January 2013

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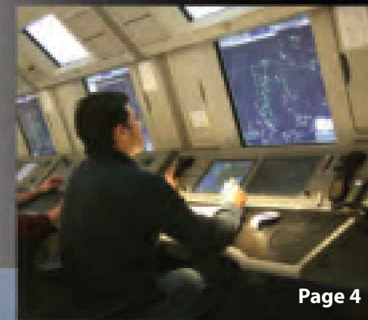

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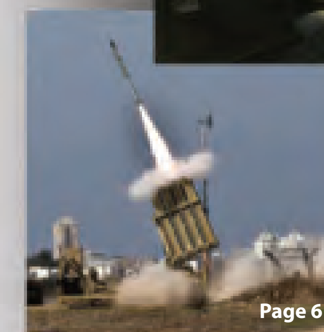

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A subscale model of a potential Boeing low-boom SST is tested at NASA Glenn. Progress in addressing the issue of sonic booms may bring supersonic transport closer to reality. Turn to page 26 for details. NASA photo by Michelle M. Murphy.

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55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference

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Editorial

In search of consensus

The end of a year, and the beginning of a new one, come with certain traditions—Top 10 lists, New Year's resolutions…and musings about NASA and its future.

In December, the National Research Council released a report, *NASA's Strategic Direction and the Need for a National Consensus,* urging the agency to establish reasoned, achievable goals and develop a plan for bringing them to fruition. The report took care to not endorse specific goals, but rather to stress the need for establishing firm directions, and making recommendations as to how best those goals, whatever they be, might be realized. It also emphasized that NASA funding does not match up with its current portfolio of programs and plans.

The committee that authored the report did have misgivings about one interim goal—the mission to visit an asteroid by 2025. Said Albert Carnesale, commitee chair, "The lack of national consensus on NASA's most publicly visible human spaceflight goal along with budget uncertainty has undermined the agency's ability to guide program planning and allocate funding."

Later that month, the House Committee on Science, Space, and Technology held a hearing, *The Future of NASA: Perspectives on Strategic Vision for America's Space Program*. In between the political posturing on both sides of the aisle, and lamentations over the Constellation program, came one consistent message: that NASA identify and establish reasoned, attainable goals and a firm strategic plan for realizing them. And for this to happen, there had to be national consensus. Sound familiar?

One of the witnesses, Maj. Gen. Ronald Sega, USAF (ret.), vice chair of that NRC report, stressed the need for the national leadership to agree upon a long-term direction for the agency: "Only with a national consensus on the agency's future strategic direction…can NASA continue to deliver the wonder, the knowledge, the national security, and economic benefits, and the technology that has typified its history," he said.

That notion was echoed by committee chair Ralph Hall (R-Texas), who observed that, "Fiscal realities demand that NASA become more efficient and sized correctly to accomplish its goals, but consensus will have to be reestablished among the agency's stakeholders to clarify NASA's strategic vision, goals, and missions."

But that consensus is not limited to the administration and the Congress. While the administration must take the lead, government is responsive to the people it represents, and the public, when inspired, stands ready to provide that support.

There may be no dazzling X-planes of intriguing configuration flying through the skies, or crowds lining the streets to watch as astronauts set off for space, and the space exploration plans in place strike few chords as currently presented.

But the public still does feel that connection to NASA, and those chords can be struck. Thousands visit the Hubble Space Telescope's website daily, and the newest Mars rover, Curiosity, has a Twitter account with over 1.2 million followers. Figure out what NASA can afford to do—and explain why these are exciting, valuable efforts—and consensus will follow.

Elaine Camhi
Editor-in-Chief

Europe's new plans for research and funding

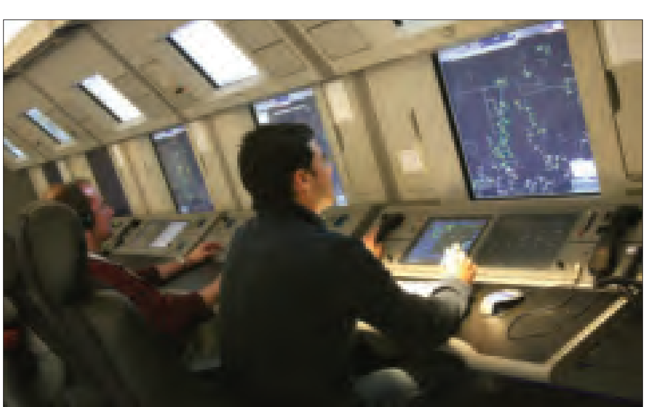
One important issue confronting EU leaders at the start of 2013 as they plan the EU budget for the next seven years is how much they should reserve for research and technology (R&T) development. The EC (European Commission) has proposed a total budget of €80 billion for 2014-2020 on R&T, in a program it calls Horizon 2020. Aeronautical research would have a fraction of this, but as every euro in EU research is matched by industry, even a small amount of EU-funded research can quickly add up to substantial sums.

