aircraft operators today don't know exactly how much their organizations spend on no fault found or how prevalent the phenomenon is. In a study being conducted by Cranfield University and the Defence Academy in the U.K., researchers are discovering that, for military aircraft, the lack of standardized terminology is obscuring the full extent of the no-fault-found rate, which might be three times higher than previously thought. Technicians working on aircraft components often use terms such as "retest OK," "tested satisfactorily" or "cannot duplicate" rather than no fault found.

"About 3 to 5 percent of the man hours are officially coded as no fault found, but we think anywhere between 10 and 15 percent can clearly and justifiably be put down as no fault found," says Chris Hockley, a former Royal Air Force aircraft maintenance engineer who is the principal investigator for a Defence Academy effort to reduce the occurrence of no fault found in all industries. "Ten to 15 percent of all the maintenance man-hours across a particular fleet of aircraft across a year is a significant amount of money."

"Everyone is hankering to know the real cost," says Lori F. Fischer, chairwoman of the AIAA No Fault Found Steering Committee and production reliability engineer for Woodward Inc., an aerospace supplier based in Fort Collins, Colo.

The NFF Steering Committee, established in 2012 under the AIAA Product Support Technical Committee, is developing a spreadsheet-based financial model to help the aviation industry determine the amount of time engineers, mechanics and salespeople devote to the problem. Once companies know what they are spending on NFF, they can track savings that result from actions designed to reduce the number of cases, Fischer says.

Another important step would be to identify the NFF components that must be replaced the most often.

"Gather data to see what is biting you on the backside the most," says Huby, managing director of Copernicus Technology Ltd., a British company that provides testing equipment and data products for maintenance organizations.

With data, companies can also prioritize potential solutions, such as revising fault-isolation manuals, diagnostic training procedures or repair policies, says Huby.

Teamwork

AIAA's NFF Steering Committee wants airlines and airframe and engine manufacturers to work with their aviation industry partners and suppliers to address the problem. That work often starts with ARINC Report 672, "Guidelines for the Reduction of No Fault Found," a standards document published in 2008. ARINC 672 says companies should take a holistic view of the no-fault-found problem, including its impact on design, documentation, training, testing and communications.

FedEx Corp. has taken that approach. The company encourages its employees — including line maintenance technicians, engineers, flight operations officials, pilots, and employees who interact with vendors and original equipment manufacturers — to play a role in keeping aircraft operating and investigating equipment problems, including no-fault-found occurrences. Uncovering problems and devising solutions "is very much detective work, but we've got a solid team that does it continually," says Patrick Doyle, the company's senior manager for hangar maintenance. "We look not only at the unit in question but also at the aircraft, its age, its wiring and modifications made that could be affecting the system."

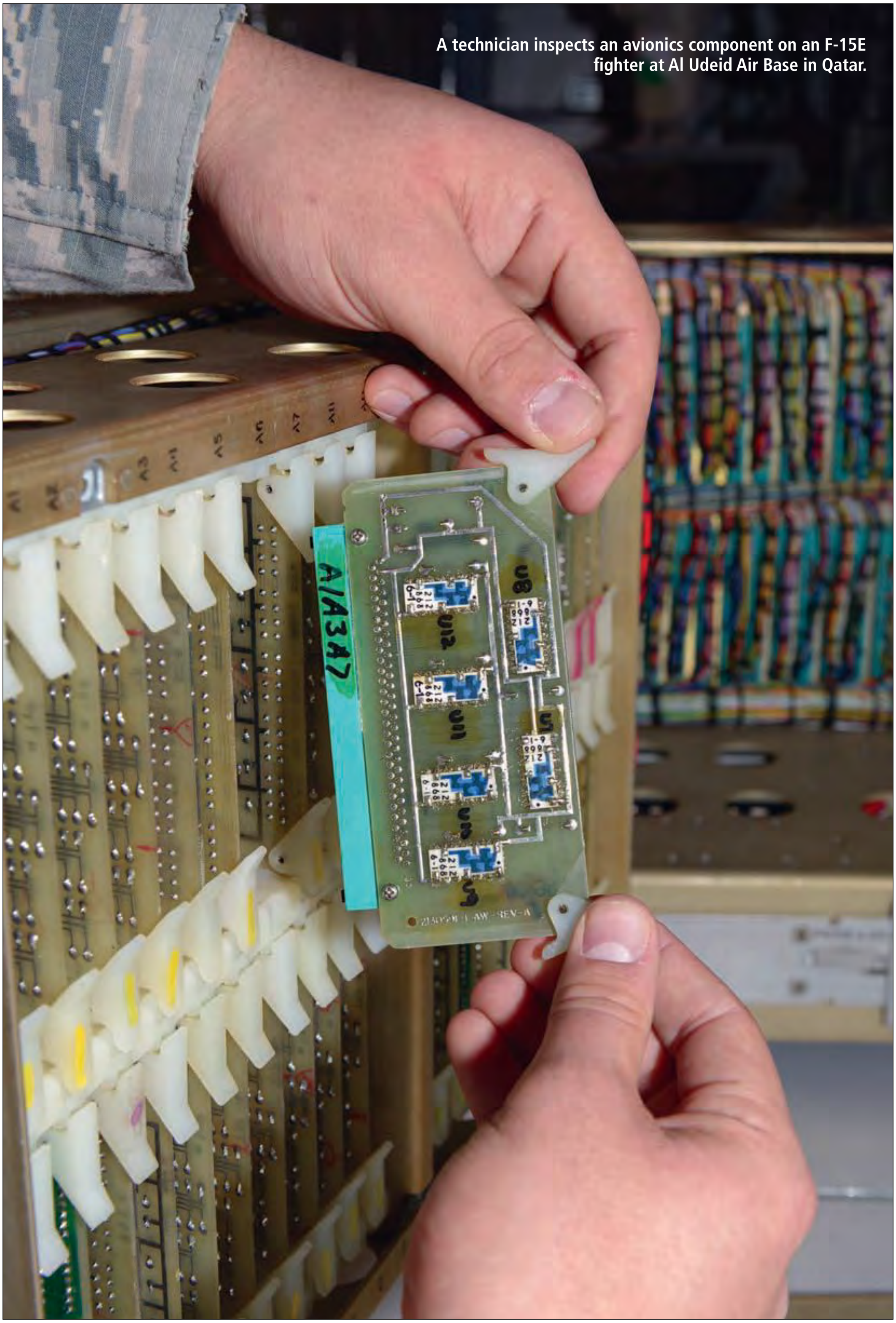
FedEx found, for example, that reported flight control computer failures were not caused by flaws in the computers but rather by aging wires connected to the units. In another case, FedEx and an original equipment manufacturer learned through destructive testing of circuits that after 10 years some microchips lost their moisture-repellent coating. With that knowledge, the vendor agreed to replace the microchips at specified intervals.

Testing tools

Normal wear and tear can result in intermittent faults, the temporary anomalies in circuits or devices caused when connections weaken due to age, environmental factors or vibration. Because the problems are intermittent, testing often results in a finding of no fault found.

Test equipment cannot replicate the flight environment precisely, but new tools are helping organizations identify intermittent faults.

U.S. Air Force F-16 fighters, for example, were encountering problems with their AN/APG-68 radar modular low-power radio frequency units. The line replaceable units sometimes malfunctioned in flight and had a 54 percent no-fault-found rate in



A technician inspects an avionics component on an F-15E fighter at Al Udeid Air Base in Qatar.

U.S. Air Force

bench tests at Hill Air Force Base in Utah, where the 523rd Electronics Maintenance Squadron uses the Intermittent Fault Detection and Isolation System, or IFDIS, developed by Total Quality Systems Inc. and Universal Synaptics of Utah. Technicians use the system of software and sensors to monitor every circuit path "individually, simultaneously and continuously" while the unit was on a shaker table inside an environmental chamber to simulate flight conditions. The process is described in a 2012 document, the Condition Based Maintenance Plus Charter, published by the U.S. Defense Department's Joint Intermittence Testing Working Integrated Product Team. The Air Force spent $2.2 million on IFDIS and reported a return on investment of $50 million, the charter says.

IFDIS pinpoints the type of small, random anomalies that indicate connections are loose or joints need resoldering, says Ken Anderson, vice president of sales and business development at Universal Synaptics, which develops hardware and software designed to reveal intermittent faults.

Cryptic messages

Improved fault reporting also helps technicians conduct more appropriate testing. One aviation supplier received a returned line replaceable unit with a note that simply read, "bad out of the box." That type of message gives technicians little guidance on how to identify potential problems or devise solutions, Fischer says.

To avoid those cryptic messages, AIAA's NFF Steering Committee is developing standards to describe "the absolute minimum amount of information that needs to be put on a fault report in order for manufacturers or maintenance facilities to be able to do a good job," Fischer says. Fault reports need to identify when, where and how problems were discovered in addition to whether related components also exhibited trouble.

If maintenance companies and manufacturers have a detailed understanding of the faults, they might be able to conduct tests that are more likely to replicate the problem, Huby says. Certain components or connections might only fail when exposed to high humidity or after hours of heating. Another tactic some groups are using to reduce no-fault-found costs is called ship-or-shelve. If an air carrier discovers that certain line replaceable units are being sent to repair shops repeatedly with no fault found, the company can opt to pull those units out of aircraft but keep them quarantined and on shelves until maintenance teams determine whether replacement parts resolved the problems. If not, the maintenance team knows the shelved parts probably are good and technicians should begin looking at associated components or wiring for solutions to the original problem.

Crews of a Bombardier Dash 8 Q400 repeatedly reported problems with an avionics computer component, but ground tests failed to find any faults with the unit.

Adrian Pingstone

FedEx devised its own ship-or-shelve approach known as Conserve All Usable Hardware. The U.K. Royal Air Force employs a similar strategy to maintain its fleet of Eurofighter Typhoon jets.

For the Bombardier Q400, technicians who subjected the aircraft's input/output processor to extensive operational testing finally discovered an intermittent fault in one of its power supply systems. By X-raying the power supply module, technicians detected cracked solders on a transformer.

As a result of those findings, the Air Accidents Investigation Branch told processor manufacturer Thales Alenia to devise new procedures to uncover intermittent faults in the power supply module. The agency also directed Bombardier Aerospace and Flybe to publish information for flight crews and maintenance teams on the impact of an input/output processor failure and guidance for handling that type of event.

No runway, no problem

The Navy and Marines want a long-endurance unmanned plane that can operate from ships and outposts that lack airstrips. Keith Button explains how the Blackjack aims to answer that call.

By Keith Button

With their long endurance and large payloads, unmanned aircraft like the venerable Predator allow operators in the U.S. to keep an eye on hot spots half a world away. But U.S. troops who could find themselves in those hot spots or aboard ships are weighing the merits of an aircraft that, while it may not have the reach and payload of a Predator,

An RQ-21A Blackjack on the deck of the amphibious transport dock Mesa Verde after its first flight at sea in 2013.

U.S. Navy

has one distinct advantage: It doesn't need a runway.

The Navy and Marine Corps have been evaluating the RQ-21A Blackjack — an 81-pound unmanned aircraft that is launched by a catapult and recovered by snagging a mast-mounted cable.

Blackjack, built by Boeing-subsidiary Insitu, is a military version of the company's Integrator. It was used for six months last year by Marines in Afghanistan, says Ryan Hartman, chief executive of Insitu, and since early 2014 the Navy has been testing it on an amphibious assault ship.

Blackjack's runway-less launch-and-recovery system is designed to give troops in the field and on ships access to endurance and sensor capabilities usually reserved for much larger drones, like the 1,100-pound Predator. Blackjack can stay aloft for 16

An Integrator aircraft is launched from a catapult at the Marine Corps Air Ground Combat Center at Twentynine Palms, California.

hours — there's a version of the Integrator that extends that to 24 hours — and reach nearly 20,000 feet, compared with up to 40 hours for the original Predator, which has a 25,000-foot ceiling. The Blackjack carries a 40-pound sensor payload, about one-tenth of the Predator's capacity. And unlike the Predator, the Blackjack won't be armed.

While their differences are significant, in many circumstances Blackjack can give Predator a run for its money, says Keven Gambold, CEO of the Americas operations for Unmanned Experts, which advises companies on drone use.

"You're getting what's a MALE class — medium-altitude, long- endurance class — of product from a tactical system," says Gambold, a U.K. Royal Air Force veteran and Predator pilot. "If this thing can fly for 24 hours, although unweaponized, and can see everything in all spectrums, and target for other munitions, and it can do all of these wonderful things at great ranges, then the Predators have to step up their game."

But the Air Force, a primary operator of Predator and the even-larger Reaper, has to keep the bigger picture in mind.

"The Air Force does theater-level ISR," says Lt. Gen. Robert P. Otto, the Air Force deputy chief of staff for intelligence, surveillance and reconnaissance. "Typically, some of those small UASs are not theater assets. They tend to be line-of-sight, low-altitude, close in. So, very good for overwatch of a patrol, a foot patrol, but not very good to get from, say...western Afghanistan to eastern Afghanistan."

Otto didn't rule out a future role for small unmanned aircraft in the Air Force. For instance, small aircraft with specific capabilities might be deployed from larger unmanned aircraft, he says.


U.S. Marine Corps

Without a net

The ability to operate without a runway was a key element in the search by Naval Air Systems Command for a Small Tactical Unmanned Aircraft System. Insitu was selected in 2010 to begin developing the Blackjack version of the Integrator, and in 2013 the company was awarded an $8.8 million contract to produce an initial production system, including aircraft, launch and recovery gear, and support equipment. The Marines began testing that system in January 2014 at Twentynine Palms, California. In December, Insitu received a $41.7 million contract from the Navy to build three more initial production Blackjack systems.

Whether on land or aboard a ship, the Blackjack is launched and recovered with similar apparatuses: a pneumatic rail catapult for launch and, for recovery, a rope/bungee system hung from a telescoping mast, called a SkyHook. The returning aircraft autonomously maneuvers so that its wing strikes the vertical rope, which slides along the wing until snagged by a hook on the wingtip. That brings the aircraft to a sudden stop and it can be lowered to the ground or ship deck.

"All Insitu systems are runway-independent, whether it's land-based or sea-based," says Hartman. "The reasoning for that is we want to be able to deploy to austere, more expeditionary environments where there is no runway, there's potentially obstructions, or whatever. We can fly pretty much anywhere."

Some of the other STUAS competitors, such as Raytheon's Killer Bee and AAI's Aerosonde, relied on net systems for recovery, which Insitu claimed were large and unwieldy compared with SkyHook. In fact,

U.S. Navy

A Blackjack is lowered from a SkyHook recovery apparatus aboard the amphibious transport dock Mesa Verde.

during the competition, some Insitu executives wore lapel pins depicting a net with a red bar through it.

Nets can also be more hazardous, Hartman says: “Nets on the back of a ship don’t give you the ability to fly a vector that’s not ever pointing the aircraft at the superstructures of the ship.”

Even with SkyHook, recovering an aircraft can be tricky on a moving vessel, Hartman says.

“It’s very intense; it’s not an easy thing to do,” he says. “You’re talking about recovering an unmanned system on a moving platform that’s not just moving in a straight line. It’s pitching and heaving and rolling all at the same time.”

If the Blackjack misses the SkyHook, it simply circles around for another attempt, he says.

Plug and play

On the ground in Afghanistan, the Marines used one complete Blackjack system: five aircraft, a catapult, a SkyHook and two ground control stations. The system can be transported by five Humvees with trailers or by a transport plane, such as a C-130. It can also be delivered from ship to shore on a surface landing craft or two CH-53A helicopters. Setup by a trained crew takes less than 30 minutes, according to Insitu.

In Afghanistan, each aircraft carried a full-motion video camera and a voice/data communications relay, Hartman says. The Marines switched out various sensors for the remainder of the payload capacity. The aircraft has nose and center-of-gravity bays, as well as bays in the wings and winglets, and two wing hardpoints.

The aircraft’s twin-boom design allows for an expansive sensor bay and creates stability in flight, making it less sensitive than other aircraft to swapping out sensors, says retired Maj. Gen. James Poss, former Air Force assistant deputy chief of staff for ISR.

“With most normal aircraft, they don’t like you taking the nose off and putting a completely different nose on, and then you have to re-trim the aircraft, and all that,” says Poss, who is heading up a Mississippi State University effort to establish an FAA unmanned aircraft test center in Mississippi and designate the university as an unmanned aircraft research center of excellence.

“The Integrator is designed to be a plug-and-play aircraft, from the ground up,” he says. “That’s particularly good for the ISR community, because they can never make up their mind on what sensors they’re going to fly.”

The Blackjack is flown by enlisted Marines and sailors. The operator can control two aircraft at the same time — one on an active ISR mission and one on a passive mission, such as loitering to serve as a communications relay.

The operators can specify point-to-point flight paths or select particular flight modes, Hartman says. In search-and-rescue mode, for example, the system determines the most efficient flight path to cover a prescribed area of open water. In a spot surveillance mode, the drone can

Marines lift an RQ-21A Blackjack onto a catapult launcher during training at Marine Corps Outlying Field Atlantic in North Carolina.

U.S. Marine Corps

be instructed to keep an eye on a specific door in a building or to follow a moving truck.

Once the shipboard testing is complete, Insitu will assess feedback from sailors and Marines to determine whether changes are needed before a final version of the RQ-21A is approved for production.

Naval Air Systems Command plans to buy as many as 37 Blackjack systems — 185 aircraft — for the Marines, but when production would begin is yet to be determined, Hartman says.

The Navy plans to buy Blackjacks for its own use. A decision on how many is expected this year, Hartman says.

Small sats,

Companies are entering the Earth-observation market with small satellites that can be launched cheaply. The big question, Natalia Mironova explains, is whether these startups will have the staying power to compete with the established commercial-imagery players.

On the afternoon of Oct. 28, Chris Boshuizen and some of his fellow staffers at Planet Labs gathered in a meeting room in their San Francisco offices to watch live video of the launch of an Antares rocket from the Mid-Atlantic Regional Spaceport in Virginia. The rocket's payload — mostly supplies and experiments bound for the International Space Station — included 26 of the company's small Earth-imaging satellites, which Planet Labs lovingly calls Doves.

At 6:22 p.m. Eastern time, just seconds after liftoff, the rocket exploded in a giant fireball, stunning the Planet Labs staffers in San Francisco. But the initial shock quickly wore off, and soon there was even some awkward laughter. Then they shrugged it off.

"It was actually a beautiful explosion in a way," says Boshuizen, one of Planet Labs' co-founders. "It was about the price of a Michael Bay movie all in one single explosion."

Even before the smoke cleared, the Planet Labs team knew what it would do. "We had another production line in process already, so we were like, 'Oops, we better make a few more,'" says Boshuizen.

The reason Planet Labs could bounce back from the loss of 26 satellites has a lot to do with the way this space company, founded in 2010, runs its business: It launches small, low-cost satellites — cubesats — made entirely of commercially sourced parts. Before the Antares explosion, the company had placed 71 Doves in orbit with six launches over 18 months.

"Our system is designed around a large number of satellites and we benefit from the redundancy that comes with having multiple units. They are low-cost, so if we lose a few we actually designed the system to tolerate that," says Boshuizen. "The explosion was more like a dampening of our capability than an existential problem. So, actually nobody here was really stressed about it."

Planet Labs is one of half a dozen companies that promise to put images of the Earth directly in the hands of its customers

by Natalia Mironova

big plans

Two Planet Labs Earth-observation cubesats are deployed from the International Space Station in February 2014.

NASA

— be they researchers at a university, a disaster relief organization or an oil and gas enterprise — and by doing so provide the private sector with geospatial data previously available only to governments. The question is: Which of these companies will have staying power and which will go the way of the busted Silicon Valley startups of the 1990s?

"It's too much too fast. I don't see how the market can support five [or] six satellite imaging companies in the next 10 years. In the next 20 years, maybe," says Joshua Hartman, CEO of Horizon Strategies Group in Washington, D.C., and former chief of finance, system engineering and acquisition for the Low Earth Orbit Program Office at the National Reconnaissance Office. "It will be survival of the fittest. There will be some that won't survive, as we saw happen with the dot-com boom."

Disruptive year

2014 was what Kevin Pomfret, executive director of the Centre for Spatial Law and Policy in Richmond, Virginia, calls a year of "disruption" for the satellite imagery market. The previous decade saw consolidation of the U.S. market. GeoEye, founded in 1992 as Orbital Imaging, purchased Space Imaging in 2006. Then DigitalGlobe, founded in 1992 as WorldView Imaging, merged with GeoEye in 2013, creating a de facto monopoly on commercial satellite imagery in the U.S. There were concerns that the merger would restrict the supply of imagery. In a pre-merger survey of consumers of U.S. commercial satellite imagery, the

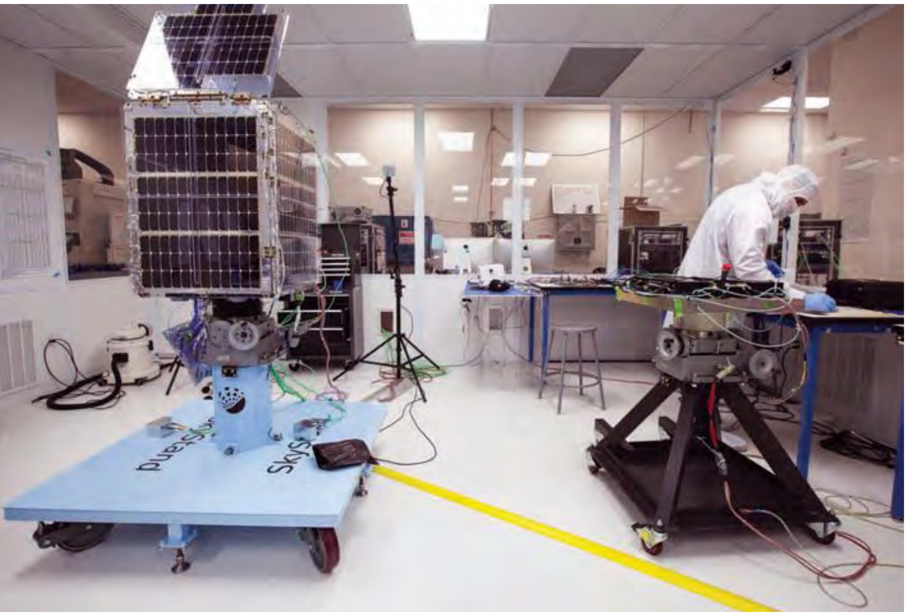
DigitalGlobe's 2,800-kilogram WorldView-3, launched in August, will collect images of Earth with a resolution of 31 centimeters.