Michael Jennings, spokesman for research, innovation and science at the EC, says: "The European aeronautics industry directly employs nearly 500,000 skilled workers and exports 60% of its production. With 12% of its turnover invested in R&D, it is research and innovation intensive and a European success story. That is why the European Commission has invested €960 million in aeronautics research since 2007 and is supporting the industry-led Clean Sky technology initiative with €800 million in funding."

The last tranche of EU R&T funding was announced in July 2012 when the EC said it would spend €8.1 billion on R&T as part of the 2007-2013 Seventh EU Research and Technological Framework Program (FP7) strategy, which Horizon 2020 will replace after this year. Of this total, aeronautical research accounted for over €400 million, including Clean Sky and SESAR (Single European Sky ATM Research), Europe's version of the FAA's NextGen ATM program. According to Axel Krein, head of R&T at Airbus: "A €100-million investment in R&T in the aeronautics sector is estimated by governments and institutions alike to raise gross domestic product by €700 million over 10 years."

Horizon 2020

Where is the Horizon 2020 money likely to go? The SESAR program has in the past accounted for a large portion of EU aeronautical research funding. On the face of it, ATM funding requirements are about to escalate further in Europe. A May 2012 high-level task force investigating the future costs of the program suggested that SESAR deployment would require total investments of over €30 billion between 2010 and 2020. "At €22 billion, airborne equipage including airlines (€11.5 billion), business aviation (€3.4 billion), general aviation (€940 million), and air forces (€6.4 billion) represents over two-thirds of the total investment. The balance (€8 billion) consists of investments in ground equipment—air navigation service providers (ANSPs), military ground systems, and airports," said the study.



Air traffic controllers at Eurocontrol's Maastricht Upper Area Control Center in the Netherlands will be managing traffic using SESAR in the coming years. Credit: Eurocontrol.

It is not yet clear how much—if any—of these equipment costs will be underwritten by the EU, and what EU budgets might be raided to provide finance for equipping aircraft and ANSPs with SESAR-compliant technologies. Equipping is not the same as research; currently the EU is directly investing €700 million in the 2008-2013 SESAR development phase, with the Brussels-based ATM agency Eurocontrol supplying another €700 million and industry an equal amount. It is possible that direct EU funding for ATM could therefore decline within the Horizon 2020 program, as most of the pure research work on SESAR should have finished by then.

So a major portion of Horizon 2020 aeronautical research is likely to go on improving aircraft fuel-burn technologies. According to Airbus's Axel Krein, "Of the €2 billion that Airbus invests annually in research, development, and technology activities, over 90% of our research investment is made in areas relating to the environment and sustainability of aviation, including reducing noise and fuel emissions."

Flightpath 2050

Europe's governments, aeronautical research organizations, aviation industry, and academic institutions have consolidated their medium- and long-term aeronautical research agendas with the EC's 'Flightpath 2050' strategy, published in March 2011. The Advisory Council for Aeronautics Research and Innovation in Europe (ACARE) is the key body that defines where strategic aeronautical research should be conducted. It is comprised of representatives from governments, the EC, manufacturing industry, airlines, airports, service providers, regulators, the research establishments, and academia. The latest version of ACARE's research priority roadmap, the Strategic Research and Innovation Agenda, was launched in September 2012 at the Berlin Air Show.

At the Technology Forum for Business, organized by the Aerospace and Defense Industries of Europe in October 2012, Airbus's Gareth Williams, head of R&T business development, identified Airbus's view of the priority areas for future research efforts.

For the near term—the Airbus A30X short-range aircraft—these priority areas include new engine concepts (with new architectures such as unducted fans to deliver a quantum leap in fuel burn efficiency), fuel cells (to reduce kerosene burn and allow for zero-emission electric taxiing), smart wings (with low-drag surfaces), optimized maintenance (through extensive systems health monitoring), an innovative cockpit (to lower crew workload and exploit new ATM architectures), and the use of advanced airframe materials.

In the longer term, Airbus is targeting research areas such as smart energy harvesting and storage systems, intelligent materials and manufacturing methods, new tail and ellipsoid-like fuselage designs, and 'blended hybrid' engines.

Speeding research from the theoretical to the practical

Program	Preliminary research	Development and integration/transfer and industrialization of concepts	In service
GLARE[1]	Delft Technical University. Work began 1978.	National Aerospace Laboratory (the Netherlands). Work began 1990.	Into service with Fokker in 2001
NURBS-based[2] aerodynamic design concepts	Universidad Politécnica de Madrid and Universidad Autonoma de Madrid. Work began in 2006.	German Aerospace Center and the National Technical Aerospace Institute (Spain) began work in 2006.	Into service with Airbus in 2010
Resin transfer molding composite aileron		The Italian Aerospace Research Center began work in 2002.	Into service with Piaggio in 2006

[1] Glass fiber reinforced aluminum.

[2] NURBS (non-uniform rational basis splines) is a mathematical model commonly used in computer graphics for generating and representing curves and surfaces.

Source: Association of European Research Establishments in Aeronautics.

Dealing with costs

The cost of developing these exotic new technologies will be high. More than €250 billion will be needed to fund all the different elements of Flightpath 2050; and with direct aeronautical research accounting (at the moment) for just 4% of the total EC-funded FP7 program, that leaves a very large shortfall. Aircraft systems and structures are only a small part of Flightpath goals. One of the more surprising elements in this vision of the future is the emphasis on tilt-rotor operations and information networks.

This is good news for AgustaWestland, the Anglo-Italian helicopter company that took over development of the 609 tilt-rotor from Bell Helicopter Textron in June 2011. Civil certification of the aircraft, currently the only civil tilt-rotor under advanced development, is expected in late 2015, with deliveries starting in 2016. It is an effort that many in Brussels see as offering Europe a substantial technology lead into the future.

Some of the shortfall in spending will be made up by speeding and simplifying the process through which research agencies and industries can acquire EC funding (a significant difference between Horizon 2020 and

(Continued on page 9)

Clean Sky: Consolidating research in lower fuel consumption

The Clean Sky JTI (joint technology initiative), launched in 2008, is a public-private partnership between the EC and industry. It is managed by the Clean Sky Joint Undertaking (CSJU) until December 31, 2017. The CSJU will deliver demonstrators in all segments of civil air transport, grouped into six technological areas called integrated technology demonstrators (ITDs). It is a €1.6-billion program, funded on a 50/50 basis by the EC (in cash) and the aeronautical industry (in-kind contribution). ITD leaders commit up to 50%, associate members up to 25%, and partners a minimum of 25%. The ITD programs are:

•SMART fixed-wing aircraft, which will deliver active-wing technologies and new aircraft configurations.

•Green regional aircraft, which will deliver low-weight aircraft using smart structures, as well as low external noise configurations. It will also integrate technology developed in other ITDs, such as engines, energy management, and new system architectures.

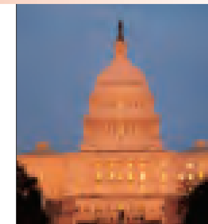
•Green rotorcraft, which will deliver innovative rotor blades and engine installation for noise reduction, lower airframe drag, integration of diesel engine technology, and advanced electrical systems for eliminating noxious hydraulic fluids and reducing fuel consumption.

•Sustainable and green engines will design and build five engine demonstrators to integrate technologies for low noise and lightweight low-pressure systems, high efficiency, low NO_x, low-weight cores, and novel configurations such as open rotors and intercoolers.

•Systems for green operations will focus on all-electrical aircraft equipment and systems architectures, thermal management, capabilities for 'green' trajectories and mission, and improved ground operations.

•Ecodesign will focus on green design and production, withdrawal, and recycling of aircraft, by optimal use of raw materials and energies, thus improving the environmental impact of the whole product's life cycle and accelerating compliance with the REACH (registration, evaluation, authorization, and restriction of chemicals) directive.

A simulation network called the Technology Evaluator will assess the performance of the technologies thus developed.