Ball Aerospace

Commerce Department noted that "comments on the potential of a DigitalGlobe-GeoEye merger were almost universally negative."

Just a year later, the landscape has changed dramatically. What no one predicted was the sheer scale of the technological development in satellites and the exponential growth of the abilities of the commercial sector, allowing companies like Planet Labs and Skybox Imaging to become major contenders. Skybox has launched two satellites, of a planned constellation of 24, that provide high-resolution images and video. The company, founded in 2009 in Mountain View, California, was snapped up by Google last year for $500 million. Another company, BlackSky Global, is poised to launch a satellite in 2015. (BlackSky declined to comment for this story, but the company's website promises "high performance 1 meter imaging capability" and "rapid revisit to anywhere in the world".)

The SkySat microsatellites have a mass of about 100 kilograms, making them affordable for a small company to launch.



Skybox Imaging

"The fact that a company like Google purchased a commercial remote sensing company says there is value in this industry," says Mark Brender, an industry veteran and an executive director of the DigitalGlobe Foundation, which provides imagery grants to support research projects.

Innovation in the commercial satellite imagery sector takes advantage of the recent strides in technology made by "our heroes in the cellphone and laptop industry who've miniaturized everything," says Planet Labs' Boshuizen. The startups are able to build cheaper, smaller satellites by relying on cheaper, smaller, components that were not designed specifically for space, but perform well enough there. Boshuizen points out that most of these commercial components can trace their tech pedigree to the early days of the space industry. Whether these commercially sourced parts can stand up to the rigors of space in the long term remains to be seen.

"Space is a very harsh environment and any satellite system must be prepared to operate in that extreme," says Brender.

For its part, DigitalGlobe continues to take advantage of technology and policy developments to acquire higher-resolution images and market them to a wider array of potential customers.

For the company's newest satellite, WorldView-3, launched in August, engineers at Exelis provided an imaging sensor capable of generating black-and-white — or panchromatic — images with a 31-centimeter resolution, which the company says makes it the finest resolution commercial satellite. Until recently, that kind of data could not be made available commercially. U.S. regulations forbade the sale, except to the government, of black-and-white imagery with a resolution of less than 50 centimeters and color (multispectral) imagery of less than 2 meters. But in June the Commerce Department said it would permit the sale of 25-centimeter black-and-white and 1-meter color images. WorldView-3 will also generate 1.24-meter color images.

A huge boon for the established commercial satellite imaging companies was the 2010 EnhancedView contract, under which the National Geospatial-Intelligence Agency committed to buying $7.3 billion worth of imagery over 10 years from two companies: GeoEye and DigitalGlobe. The caveat of this lucrative contract? It had to be renewed every year. What happened next shows the risk of relying largely on the U.S. government as a client. When the NGA canceled the GeoEye portion of the contract in 2012, citing budget constraints, the company floundered and the following year was absorbed by DigitalGlobe. DigitalGlobe continues to be the top dog in the world of commercial satellite imagery, getting a steady cash injection of $25 million per month from the EnhancedView contract. And the company is looking to clients beyond the U.S. government. In 2014 DigitalGlobe acquired Boulder, Colorado-based Spatial Energy, a geospatial data provider serving the oil and gas industry.

Skybox Imaging

SkySat-1 collected this color infrared image of Port Fuad, Egypt, in February 2014.

Strength in numbers

For the new, smaller companies, the technology is only one hurdle, says Horizon Strategies' Hartman. "For these companies to survive they don't have to only figure out a way to gather quality imagery, they also need to have a solid business model," he says.

Planet Labs might be on the right track. The Dove cubesats are small — 10-by-10-by-30 centimeters; about the size of a shoebox — made with commercially available parts and are relatively inexpensive to build, although Boshuizen declined to say how much each one costs. That makes them easy to launch in large numbers.

"Were using an industrial base that supports manufacturing of all the modern computing devices to build extremely powerful, very low-cost satellites," says Boshuizen. In fact, the manufacturing process is so uncomplicated that just nine days after the Antares launch failure, Planet Labs built two new satellites and readied them to be launched on the next cargo mission to the ISS flown by SpaceX. The cubesats are capable of providing images at 3-to-5 meter resolution.

Planet Labs is currently authorized to maintain a constellation of as many as 67 Doves — up to 56 at an altitude of about 400 kilometers and 11 at 620 kilometers, according to a licensing application that was granted by the Federal Communications Commission in October. The lower-orbiting satellites, to be deployed from the International Space Station, will have lifespans of seven months, due to natural orbital decay. To maintain the constellation, the company plans to launch as many as 500 satellites over 10 years, according to the FCC application. The higher-orbiting satellites are already in place and will last about 17 years. Planet Labs says it plans to expand the constellation over the next 18 months through a series of larger-capacity launches.

Boshuizen says having a large number of satellites gathering imagery around the world produces never-before-seen “big picture” sets of data that will be useful to a variety of clients, from small nonprofits to national governments.

“When you have a high revisit rate and global coverage you can detect change on the planet,” he says. “[Our] customers fall on a spectrum — some are extremely sophisticated and have their own data processing teams and imagery experts, other people just want the answer to their question. We’d like to serve everybody in-between those two extremes.”

Without getting into specifics, Boshuizen said he doesn’t rule out the U.S. government’s national security agencies as future customers for Planet Labs.

Like Planet Labs, Skybox Imaging is taking advantage of greater access to technology and launch systems. “We are ardent believers in the power of commodity, commercial electronics to change the cost of doing business in space,” the company says on its website. Skybox has built and launched two microsatellites so far, called SkySats. At 100 kilograms each they are larger than cubesats — about the size of a mini-fridge — but small enough to make launches affordable. The SkySats are in 600-kilometer polar orbits and have an expected life of at least four years.

Unlike Doves, which only take still images, SkySats can capture high-definition video in segments up to 90 seconds long at 30 frames per second. The 1.1-meter video resolution “is high enough to observe objects that impact the global economy, like shipping containers, but not close enough to view or identify human activity,” the company says. SkySats can also capture 90-centimeter panchromatic and 2-meter multispectral imagery.

25 Years Ago, February 1990

Feb. 1 The first in-space tests are made of the Soviet Union's Icarus manned maneuvering unit by cosmonauts in space walks from the Kvant 2 module docked with the Mir space station. Icarus uses compressed air. Flight International, Feb. 14-20, 1990, p. 20.

Feb. 10 The Galileo spacecraft swings around Venus at a distance of 10,000 miles, raises its speed by about 5,000 miles per hour and heads for Jupiter. The probe takes several pictures of Venus's cloud and weather patterns. NASA, Astronautics and Aeronautics, 1986-90, p. 252.

50 Years Ago, February 1965

Feb. 1 In a White House ceremony on the day of his retirement, Air Force Gen. Curtis LeMay is awarded a third oak-leaf cluster representing his fourth Distinuished Service Medal by President Lyndon Johnson. During World War II, LeMay championed and implemented a highly effective strategic bombing campaign in the Pacific Theater, and after the war he oversaw the Berlin Airlift. New York Times, Feb. 2, 1965, p. 14.

Feb. 3 The Douglas DC-9 twin-jet short-haul transport aircraft starts taxi tests at Long Beach, Calif. Flight Intercontinental, Feb. 18, 1965. p. 239.

Feb. 3 The Orbiting Solar Observatory 2 is launched by a Delta rocket from Cape Kennedy, Fla. The satellite carries eight scientific experiments for direct observations of the sun with instruments controlled by ground commands. The experiments are designed to map the frequency and energy of solar emissions. NASA Press Release 65-14.

Feb. 4 A 75-foot-tall, 250-ton, 1-million-pound thrust solid-propellant rocket motor under development by United Technology Center is test fired at Edwards Air Force Base, Calif. The motor is one of a pair of strap-on boosters for the Titan 3C launch vehicle. Flight International, Feb. 18, 1965, p. 267.

Feb. 5 The first major piece of Apollo program hardware, a boilerplate model of the service module, undergoes a static test firing at the NASA Manned Spacecraft Center at White Sands, N.M. The boilerplate module has a 22,000-pound-thrust Aerojet General rocket motor. During Apollo flights, this motor would slow the service module for entry into lunar orbit and propel the spacecraft during its escape from lunar orbit back to Earth. Aviation Week, Feb. 8, 1965, p. 25.

Feb. 5 Sir Alwyn Crow, a British rocket pioneer and originator of the Z rocket anti-aircraft gun of World War II, dies in Washington, D.C. Crow's work with rockets began in 1934 when he was the director of ballistics research at the Royal Arsenal in Woolwich and was prompted by rumors of secret rocket activities in Germany. Crow was given permission and resources to develop anti-aircraft rockets based on cordite, a smokeless solid-propellant. Crow and his team developed a wide variety of rockets, including the anti-aircraft Z gun, which was so named in order to keep it secret. Crow's weapons were highly effective in the war and he was later knighted for his achievements. Flight International, Feb. 11, 1965, p. 198; Space Chronicle—Journal of the British Interplanetary Society, Supplement 1, 2011, pp. 45-54.

Feb. 5 Deactivation of 129 obsolete intercontinental ballistic missile sites begins to prepare for the activation of more modern systems. The older sites include those for the Atlas and Titan 1 while the newer weapons are the Titan 2, Minuteman and Polaris. New York Times, Feb. 7, 1965, p. 64.

Feb. 14 Fred L. Whipple, director of the Smithsonian Astrophysical Observatory, suggests a plan to land a spacecraft on a comet. Almost 50 years later, on Nov. 12, 2014, this is achieved when the European Space Agency's Rosetta spacecraft arrives at comet 67P/Churyumov-Gerasimenko after a 10-year mission and deploys a lander to the surface. New York Times, Feb. 14, 1965, p. 5; New York Times, Nov. 12, 2014, p. 1.