Reaching across the abyss

As this issue went to press, the nation was eyeball-to-eyeball with the 'fiscal cliff'—tax increases and spending cuts that, starting this month, would trim $454 billion in Pentagon funding over the next 10 years. In Washington, leaders of both political parties were clearly in a mood for compromise, at a moment when it was still possible for Congress and the White House to pull the nation away from the edge, fill the vacuum left by the absence of a budget for the current fiscal year, and avoid a looming debate over the national debt ceiling.

Cliff notes

Here is a reminder of the background to the so-called, and somewhat misnamed, fiscal cliff issue, also known inside the beltway as sequestration:

In 2001 President George W. Bush signed large tax cuts that were supposed to expire 10 years later, in 2011. In negotiations with Congress, President Barack Obama extended that expiration date to January 1, 2013. If no agreement were reached and no new legislation enacted, tax rates would go back up to the rates paid in 2001. Other tax changes, including the expiration of a so-called payroll tax holiday and elimination of some tax credits, would similarly become mandatory as of January 1.

Spending cuts (the sequester) were integral to the bill that the Congress passed and Obama signed into law. The sequester is a set of deep spending cuts that would be carried out indiscriminately, across the board, on a percentage-point basis. "For example," as one Washington insider described it, "if a typical squadron has 24 planes and you have a 10% sequester, each squadron will have to get rid of 2.4 planes." One analyst called this the 'meat cleaver approach,' since it does not discriminate from one weapon system to another, or one strategy issue to another. Secretary of Defense Leon Panetta says this approach would be "a disaster" for the Pentagon.

Secretary of Defense Leon Panetta

Panetta also says that some compromise, in some form, is inevitable sooner or later and will include defense cuts. He would like to see Washington's panoply of fiscal issues resolved, because he wants to leave office and go home to California. Secretary of State Hillary Clinton has also announced she will not be staying on for Obama's second term.

But long before the fiscal cliff became an issue, Washington was limping along without a budget. The government still needs to get settled in for FY13, which began last October 1.

Fiscal freeze

For now, the federal government is operating under a continuing resolution (CR). This has become an annual ritual, but this year the CR is unusual in imposing severe restrictions on what the armed forces can do, not merely in proceeding with programs but even in making routine transfers of equipment. The CR comes down particularly hard on the Air Force. In the absence of a budget, it is "all but impossible to execute [programs] with precision and efficiency," Lt. Gen. Charles Davis, the Air Force's deputy for acquisitions, told the trade journal *Defense News*. And according to a senior officer who did not want to be named, "What used to be everyday stuff, like shifting a squadron from point A to point B, has become stuff we can't do at all."

Regardless of what fiscal decisions are made, the Air Force will be under intense budget pressure in the year immediately ahead and will need "an honest look in the mirror," chief of staff Gen. Mark Welsh III said in Senate testimony.

For the Air Force, the CR freezes aircraft transfers considered routine when they were planned. Examples include transfers of F-15C/D Eagle fighters from the Montana Air National Guard at Great Falls to the California Guard in Fresno, and of active-duty F-16C/D Fighting Falcons within the state of Alaska. Yet another example, and one that is key to Air Force plans: the transfer of a squadron of F-22 Raptors from Holloman AFB, New Mexico, to Tyndall AFB, Florida, and the disbanding of a second Holloman-based F-22 squadron.

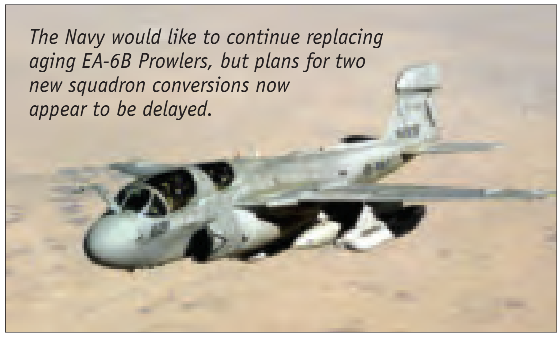
This freeze has a direct impact on real people. According to Col. Michael Buck, a recently retired squadron commander in the Montana unit, Fresno now has 16 newly trained Eagle pilots but no Eagles for them to fly, while Great Falls, which still has the Eagles it was supposed to give up, has seen its

Gen. Mark Welsh III

number of pilots drop from 32 to 22. "The squadron in Great Falls has low morale," Buck says. "We have an entire community here that doesn't know what will happen next."