Feb. 16 The first of three Pegasus micrometeoroid-detection satellites is launched by a Saturn 1 from Cape Kennedy, Fla. The Pegasus satellites help define the density of micrometeoroid particles surrounding Earth. Once in orbit, two panels — 14 feet wide and spanning 96 feet — are unfolded to detect micrometeoroid strikes. This is the eighth successful Saturn flight and the first to carry an active payload. David Baker, Spaceflight and Rocketry, p. 28; Flight International, Feb. 25, 1965, pp. 304-306.

Feb. 16 The North American Aviation XB-70A, formerly a prototype of the B-70 deep-penetration strategic bomber but now a test aircraft, makes

Past

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

its first supersonic flight of Mach 1.6 from Palmdale, Calif. This also marks the first time the wing tips are folded to 25 degrees, then adjusted to the full-down position of 65-degrees. Aviation Week, Feb. 22, 1965, p. 22.

Feb. 17 The Ranger lunar probe lifts off from Cape Kennedy, Fla., on an Atlas-Agena-B launch vehicle. Three days later, just 23 minutes before impact upon the lunar surface, Ranger's six TV cameras take close-up pictures of the Sea of Tranquility, which will be the site of the first manned lunar landing in 1969. In all, Ranger 8 transmits some 7,137 pictures, the final one from 1,540 feet above the surface. Flight International, Feb. 25, 1965, p. 303; David Baker, Spaceflight and Rocketry, p. 28.

Feb. 21 The Soviet Union orbits three satellites — Cosmos 54, 55 and 56 — with a single launch vehicle, the third multiple launch by the USSR. Flight International, Feb. 25, 1965, p. 303.

75 Years Ago, February 1940

Feb. 1 Helicopter pioneer George de Bothezat dies in Boston at age 57. Born in Russia, de Bothezat emigrated to the U.S. in 1920 and worked as an aerodynamicist for NACA at McCook Field in Dayton, Ohio. In 1922 he built his first helicopter for the Army Air Service. On Feb. 21, 1923, his machine achieved an altitude of 15 feet for 2 minutes, 45 seconds, which was considered a remarkable achievement. E.M. Emme, ed., Aeronautics and Astronautics 1915-60, pp. 12, 16; W.J. Boyne and D.S. Lopez, eds., The Age of the Helicopter, pp. 8-9.

Feb. 3 Flight Lt. Robert Voase Jeff becomes the first British Royal Air Force officer to be decorated by France when he is given the Croix de Guerre for shooting down a German Heinkel bomber on Nov. 2, the first to be brought down in France. He was flying a Hawker Hurricane. The Aeroplane, Feb. 23, 1940, p. 242.

Ludwig Prandtl

Feb. 4 Ludwig Prandtl, famed German scientist and chief of the Research Institute for Aerodynamics at Gottingen, is awarded the Goethe Medal on his 65th birthday. Interavia, Feb. 13, 1940, p. 5.

Feb. 17 In France, Wladyslaw Sikorski, the Polish prime minister in exile, and the French air minister sign an agreement at the Polish Embassy in Paris calling for the formation of a Polish Air Force in France. Interavia, Feb. 20, 1940, p. 7.

Feb. 19 Capt. H.H. Balfour, British undersecretary of state for air, returns to London after a 7,000-mile tour of military units in Palestine, Trans-Jordan, Iraq and Egypt. The Aeroplane, March 1, 1940, p. 283.

Feb. 24 The Navy's Bureau of Aeronautics issues a contract for airborne television systems for potential use in providing target and guidance data in guided missiles. E.M. Emme, ed., Aeronautics and Astronautics 1915-60, p. 39.

Feb. 24 The Hawker Typhoon prototype, powered by a Napier Sabre 11 engine, makes its first flight. E.M. Emme, ed., Aeronautics and Astronautics 1915-60, p. 39.

Feb. 25 The first Royal Canadian Air Force squadron to be recruited and trained for service overseas arrives in London. The squadron is the oldest auxiliary squadron in Canada and was formed in Toronto. It is commanded by W.D. Van Vliet. The Aeroplane, March 1, 1940, p. 267.

Feb. 29 The Navy's Bureau of Aeronautics begins studies that lead to a contract with H.O. Croft of the State University of Iowa to investigate turbojet propulsion for aircraft. E.M. Emme, ed., Aeronautics and Astronautics 1915-60, p. 39.

Robert H. Goddard

100 Years Ago, February 1915

Feb. 17 HMS Ark Royal, Britain's first seaplane carrier, becomes the first aircraft carrier to serve in war, patrolling the Dardanelles and dispatching a seaplane on a reconnaissance mission against the Turks. Francis K. Mason and Martin Windrow, Know Aviation, p. 17; David Wragg, Wings Over the Sea, p. 22.

Feb. 19 Robert H. Goddard begins rocketry experiments by weighing Coston Coast Guard signal rockets and recording the mass of the propellants. Goddard tests their efficiency and develops steel-cased rockets using smokeless powder with the addition of an exhaust nozzle. His solid-fuel period ends in January 1921, when he begins his liquid-fuel period that lasts until his death in 1945. Esther C. Goddard and G. Edward Pendray, eds., The Papers of Robert H. Goddard, Vol. II, p. 159.

Career Opportunities

Embry-Riddle Aeronautical University, Daytona Beach

Department of Aerospace Engineering Faculty Positions

The Department of Aerospace Engineering at Embry-Riddle Aeronautical University in Daytona Beach, Florida has an ambitious agenda for the next five years focused on expanding graduate programs, research capabilities, facilities, and recruiting highly talented faculty. An exciting plan for a new state-of-the-art engineering building housing research laboratories including new wind tunnels and supporting facilities have been approved and will be completed in the next two years in support of this agenda.

The Department invites applications for several faculty positions at all rank levels. Successful candidates for the Assistant Professor rank should demonstrate a potential to establish and grow a strong research program and to excel at teaching and mentoring undergraduate and graduate students. Applicants for the Associate rank should have an exemplary record of teaching and scholarly activities including externally funded research. Appointment at the Professor rank will be considered from individuals with exceptional qualifications and those with national recognition. We intend to fill these positions starting in August 2015. Applicants in all areas of Aerospace Engineering will be considered.

Current research thrust areas of the Department include: aeroacoustic modeling, rotorcraft aerodynamics, flow control, airbreathing hypersonic and rocket propulsion, autonomous unpiloted air and ground vehicles, aircraft & spacecraft guidance, navigation and control, aeroelasticity, composites, nanomaterials, smart materials, structural health monitoring, computational structural mechanics and design optimization. The Department offers bachelors, masters, and Ph.D. degrees in Aerospace Engineering. The undergraduate program is the nation's largest with about 1260 full-time students and has been ranked # 1 in its category by U.S. News and World Report for the past fifteen years.

Embry-Riddle Aeronautical University, the world's largest, fully accredited university specializing in aviation and aerospace, is a nonprofit, independent institution offering more than 70 baccalaureate, master's and Ph.D. degree programs in its colleges of Arts & Sciences, Aviation, Business, Engineering and Security & Intelligence. For more information, visit www.embryriddle.edu.

An earned doctorate in Aerospace Engineering or a closely related field is required. Women and underrepresented minorities are especially encouraged to apply. Applicants must submit a cover letter, a curriculum vitae, a detailed research and teaching plan, and the names of at least three references to the ERAU web site http://eraucareers.erau.edu.

AIAA Bulletin

In November, the AIAA Indiana Section hosted AIAA Fellow and Distinguished Lecturer **Dr. Wilson Felder**, who spoke on "The Air France 447 Accident: A Case Study in Complex System Design."

FEBRUARY 2015

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

Event & Course Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
2015			
4 Mar	**AIAA Congressional Visits Day**	Washington, DC	
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)	
8–9 Mar	**Overview of Missile Design and System Engineering**	Laurel, MD	
10–12 Mar	**AIAA DEFENSE 2015** **(AIAA Defense and Security Forum)** **Featuring:** **AIAA Missile Sciences Conference** **AIAA National Forum on Weapon System Effectiveness** **AIAA Strategic and Tactical Missile Systems Conference**	Laurel, MD	**4 Nov 14**
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**
30 Mar–1 Apr†	**50th 3AF Conference on Applied Aerodynamics – Forthcoming Challenges for Aerodynamics**	Toulouse, France (Contact: Anne Venables, +33 1 56 64 12 30, Secr.exec@aaaf.asso.fr, www.3af-aerodynamics2015.com)	
13–15 Apr†	**EuroGNC 2015, 3rd CEAS Specialist Conference on Guidance, Navigation and Control**	Toulouse, France (Contact: Daniel Alazard, +33 (0)5 61 33 80 94, alazard@isae.fr, w3.onera.fr/eurognc2015)	
13–17 Apr†	**2015 IAA Planetary Defense Conference**	Frascati, Italy (Contact: William Ailor, 310.336.1135, william.h.ailor@aero.org, www.pdc2015.org)	
6 May	**Aerospace Spotlight Awards Gala**	Washington, DC	
25–27 May†	**22nd St. Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia, (Contact: Prof. V. G. Peshekhonov, 7 812 238 8210, icins@eprib.ru, www. Elektropribor.spb.ru)	
4 Jun	**Aerospace Today ... and Tomorrow—An Executive Symposium**	Williamsburg, VA	
16–19 Jun†	**7th International Conference on Recent Advances in Space Technologies – RAST 2015**	Istanbul, Turkey (Contact: Capt. M. Serhan Yildiz, +90 212 6632490/4365, syildiz@hho.edu.tr or rast2015@rast.org.tr)	
20–21 Jun	**Optimal Design in Multidisciplinary Systems**	Dallas, TX	
20–21 Jun	**FUN3D Training Workshop**	Dallas, TX	
22–26 Jun	**AIAA AVIATION 2015** **(AIAA Aviation and Aeronautics Forum and Exposition)** **Featuring:** **21st AIAA/CEAS Aeroacoustics Conference** **31st AIAA Aerodynamic Measurement Technology and Ground Testing Conference** **33rd AIAA Applied Aerodynamics Conference** **AIAA Atmospheric Flight Mechanics Conference** **7th AIAA Atmospheric and Space Environments Conference** **15th AIAA Aviation Technology, Integration, and Operations Conference** **AIAA Balloon Systems Conference** **AIAA Complex Aerospace Systems Exchange** **22nd AIAA Computational Fluid Dynamics Conference** **AIAA Flight Testing Conference** **45th AIAA Fluid Dynamics Conference** **22nd AIAA Lighter-Than-Air Systems Technology Conference** **16th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference** **AIAA Modeling and Simulation Technologies Conference** **46th AIAA Plasmadynamics and Lasers Conference** **45th AIAA Thermophysics Conference**	Dallas, TX	**13 Nov 14**
28 Jun–2 Jul†	**International Forum on Aeroelasticity and Structural Dynamics (IFASD)**	Saint Petersburg, Russia (Contact: Dr. Svetlana Kuzmina, +7 495 556-4072, kuzmina@tsagi.ru, www.ifasd2015.com)	
6–9 Jul	**20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference**	Glasgow, Scotland	**8 Dec14**
12–16 Jul†	**International Conference on Environmental Systems**	Bellevue, WA (Contact: Andrew Jackson, 806.834.6575, Andrew.jackson@ttu.edu, www.depts.ttu.edu/ceweb/ices)	