Similar stories are unfolding around the nation. Affected at least temporarily by the CR freeze: plans to retire 102 A-10 Thunderbolt attack planes (of 356 in inventory), the entire fleet of 13 C-27J Spartan airlifters, and a dozen RQ-4B Global Hawk unmanned aircraft systems. All were considered routine moves that were expected to begin last fall.

U.S. naval aviation is also stalled by the freeze imposed in the CR. During the current fiscal year, the Navy would like to continue fielding the EA-18G Growler electronic attack aircraft to replace aging EA-6B Prowlers, but plans for two new squadron conversions now appear to be delayed. Also facing unexpected uncertainty are the Navy's plans to upgrade its versions of the well-known Black Hawk, or H-60, helicopter, using new MH-60R and MH-60S models to replace older SH-60Bs and SH-60Fs.



The Navy would like to continue replacing aging EA-6B Prowlers, but plans for two new squadron conversions now appear to be delayed.

Industry issues

Shifting from the military to industry, one of Washington's important institutions is the Aerospace Industries Association (AIA), led by Marion Blakey, former FAA administrator. Blakey may be preoccupied with the budget issues that confront everyone in aerospace, but she can also feel pleased by some good news: As of January 1, women will be running three of the nation's six largest aerospace companies.

Marillyn A. Hewson, 58, is the new CEO at Lockheed Martin. The company is the world's largest defense firm and the second largest U.S. company in the aerospace sector behind Boeing, making Hewson's the most prominent and influential position ever held by a woman in the aerospace field. On the same day, Phebe Novakovic, 55, takes over General Dynamics, the nation's fifth-largest defense firm. Linda Hudson, 62, is already head of the U.S. unit of the British military contractor BAE Systems and has been named 'first lady of defense' by *Washingtonian* magazine.

"The ascension of women like Marillyn Hewson and Phebe Novakovic to the top of the corporate ladder suggests that while the glass ceiling in aerospace and defense may not have been entirely shattered, it's certainly become more transparent," Blakey said in a statement. Some observers say the field is still dominated by men and that change has been glacial since a 1989 report by the GAO found that "men predominate in the aerospace industry in most job categories."

Two views of JSF

Lockheed Martin does 82% of its business with the U.S. government, compared to a more comfortable 71% for Boeing. Lockheed's future is inexorably linked to the costly, controversial F-35 Lightning II Joint Strike Fighter, the largest aircraft program in history as measured in dollar amounts. The Pentagon is moving ahead with JSF under its plan for 'concurrency,' which means testing the aircraft and making it operational at the same time.

The GAO summarized the JSF in a report last June, saying the program seeks "to simultaneously develop and field three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The JSF is critical to DOD's long-term recapitalization plans to replace hundreds of legacy aircraft. Total U.S. investment is now projected at nearly $400 billion to develop and acquire 2,457 aircraft through 2037 and will require a long-term, sustained funding commitment. The JSF has been extensively restructured over the last two years to address relatively poor cost, schedule, and performance outcomes."

To critics the JSF is inexcusably behind schedule, over cost, and challenged by technical issues; but to Americans working on the aircraft, it is the shape of the future. "With any program you have your bumps and bruises," says JSF crew chief Tech. Sgt. Matthew Burch. "But the F-35 is a pretty awesome thing to have in our arsenal," he tells this author.

Burch is at Eglin AFB, where the joint-service 33rd Fighter Wing is a showcase for everything that is right and not so right with the JSF effort. Although it is two years behind schedule in doing so, Eglin is now beginning to train F-35 pilots and maintainers for the first time. In addition to training users of the Air Force F-35A, Marine Corps F-35B, and Navy F-35C, Eglin recently acquired two F-35Bs intended for delivery to Britain and is training two British pilots.

Reflecting the concept of concurrency, the first F-35B to reach an operational squadron was delivered to

The Marine Corps redesignated Marine All-Weather Attack Squadron 121 as the first operational F-35 squadron at Marine Corps Air Station Yuma, Ariz., Nov. 20, 2012. The ceremony also welcomed the squadron's first three F-35B aircraft. Image courtesy Lockheed Martin.