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
25–26 Jul	Business Management for Engineers	Orlando, FL	
25–26 Jul	The Application of Green Propulsion for Future Space	Orlando, FL	
25–26 Jul	Advanced High Speed Air Breathing Propulsion	Orlando, FL	
27–29 Jul	**AIAA Propulsion and Energy 2015 (AIAA Propulsion and Energy Forum and Exposition)** **Featuring:** 51st AIAA/SAE/ASEE Joint Propulsion Conference 13th International Energy Conversion Engineering Conference	Orlando, FL	**7 Jan 15**
9–13 Aug†	2015 AAS/AIAA Astrodynamics Specialist Conference	Vail, CO (Contact: Dr. W. Todd Cerven, william.t.cerven@aero.org, www.space-flight.org/docs/2015_astro/2015_astro.html)	
31 Aug–2 Sep	**AIAA SPACE 2015 (AIAA Space and Astronautics Forum and Exposition)**	Pasadena, CA	**10 Feb 15**
7–10 Sept†	33rd AIAA International Communications Satellite Systems Conference and Exhibition (ICSSC-2015)	Gold Coast, Australia (Contact: Geri Geschke, +61 7 3414 0700, Geri.geschke@emsolutions.com.au, www.satcomspace.org)	**1 Apr 15**
12–16 Oct†	66th International Astronautical Congress	Jerusalem, Israel (Contact: www.iac2015.org)	
2016			
4–8 Jan	**AIAA SciTech 2016 (AIAA Science and Technology Forum and Exposition)** **Featuring:** 24th AIAA/AHS Adaptive Structures Conference 54th AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference 15th Dynamics Specialists Conference AIAA Guidance, Navigation, and Control Conference AIAA Infotech@Aerospace Conference AIAA Modeling and Simulation Technologies Conference 18th AIAA Non-Deterministic Approaches Conference 57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 9th Symposium on Space Resource Utilization 4th AIAA Spacecraft Structures Conference 34th Wind Energy Symposium	San Diego, CA	
5–12 Mar†	2016 IEEE Aerospace Conference	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, Erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)	

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

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

AIAA Continuing Education courses.

From the Corner Office

AEROSPACE POLICY— THE KEYS TO RELEVANCE

Mary Snitch, Vice President, Public Policy

With the 114th Congress currently underway, we look forward to the opportunity to reengage our nation's lawmakers and the public at large about the importance and relevance of aerospace. As we have done in previous years, the AIAA Public Policy Committee (PPC), with input from the Technical Activities Committee, has established public policy key issues that will become the focal points of the Institute's engagement with congressional decision makers, the administration, and state and local officials.

Throughout the years, the Institute's key issues have encompassed a wide range of topics, examining the top issues facing the aerospace community, identifying areas of concern, and proposing policy solutions to address those concerns. This year, we decided to approach the development and promotion of our key issues in a slightly different manner. With a narrower focus and an amplified message, we can now establish a "roadmap" for policy development and advocacy. This change of strategy is based on feedback from congressional staff who appreciate the advocacy of AIAA's individual members, but recommended fewer, more focused issues that include a clear concise "ask" of policymakers.

The PPC has identified four significant issue areas where the Institute will help shape public policy in 2015 that are both timely and of major concern to our members. These key issue areas are 1) Aerospace & Defense (A&D) Budget Funding and Procurement, 2) A&D Competitiveness, 3) Aerospace Cybersecurity and Safety, and 4) A&D Workforce Enhancement.

Our nation's A&D industrial base will continue to face several challenges this year. The acquisition process remains slow and bureaucratic, and, once again, mandated across-the-board funding cuts will be reintroduced should Congress not act before the end of the fiscal year. Meanwhile, the current FAA authorization bill will expire on 30 September, while NASA has continued to operate without direct authorization by Congress.

Several other items must also be addressed by Congress in order for our nation's A&D industrial base to remain competitive in a growing global market. For decades, the U.S. Export-Import Bank has helped domestic aerospace manufacturers export to new markets where commercial lending is scarce. The bank is currently operating under a short-term authorization that will expire on 30 June, and Congress must pass a long-term reauthorization. Moreover, Congress must modify existing export regulations to focus on truly protected technologies and make the R&D tax credit permanent.

Another item of significance to our members is the growing threat of cyber attacks. Rapidly evolving threats, budget constraints, bureaucratic barriers, and the challenges to information sharing hamper federal agencies in properly addressing these threats, the effects of which ultimately impact the private sector. While similar cybersecurity challenges threaten the private sector, the A&D industry is often more able to develop and exploit technologies that prevent or mitigate the severity of attacks. We must ensure adequate funding and the enactment of new policies if we are to tackle these shortcomings within our nation's cybersecurity framework. At the same time, we must forge enhanced partnerships between agencies and industry, working with a mutually acceptable framework, roadmap, and strategy, to develop and deploy appropriate technologies needed to combat this threat to national security.

A robust and technologically-proficient A&D sector is also essential to our national security, and it is imperative for Congress to continue to promote policies that will enhance our workforce. This includes improving the pipeline of STEM-educated workers into the U.S. economy, providing additional funding to graduate students in STEM fields, and offering tax incentives to companies that participate in STEM outreach. Furthermore, Congress must act to retain highly-skilled foreign-born STEM graduates who receive degrees at U.S. universities, which is essential for our economic prosperity and necessary for the United States to remain competitive.

Our key issues will form the supporting pillars of AIAA's Congressional Visits Day (CVD) program that brings more than 100 aerospace professionals and students to Washington, DC, each year for a day of advocacy with lawmakers. Participants of the CVD program meet with members of their state's congressional delegation and staff from congressional committees that have jurisdiction over aerospace issues. CVD unites our community and brings attention to these important matters. This year's CVD will take place **Wednesday, 4 March**, and we are excited about our members' continued involvement in this successful program.

AIAA's key issues and related subtopics will also form the basis of a number of smaller focused events and roundtables throughout the year, as well as drive panel discussions at our annual forums. We look forward to our esteemed panel experts stimulating thought-provoking conversations and providing alternative ideas to help our community address our policy agenda.

2015 is shaping up to be a great year for AIAA on the public policy front, but we need your support to help achieve our goals. Participation is power and your involvement at the federal, state, and local levels drives our success and ensures that the Institute continues to lead the way on issue advocacy impacting the aerospace sector.

Please see the complete 2015 AIAA Key Issues on pages B6–B8.

CVD 2015: Don't Miss A Chance To Make A Difference

Please join us on **4 March 2015** for AIAA's Congressional Visits Day, so Congress can hear your voice. You can tell them yourself how important aerospace is to our nation's continued economic prosperity and national security. To help you attend the event, AIAA is pleased to make limited travel stipends available to defray the cost of participation. For more information on the AIAA Congressional Visits Day program, or on the travel stipends, please contact Steve Sidorek, AIAA Public Policy, at steves@aiaa.org or at 703.264.7625. Please join us on **4 March 2015** to speak up for aerospace.

More Info about CVD (**http://www.aiaa.org/Secondary.aspx?id=4343**)
Register for the 2015 CVD (**https://www.aiaa.org/CVD2015**)

AIAA 2015 KEY ISSUES

Aerospace & Defense Budget Funding and Procurement

Background: The aerospace and defense (A&D) industry is the nation's largest manufacturing exporter. A&D exports of $110.8 billion provided the economy with a $72.1 billion foreign trade surplus in 2013. Sales in 2013 totaled $220 billion—leveling off after nine consecutive years of growth. Continued stability of the A&D industrial base is critical to our economy, national security, infrastructure, and future workforce. As the world's largest aerospace professional society, serving a diverse range of more than 30,000 individual members from 88 countries, and 95 corporate members, the American Institute of Aeronautics and Astronautics (AIAA) urges Congress to enact and sustain policies that will strengthen the long-term viability of the A&D industrial base.

Issue: Budget Instability. The A&D industry is facing one of its greatest challenges in history as Congress and the administration deal with mounting national debt and the need to balance the federal budget. All federal agencies face significant budget reductions, with the Department of Defense (DoD) potentially bearing the biggest burden. While all areas must be examined to identify unnecessary spending that can be reduced or eliminated, we must make sure that the nation's future is not mortgaged to address today's crises.

The current framework of the Bipartisan Budget Act expires on October 1, 2015, meaning that without action by Congress the renewed enforcement of mandated reductions under the Budget Control Act, known as sequestration, will severely damage the A&D industrial base again.

The A&D industrial base possesses unique capabilities and expertise to address the distinctive and diverse missions required by its civilian and military customers. Small business is the backbone of the U.S. economy and technology innovation. The domino effect of reduced federal budgets will undoubtedly force some companies out of business and others to scale back significantly, potentially resulting in single-source suppliers or elimination of domestic suppliers for items on critical development paths. If those capabilities are allowed to erode in this lean budget environment, the United States could risk losing its technological edge and be unable to address future threats to our national security or economic stability. In addition, constrained and uncertain budgets limit test opportunities and create a potentially dangerous climate of risk aversion. For far too long Congress has operated under continuing resolutions without a normal appropriations process. A budget deal that extends beyond FY15 is needed almost immediately so that the nation, including the A&D industrial base, can begin work on initiatives critical to a robust and secure future.

Issue: Acquisition Reform. The timely federal procurement of required goods and services is critical to the stability of this nation's economy and national security. While there have been a number of national initiatives to speed up the acquisition process, it remains slow and bogged down in bureaucracy. Sequestration further negatively impacted an already slow process. Delays in contract execution severely impact budgets and manpower requirements within the A&D industry. The recent release of the DoD's Better Buying Power 3.0 Initiative could further complicate the procurement process. It is essential that if this new plan is enacted that it be balanced with a process that enables timely contract execution. Protection and retention of A&D intellectual property must also be addressed in any reform of the acquisition process.

Issue: Reauthorize FAA. Following five short-term extensions, the current FAA authorization bill, which passed in 2012, will expire on September 30, 2015. The bill's expiration threatens several projects vital to our nation's future as an aerospace leader: placing unmanned aerial vehicles in the national air space, meeting the growing demands for expanded commercial air travel, and developing the Next Generation Air Traffic Control System. Only reauthorization of the bill, at adequate funding levels, ensures that our nation remains the world leader in aerospace innovation.

Issue: Reauthorize NASA. Since last authorized in 2010, NASA continues to prove why the United States is the world's leader in aerospace innovation. NASA's Mars Science Laboratory Curiosity Rover continues conducting wide-ranging tests, delivering significant information about the Red Planet. Commercial contractors are revolutionizing space technology, and providing regular cargo resupply missions to the International Space Station. And this past December, the Orion spacecraft completed its first successful test, orbiting the Earth twice. In skies closer to us, NASA's National Partnership for Aeronautical Testing is helping to establish the future of aeronautic test facilities, while its Aviation Safety Program continues to make our skies and commercial flight safer through its development of innovative safety systems; and its Fundamental Aeronautics program continues to find ways to make aviation more environmentally friendly and efficient.

Despite this progress, shifting priorities on Capitol Hill have left NASA without a clear direction. While a reauthorization bill passed the House of Representatives last year by an overwhelming margin, the Senate never considered the legislation. It is imperative that Congress pass a multi-year NASA reauthorization bill providing stable funding and policy direction that will help sustain U.S. leadership in aeronautics, spaceflight, and related research for years to come.

AIAA Recommendations

- End sequestration and employ sound budgetary principles for the long-term development and manufacture of complex aerospace systems and architecture necessary to accomplish strategic national goals
- Reauthorize and adequately fund the FAA
- Reauthorize and adequately fund NASA

Aerospace & Defense Competitiveness

Background: The aerospace and defense (A&D) industry is the nation's largest manufacturing exporter. Technology drives over half of the U.S. Gross Domestic Product. To keep our technology edge, we must continue to invest in research and development in an effort to compete with the growing investment by other nations. Stability of the A&D industrial base is also critical to our economy, national security, infrastructure, and future workforce. As the world's largest aerospace professional society, serving a diverse range of more than 30,000 individual members from 88 countries, and 95 corporate members, the American Institute of Aeronautics and Astronautics (AIAA) urges Congress to enact and sustain policies that will strengthen the long-term viability of the A&D industrial base.

Issue: Reauthorization of the Export-Import Bank. As more foreign companies continue to enter the aerospace market, the Export-Import Bank of the United States (Ex-Im Bank) has helped U.S. aerospace manufacturers export to new markets where commercial lending is scarce to keep up with growing global competition. Currently, the Ex-Im Bank is functioning under a short-term extension that is set to expire on June 30, 2015. Its charter has been renewed with bipartisan support from Congress for over 80 years, having passed both chambers overwhelmingly in 2012. It is important to note that the Ex-Im Bank has not incurred any losses in recent years and it operates at no cost to the American taxpayer. Over the last five years, the bank has actually returned $2 billion more than it was required to the Treasury to cover operating costs and any bad loans. AIAA calls on Congress to reaffirm its commitment to the Ex-Im Bank and to pass a five-year reauthorization so U.S. aerospace companies can remain competitive in the global market.

Issue: ITAR Reform. Aerospace systems are becoming increasingly complex, software-intensive, and interdependent. Imperfectly executed export controls exacerbate the challenges facing the A&D industry. The current set of regulations was intended to protect technology that could be used for military purposes by our adversaries. However, the implementation of existing regulations has served to prevent American companies from doing business with friendly nations in nonmilitary applications. These policies need to be updated to focus on truly protected technologies.

Issue: R&D Tax Credit. The R&D tax credit was originally introduced in the Economic Recovery Act of 1981 as a way to stimulate research and development by providing a tax credit for companies that are incurring R&D expenses. The R&D tax credit has been renewed on a bipartisan basis 16 times since its inception, and AIAA strongly believes that Congress should make this policy permanent.

AIAA Recommendations

- Pass a five-year reauthorization of the Export-Import Bank so U.S. aerospace companies can remain competitive in the global market
- Congress should modify existing regulations by updating protected technologies and alleviating unintended complications of doing business with friendly nations
- Make the R&D tax credit permanent

Aerospace Cybersecurity and Safety

Background: As the world's largest aerospace professional society, serving a diverse range of more than 30,000 individual members from 88 countries, and 95 corporate members, the American Institute of Aeronautics and Astronautics (AIAA) urges Congress to enact policies that will address the growing threat, costs, and potential shortcomings relative to cybersecurity at various federal agencies, and within the aerospace and defense (A&D) industry in general.

The full scope of cybersecurity threats is difficult to grasp and quantify. Vulnerabilities run the gambit from compromised Personally Identifiable Information (PII) to Distributed Denial of Service (DDoS) attacks on critical infrastructure all the way to economic espionage and the subversion of critical national security and public safety systems. Agencies and companies are facing significant and ongoing cybersecurity and safety threats, while at the same time confronting nontechnical issues including budget uncertainty, an evolving national strategy, and how, when, where, and if information can be shared among impacted agencies and industries. While key agencies within the federal government are currently dealing with these challenges, this ambiguity on strategy and information sharing is impacting the private sector.

Budget constraints forced upon the federal government as a result of sequestration and the Budget Control Act have resulted in the consideration of tough tradeoffs as agencies focus their limited dollars on the areas vital to the overall safety and security of the systems and assets they oversee on the "franchise" programs (i.e., Next Generation Air Traffic Control System, International Space Station, etc.). Alternatively, an agency could choose to spread fewer dollars over all areas equally. Regardless, critical systems and programs are put in jeopardy. Developing and implementing a robust cybersecurity strategy will require barriers to be identified and addressed—not the least of which are technology challenges—and sustained and adequately funding, as well as overall coordination and collaboration.

Most federal agencies struggle to stay current with the rapidly changing threats of cybersecurity, let alone anticipate new developments. Government Accountability Office (GAO) reports continue to highlight shortcomings and gaps in agencies' efforts to address both physical and network cyber challenges. Additionally, the Office of Inspector General (OIG) at both NASA and the FAA have highlighted information technology (IT) infrastructure as key areas of concern among top management challenges at both agencies. The FAA IG specifically called for developing a strategic vision to better manage current technologies, plan for future systems, and maximize cost savings.

These reports, as well as recent cyber and physical intrusion events, highlight vulnerabilities in the safety, reliability, and redundancy of key federally managed systems. The A&D private sector faces similar cybersecurity challenges related to industrial espionage, loss of technology, and cyber attacks that have national security and safety implications as well. Relationships between federal and private entities can leave both systems vulnerable to attack. With today's commercial aircraft network flying more than ever before, commercial aircraft are becoming targets for cyber attacks. Understanding the nature of the threat and breaking down barriers to information sharing will be key aspects of developing a robust and viable national cybersecurity strategy.

Issue: Open Sharing of Information. Sharing of current threats, recent breaches, and evolving intelligence is paramount to addressing future threats. The Director of the National Security Agency (NSA) said, "It's only matter of the 'when,' not the 'if,' that we are going to see something dramatic." Methods of successful cyber attacks are frequently copied. If agencies and companies know what current attack methods have been used and what vulnerabilities were exploited, additional attacks can be minimized or mitigated, if not thwarted. Information Sharing and Analysis Centers (ISAC) were established to facilitate the exchange of information. Subsequent actions (PPD-21, etc.) were done to strengthen that sharing. Congress should conduct a review of the current sharing protocols and direct the Department of Homeland Security (DHS) to report on shortcomings and proposed changes.

Issue: Cybersecurity Framework and Roadmap. The number of public and private sector players in the cybersecurity realm is extensive. A framework that leads to a roadmap and an implementable strategy are essential to organize the stakeholders and build consensus. In 2013, AIAA released a framework to address commercial aviation. Frameworks for tackling cyber challenges in the space and defense sectors need to be established. Participation by key government agencies (DHS, DoD, DoT, etc.) will be critical to developing a unified and actionable framework from which a roadmap and strategy can evolve. Congress should direct all relevant federal agencies to participate in and support the development of a unified framework for cybersecurity in the space and defense sectors and support the advancement of the 2013 commercial aviation framework to an accepted national level strategy.

Issue: A&D Industry Assessment. After the 2008 financial crisis, the Federal Reserve began conducting periodic “stress tests” on financial institutions to determine their ability to cope with certain hypothetical scenarios. Currently there is no similar government-wide, standard approach for conducting a cybersecurity stress test. Before directed action to address vulnerabilities can be taken, the current state of the system must be established. Recent GAO reviews have been of limited scope with regard to agencies and infrastructure (GAO-15-6). A comprehensive review is necessary. Congress should direct that a plan be developed for a government-wide stress test that will incorporate the relevant aspects of the DHS National Infrastructure Protection Plan (DHS NIPP), called for in the National Institute of Standards and Technology (NIST) document “Framework for Improving Critical Infrastructure Cybersecurity” (Feb. 2014), and AIAA’s “A Framework for Aviation Cybersecurity” (Aug. 2013).

AIAA Recommendations

- GAO conduct review of barriers to open sharing of information regarding cyber threats
- Direct the responsible agencies to participate in public-private partnerships in the development of Cybersecurity Roadmaps for Defense and Space comparable to the AIAA “Framework for Aviation Cybersecurity”
- GAO conduct federal agency stress test that will incorporate the relevant aspects of the DHS NIPP, NIST document, and AIAA’s “Framework for Aviation Cybersecurity”

Aerospace & Defense Workforce Enhancement

Background: As the world’s largest aerospace professional society, serving a diverse range of more than 30,000 individual members from 88 countries, and 95 corporate members, the American Institute of Aeronautics and Astronautics (AIAA) urges Congress to enact and sustain policies that will enhance a robust, technologically-proficient aerospace and defense (A&D) sector that is essential to our national security.

The adequacy of the U.S. science and engineering workforce is an ongoing concern of Congress and the aerospace industry. Scientists and engineers are essential to U.S innovation and growth, including in the A&D sector. To that end, the Government Accountability Office recently reported that the number of science, technology, engineering, and mathematics (STEM) degrees awarded grew 55 percent from 1.35 million in the 2002–2003 academic year to over 2 million in the 2011–2012 academic year. AIAA commends the programs that have been put in place by Congress and hopes to see these continually enhanced.

Issue: Workforce Preparation. Building on this success, AIAA strongly believes that the 114th Congress should pass legislation, with a theme similar to portions of the recent America COMPETES and FIRST Acts, that includes provisions that will enhance the pipeline of STEM-educated workers into the U.S. economy. The National Science Foundation (NSF) Graduate Research Fellowship, the oldest STEM program available to graduate students, should be enhanced to provide additional funding to graduate students in STEM fields today. In addition, Congress should include both tax incentives for industry to participate in STEM outreach and built-in minimum requirements for STEM-related activities associated with STEM-based contracts under the Federal Acquisition Regulation.

Issue: Foreign Professionals in STEM Fields. While bolstering the U.S. base of STEM workers, Congress should also renew its interest in facilitating the immigration of foreign professional workers in STEM fields. Efforts in the 112th and 113th Congress to pass legislation that would provide expedited immigration avenues to foreign workers in STEM fields failed, and it is AIAA’s belief that these efforts should be revived in the 114th Congress. Highly skilled, foreign-born workers who have been educated at U.S. colleges and universities in STEM fields are engines of entrepreneurship and economic growth. Keeping more of these foreign-born STEM graduates in the United States is vital to ensuring economic prosperity throughout the A&D sector and enhancing that sector’s contributions to U.S. competitiveness. If those graduates are able to remain in the U.S., it alleviates the likelihood that they will set up a business that will compete with U.S. interests in their home countries or elsewhere.

Issue: Maintaining a Skilled Workforce. In addition to implementing programs that will help drive qualified individuals into the STEM workforce, industry, government, and academia must do a better job of sharing information and facilitating exchange with one another. Such efforts will go a long way to developing and preserving critical skills in the workforce. The Department of Defense (DoD) has programs for temporary exchange of DoD and private sector employees who work in the field of information technology in the Information Technology Exchange Program. This type of model should be expanded to include intergovernmental agreements throughout the A&D sector that includes exchange between industry, government, and academia alike. Congress should play a key role in encouraging the administration to develop a program that conducts this exchange. Mechanisms should be put in place to encourage industry to continue training and development activities with the current workforce.

Issue: Integrating New Knowledge Into the Workforce. Finally, with many new, exciting fields emerging in A&D engineering, Congress must continue to work to develop programs that will help integrate these fields into the knowledge base and competency of the existing workforce. For example, advances in technology have increased workforce reliance on computational tools. This reliance potentially adds risk to the research and design process unless a proper balance is encouraged to complete adequate end demonstrations of the technology through simulations, ground tests, and flight tests. Developing and sustaining the skills necessary to strike this balance is important to long-term U.S. preeminence in aviation, and teaching these skills in STEM mentoring programs ensures retention of hard-won lessons.

AIAA Recommendations

- Pass legislation, with a theme similar to portions of the recent America COMPETES and FIRST Acts, that includes provisions to enhance the pipeline of STEM-educated workers into the U.S. economy

  — Enhance NSF Graduate Research Fellowship funding

  — Provide tax incentives for industry to participate in STEM programs and training and development programs for the existing workforce
- Pass STEM visa legislation similar to that considered in the 112th Congress to encourage the retention of foreign professional STEM workers in U.S. industry
- Direct more exchange between government, industry, and academia in the A&D sector via intergovernment personnel agreements, and provide incentives to participate in these activities
- Develop programs that enable integration of emerging A&D fields into the knowledge base and competency of the existing workforce, including the skills necessary to complete end-demonstrations of new technologies

AIAA ANNOUNCES FELLOWS AND HONORARY FELLOWS—CLASS OF 2015

AIAA has selected its Class of 2015 AIAA Fellows and Honorary Fellows. Presentation of the new Fellows and Honorary Fellows will take place at the AIAA Aerospace Spotlight Awards Gala on 6 May 2015 at the Ronald Reagan Building and International Trade Center in Washington, DC.

Honorary Fellow is the highest distinction conferred by AIAA, and recognizes preeminent individuals who have had long and highly contributory careers in aerospace and who embody the highest possible standards in aeronautics and astronautics. The 2015 Honorary Fellows are:

Frederik J. Abbink, The National Aerospace Laboratory of the Netherlands
Kyle T. Alfriend, Texas A&M University
Wanda M. Austin, The Aerospace Corporation
Ben T. Zinn, Georgia Institute of Technology

"The titles of AIAA Fellow and Honorary Fellow are among the most prestigious honors in the aerospace profession," said AIAA President Jim Albaugh. "Each title is a mark of excellence and distinction, and recognizes extraordinary contributions to aerospace. AIAA congratulates the members of the 2015 Class of Fellows and Honorary Fellows on their selection."

AIAA confers the distinction of *Fellow* upon individuals in recognition of their notable and valuable contributions to the arts, sciences, or technology of aeronautics and astronautics. The 2015 Fellows are:

Allen Arrington, Jr., Sierra Lobo Inc.
Thomas Beutner, Office of Naval Research
Lawrence Brase, The Boeing Company
John Crassidis, University at Buffalo, State University of New York
David Eames, Rolls-Royce Corporation
Eric Evans, Massachusetts Institute of Technology (MIT) Lincoln Laboratory
Debra Facktor Lepore, Ball Aerospace & Technologies Corporation
Alison Flatau, University of Maryland
Michimasa Fujino, Honda Aircraft Company
Wayne Goodman, The Aerospace Corporation
Jayanth Kudva, NextGen Aeronautics Inc.
Timothy Lieuwen, Georgia Institute of Technology
E. Glenn Lightsey, University of Texas at Austin
Eli Livne, University of Washington
James Maser, James G. Advisors LLC
Paul McManamon, Exciting Technology LLC
David W. Miller, Massachusetts Institute of Technology/NASA
Alton Romig, Jr., Lockheed Martin Corporation
Robert H. Smith, Honeywell International, Inc.
Ashok Srivastava, Verizon Corporation
James Walker, Southwest Research Institute
Zhi Jian Wang, University of Kansas

"This year, as in every year, each of the nominees for AIAA Fellow stands at the top of our aerospace community in terms of their contributions to our profession, and that makes our selection process a particularly difficult one," said George Muellner, chair of the AIAA Fellows Selection Committee. "In the end, we picked 22 individuals whose work has been truly outstanding. AIAA congratulates our Class of 2015 AIAA Fellows and we look forward to their continued roles in shaping the future of aerospace."

In 1933, Orville Wright became AIAA's first Honorary Fellow. Today, AIAA Honorary Fellows and AIAA Fellows are the most respected names in the aerospace industry. For more information on AIAA's Honors Program, or the AIAA Honorary Fellows or Fellows program, please contact Patricia A. Carr at 703.264.7523 or at triciac@aiaa.org.

NASA ORION EFT-1 LAUNCH VIEWING ASSEMBLY AT LEEDS ELEMENTARY SCHOOL

For NASA's Orion EFT-1 launch, the **AIAA Delaware Section** sponsored a launch viewing event for the entire student body at Leeds Elementary School in Elkton, MD, in honor of the first graders at Leeds Elementary who were serving as virtual crew members for the mission. The first graders had earned this opportunity by participating as kindergarteners last February in the NASA Exploration Design Challenge that was facilitated by the AIAA Delaware Section. As part of the challenge, students learned about the effects of radiation on human space travelers and analyzed different materials that simulate space radiation shielding for NASA's Orion spacecraft. To reinforce what was learned as part of the NASA Exploration Design Challenge, the AIAA Delaware Section worked with Lockheed Martin and ATK to provide background materials on Orion to all teachers at Leeds Elementary, who incorporated the information into their curriculum for the week leading up to the EFT-1 launch.

On the day of the first Orion EFT-1 launch attempt, AIAA Delaware Section Public Policy Officer, Tim Dominick, and member, Eric Rorhbaugh, visited Leeds Elementary to give a presentation to the entire school on Orion and the EFT-1 mission where the students learned that Orion is ~50% larger than Apollo and will hold up to six astronauts, and that SLS is taller than the Statue of Liberty and produces more power than 13,400 locomotives. The students also learned about how local engineers are contributing to the NASA Orion program through working on the Orion Launch Abort System (LAS) Attitude Control Motor (ACM) at ATK in Elkton, MD. The ACM is 62-inches tall and 32 inches in diameter and is designed to steer the Orion spacecraft to safety in case of an emergency on the launchpad or in flight. Anticipation for the Orion EFT-1 launch was built by showing videos of an ACM static test and the Orion "Trial By Fire" YouTube video describing what the Orion spacecraft would experience as part of its EFT-1 flight. The students seemed to appreciate both videos and the accompanying smoke and fire!

AIAA Delaware Section Public Policy Officer Tim Dominick presents an SLS model to representatives of the Leeds Elementary 1st Grade Class. Ryne Dominick, Mason Gentry, and Isabella Moran accepting the SLS model donated by ATK Elkton.

Since the launch was scheduled for earlier in the day, the AIAA Delaware Section made arrangements for the students to watch it on tape delay. The first launch attempt was aborted, which proved to be a good opportunity for the students to learn that not everything always goes as planned, and that rocket science really is hard. Fortunately, Orion EFT-1 successfully launched the next day, and the students were all able to watch the launch and recovery live from their classrooms.

At the end of the assembly, Mr. Dominick and Mr. Rohrbaugh presented representatives of the Leeds Elementary First Grade Class with a 1/200-scale model of SLS and Orion donated by ATK in Elkton, MD, in honor of the first graders serving as virtual crew on EFT-1. Every classroom at Leeds Elementary will have the opportunity for the model to visit their classroom for a week. After its tour of the school, the model will be displayed in the school library to remind students at Leeds Elementary how exciting space exploration can be.

AIAA Delaware Section Public Policy Officer Tim Dominick presenting details on the Orion EFT-1 mission to students at Leeds Elementary.

DR. ALEXANDER "LEX" SMITS APPOINTED AS NEW EDITOR-IN-CHIEF OF THE *AIAA JOURNAL*

On 6 January 2015, AIAA President James Albaugh formally appointed **Dr. Alexander Smits** as editor-in-chief of the *AIAA Journal* (*AIAAJ*).

Prof. Smits holds B.Eng. (Mech.) and Ph.D. degrees from the University of Melbourne, Australia. Currently, Smits is the Eugene Higgins Professor of Mechanical and Aerospace Engineering at Princeton University; he also serves as a Monash Professorial Fellow at Monash University in Australia. He has been at Princeton since 1981 and is a leading figure in aerospace research, innovation, and education, and an exemplar of the highest standards of personal integrity and professional conduct who will bring authority and distinction to the editor-in-chief position.

Smits recently served a second term as chair of Princeton's Department of Mechanical and Aerospace Engineering from 2007 to 2014. His research interests are diverse, including fundamental research in turbulence and fluid mechanics, the behavior of low and high Reynolds number turbulent boundary layers at subsonic, supersonic and hypersonic speeds; shock-wave/turbulent boundary layer interactions; effects of roughness; flow control; Taylor-Couette flows; biomimetic flows; sports ball aerodynamics, wind turbine aerodynamics, and the development of new and improved measurement techniques.

From a publications perspective, Smits brings extensive experience to his new role, having served as an editorial board member of the *Proceedings of The Institution of Mechanical Engineers, Part P*; an associate editor of the *Journal of Turbulence* and the *Journal of Fluid Mechanics*, and as a member of the editorial board of the *Journal of Experimental Thermal and Fluid Science*. He is also one of the chief editors of fluids.com, a web portal for researchers in the field of fluid dynamics. He has also served as editor-in-chief of the *Journal of Experimental Thermal and Fluid Science*.

A Fellow of AIAA, Smits' past honors include the 2014 AIAA Fluid Dynamics Award, the 2007 AIAA Pendray Aerospace Literature Award, and the 2004 AIAA Fluid Dynamics Award. Smits is a member of the National Academy of Engineering, as well as a fellow of the Australasian Fluid Mechanics Society, the American Association for the Advancement of Science, the American Society of Mechanical Engineers, and the American Physical Society. He has been a member of AIAA's Institute Development Committee and the Fluid Dynamics Technical Committee.

Lex Smits was selected from a competitive pool of applicants, and becomes the seventh editor-in-chief of the journal. The *AIAA Journal* was established by AIAA in 1963, following the merger of the Institute of the Aerospace Sciences and the American Rocket Society, and grew out of these predecessor societies' journals, the *Journal of the Aerospace Sciences* and *ARS Journal*, respectively. Smits succeeds Prof. Peretz Friedmann of the University of Michigan, who served as editor-in-chief of *AIAAJ* from 2009 to 2014.

OBITUARIES

AIAA Associate Fellow Balas Died in November

Gary Balas passed away on 12 November 2014. He was 54 years old.

Professor Balas was a faculty member at the University of Minnesota in the Department of Aerospace Engineering and Mechanics from 1990–2014. He was an international leader in the field of experimental and theoretical control systems. Balas was a Distinguished McKnight University Professor and served as the Department Head for eight years. He also served as Director of Graduate Studies and Co-Director of the Control Science and Dynamical Systems Program, and served the University of Minnesota in many capacities, including as chair of the Faculty Consultative Committee of the University Senate.

Professor Balas' research focused on the application of software-enabled control to uninhabited aerospace vehicles and on the development of robust, state-of-the-art algorithms and tools for control engineering. He was a visiting scholar and lecturer at institutions around the world and was a consultant to government and industry.

Balas was an accomplished scholar who authored or co-authored over 75 journal publications, over 160 referred conference papers and invited papers, and 10 book articles. He was the thesis adviser for 36 Masters and 21 Ph.D. students. His leadership of the Department and his unwavering positive energy were instrumental in bringing talented people to Minnesota.

Balas was a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), an AIAA Associate Fellow, an IEEE Control System Society Fellow, and a Fellow of the Committee on Institutional Cooperation Academic Leadership Program. He was the Chair of the Aerospace Department Chairs Association (ADCA) and an Honorary Member of the Hungarian Academy of Engineering. He was associate editor of the International Federation of Automatic Control's *Control Engineering Practice Journal*, associate editor of the AIAA *Journal of Guidance, Dynamics, and Control*, and served as a reviewer for many other international journals. Balas' honors included the Outstanding Young Investigator Award, the Institute of Technology George Taylor Distinguished Research Award, the IEEE Control Systems Society Technology Award, the O. Hugo Schuck Best Paper Award, and the Prize for Development of the Hungarian Aeronautical Science, among others.

AIAA Fellow Schaufele Died in December

Roger D. Schaufele died on 10 December 2014.

Mr. Schaufele was a graduate of Rensselaer Polytechnic Institute and the California Institute of Technology. He was a naval reservist. He worked for 39 years at the Douglas Aircraft Company, where he rose to the position of Vice President of Engineering.

Mr. Schaufele was elected as an AIAA Fellow and served as a member of two NASA advisory panels. He was selected as the Orange County Engineer of the Year in 1985, and in 2014 was inducted into the San Diego International Aviation Hall of Fame.

Associate Fellow Elliott Died in December

Jarrell (Jerry) R. Elliott passed away on 15 December 2014.

After one year at Little Rock University, Mr. Elliott won a Navy scholarship to Auburn University, where he graduated with a degree in Aeronautical Engineering. Following service in the Marine Corps and a brief stint in the aircraft industry, he returned to Auburn to earn his M.S. in Applied Mathematics.

In 1956, Jerry joined the Theoretical Aerodynamics Group at NASA Langley Research Center and eventually headed the Theoretical Methods Branch, the Analytical Methods Branch and the Aircraft Guidance and Controls Branch. He contributed to trajectory optimization theory, including development of the PRESTO program and early work on lifting trajectories for the space shuttle, and to guidance and control theory as applied to programs such as the SCOUT 4 Stage Rocket program, the F-8 Digital Fly-By-Wire Program, the F-18 High Angle of Attack Research Program, and the National Aero Space Plane. He was a nationally and internationally recognized expert in development of applied aircraft and control theory and was active in the AIAA in various capacities. His awards included the NASA Apollo Achievement Award, the Special Achievement Award and the NASA Exceptional Service Medal. He retired from NASA in 1994.

Rocket Pioneer Grau Died in December

Dieter Grau, rocket pioneer and member of the original Wernher von Braun Team, passed away on 17 December 2014, at the age of 101. He dedicated his life to the development of guided missiles, manned space flight and keeping the dream of space alive for future generations.

Born in Berlin, Germany, he received his Master's Degree in Electrical Engineering from the Technical University in Berlin in 1937 and started his career at Siemens designing and building electrical power networks. In 1939, he was drafted into the German Army and was assigned to repair electrical systems for tanks and other vehicles.

After a short stay in the army, Siemens was able to obtain his release so that he could continue his work on electrical systems. At that time, Siemens sent him to Peenemuende to build the electrical network for the development of rocketry. Mr. Grau continued to work for Siemens in Peenemuende until early 1943. In March 1943, he was drafted again and sent to the Russian front. After 4 months in Russia, he received orders to return to Peenemuende and work for the Rocket Development Center under Wernher von Braun. There he was assigned to work at Test Stand VII to help debug the rockets and prepare them for static firing and launching.

At the end of World War II, Wernher von Braun surrendered to the U.S. Army. The U.S. military authorized 125 German scientists, engineers, and craftsmen to come to the United States under Operation Paper Clip to continue the rocket program. In January 1946, Mr. Grau was sent to Fort Bliss near El Paso, TX, to continue the development of rockets. He worked on the development of guidance systems and electrical networks for the rockets. In 1950, the U.S. Army rocket program moved to Huntsville, AL.

Mr. Grau became a U. S. citizen in 1954. In Alabama, he continued to work for the Army Ballistic Missile Agency until the establishment of NASA and the Marshall Space Flight Center. In 1960, Dr. von Braun selected him to become the Director of Quality and Reliability Assurance. He and his team were responsible for the successful launching of the manned space flight projects Mercury, Gemini, and Apollo. The quality standards established under Mr. Grau's guidance were applied throughout the NASA organization. During his active years Dieter Grau was a member of AIAA and the American Society of Quality Control. He received numerous awards, including the NASA Apollo Achievement Award and the NASA Exceptional Service Medal. He retired from NASA in 1973.

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.


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CALL FOR NOMINATIONS

Recognize the achievements of your colleagues by nominating them for an award! Nominations are now being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 February**. Awards are presented annually, unless other indicated. However AIAA accepts nomination on a daily basis and applies to the appropriate year.

Any AIAA member in good standing may serve as a nominator and are highly urged to carefully read award guidelines to view nominee eligibility, page limits, letters of endorsement, etc.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Upcoming AIAA Continuing Education Courses

Course at AIAA Defense and Security Forum 2015 (AIAA DEFENSE 2015)
www.aiaa-defense.org/ContinuingEd

8–9 March 2015

Overview of Missile Design and System Engineering (Instructor: Eugene L. Fleeman)

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

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

Courses at AIAA Aviation and Aeronautics Forum 2015 (AIAA AVIATION 2015)
www.aiaa-aviation.org/ContinuingEd

20–21 June 2015

Optimal Design in Multidisciplinary Systems (Instructors: Joaquim R. R. A. Martins and Jaroslaw Sobieski, Ph.D)

When you are designing or evaluating a complicated engineering system such as an aircraft or a launch vehicle, can you effectively reconcile the multitude of conflicting requirements, interactions, and objectives? This course introduces you to methods and tools that have been developed over the years for the design optimization of engineering systems.

You will be presented with a review of the state-of-the-art methods for design optimization that exploit the modern computer technology for applications with large numbers of variables, and design constraints. You will learn how to evaluate sensitivity of the design to variables, initial requirements, and constraints, and how to select the best approach among the many that are currently available.

The last part of the course will take you to system-level applications where the primary problem is in harmonizing the local disciplinary requirements and design goals to attain the objectives required of the entire system, and where performance depends on the interactions and synergy of all its parts. In addition to imparting skills immediately applicable, the course will give you a perspective on emerging methods and development trends.

Key Topics
- Multidisciplinary design-components, challenges, and opportunities
- Optimization methods
- Sensitivity analysis
- Decomposition architectures in multidisciplinary design
- Surrogate modeling in design
- Soft computing methods in optimal design

FUN3D Training Workshop

Please note that FUN3D is export-controlled software and may only be provided to U.S. persons.

This workshop will provide participants with guidance on how to install and execute the NASA Langley Research Center FUN3D computational fluid dynamics software for common aerospace applications. The objective of this workshop is to provide engineers and scientists with sufficient instructions to apply a large-scale Navier-Stokes solver to their analysis and design applications of interest. Detailed instructions will be provided for topics including analysis of steady and unsteady flow, boundary conditions, application to dynamic and overset mesh simulations, adaptive gridding, aerospace computations, geometry parameterization, and adjoint-based design optimization.

Courses at AIAA Propulsion and Energy Forum 2015
www.aiaa-propulsionenergy.org/ContinuingEd

25–26 July 2015

Business Management for Engineers (Instructors: Alan C. Tribble and Alan Breitbart)

This course will help individuals with a technical background master the business principles that guide the leadership of an engineering-oriented company. The course will prepare students for the transition from the role of a technical contributor to that of a business leader.

Key Topics
- Capitalism and free markets
- Business finance

- Business structure and functions
- Relationship between systems engineering and program management
- Communicating for business impact versus technical
- Globalization

The Application of Green Propulsion for Future Space

Liquid propulsion systems are critical to launch vehicle and spacecraft performance and mission success. This two-day course, taught by a team of government, industry, and international experts, will cover propulsion fundamentals and topics of interest in launch vehicle and spacecraft propulsion, non-toxic propulsion drivers, propellants and figures of merit, applications of non-toxic propulsion, flight experience, and advances in smallsat propulsion. Lessons learned from development and flight of components and systems will be discussed.

Key Topics
- Rocket propulsion fundamentals
- Structural considerations in rocket engine design
- Rocket engine testing
- Development and flight experience with green monopropellants
- Microsat, nanosat, and cubesat propulsion
- Dual mode engines and propulsion system trades

Advanced High Speed Air-Breathing Propulsion

Revolutionary methods of high speed air-breathing propulsion are needed to extend the flight regime of aircraft, missiles, and improve Earth-to-orbit spacecraft. Advanced High Speed Air-Breathing Propulsion will introduce students to the design and development processes of high speed propulsion, including ramjet/scramjets and TBCC concepts. The course will present a comprehensive overview of the state of the art, including highlights of current high speed propulsion programs in the world. An introduction to multidisciplinary design optimization (MDO) will help students appreciate the challenges of developing this breakthrough propulsion technology.

The instructors are actively engaged in high-speed propulsion R&D. They will discuss the challenges, and development trends and future of the propulsion technologies needed to make truly high speed flight a reality. This course is sponsored by the AIAA High Speed Air Breathing Propulsion Technical Committee (HSABP TC).

Key Topics
- Mission requirements
- Combined cycle propulsion concepts
- Ramjet/scramjet inlet design
- Ram/scramjet combustion structural design
- Fuels and thermal management engine/airframe integration, TBCC integration
- Advanced materials
- CFD modeling and simulation of high speed reacting flow
- Propulsion multidisciplinary design optimization (MDO)
- High speed propulsion ground testing
- High speed flight testing