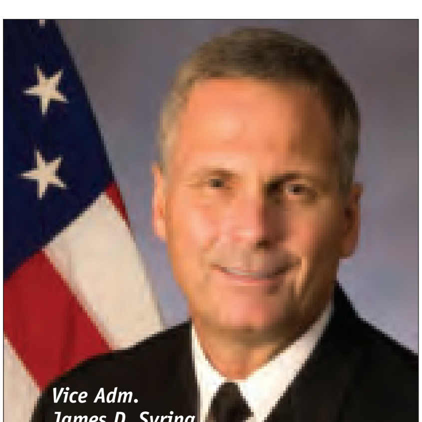
Israel's Iron Dome short-range defense system has had some highly visible successes recently.

Marine Fighter Attack Squadron 121, or VF-121, at Yuma, Arizona, on November 20, 2012. Among those in attendance were Sen. John McCain (R-Ariz.) and Marine Corps Commandant Gen. James Amos. Standing in front of the aircraft Amos told the crowd: "For the first time in aviation history, the most lethal fighter characteristics—supersonic speed, radar-evading stealth, extreme agility, short takeoff/vertical landing capability, and an impressive array of 21st-century weapons—have been combined in a single platform…the F-35B Lightning II you see behind me."

But the JSF is still far from being fully operational. One key issue is the helmet-mounted cueing system, which provides a virtual head-up display for the pilot. Unlike other fighters, the JSF lacks a physical HUD. The virtual system is having vibration problems that have not yet been resolved.

Missile defense?

Mideast tensions, coupled with some highly visible successes by Israel's Iron Dome short-range defense system, are prompting a few lawmakers in Washington to urge a new U.S. policy that will give higher priority to missile defense of the U.S. homeland.



Vice Adm. James D. Syring

A debate over whether and when to provide a missile shield for the nation, and at what cost, has been an on-again, off-again phenomenon in Washington since President Ronald Reagan proposed a Strategic Defense Initiative (often dubbed 'Star Wars') in an announcement on March 23, 1983. The topic got new attention prior to a November 21, 2012, cease-fire between Hamas and Israel after Israel's Iron Dome knocked down 421 rockets launched from Gaza and bound for Israeli cities, achieving an 84% success rate, according to reports from the Israeli military. In past conflicts—including the first Persian Gulf War in 1991, when the U.S. Patriot missile dominated the headlines—such claims have often been reexamined later and found to be exaggerated.

Rep. Michael Turner

That does not prevent supporters of missile defense seeing Israel's successes as a lesson for the U.S. "Since entering office, the Obama administration has demonstrated a lack of interest in…missile defense—specifically, the defense of the United States," says Rep. Michael Turner (R-Ohio), chairman of the House strategic forces subcommittee. The administration's missile defense budget request slashed $3.6 billion for FY13 through FY26, which, as Turner views it, means fewer missile silos as well as "[funds] to maintain all the silos we have." The budget request mothballs some antimissile radar systems, cuts 60 THAAD (terminal high-altitude area defense) interceptors, and allocates no money for an East Coast national missile defense site, which lawmakers and some military leaders have been calling for.

Missile defense is the responsibility of the Pentagon's Missile Defense Agency, where Vice Admiral James D. Syring became director on November 19. Syring replaced a leader with an unpopular management style but has little leeway to alter a well-entrenched set of policies and resources. The U.S. maintains a layered defense that includes long-range, ground-based interceptors, or GBs—Minuteman-class missiles with exoatmospheric kinetic kill warheads—at Vandenberg AFB and at Fort Greely, bolstered by recently installed medium-range THAADs at Barking Sands, Hawaii. In October, Hawaii-based THAADs scored the largest and most complex missile-defense flight test achievement, engaging five ballistic and cruise missiles at the same time.

The administration's FY13 budget request seeks funding for regional missile defenses for Europe.

U.S. cooperation with Israel's missile defense efforts, including significant support with funding and management by MDA, includes work on the David's Sling/Magic Wand system, which has greater range than Iron Dome. David's Sling underwent a successful test last November, intercepting a midrange incoming missile successfully. Designed to intercept incoming missiles at a distance of up to 300 mi., the system is of "immense importance," says Israeli Defense Minister Ehud Barak.

FAA appointment

Before stepping down from his seat to accept a position as president of the Heritage Foundation, Sen. Jim DeMint (R-S.C.) lifted a hold on the nomination of Michael Huerta to head the FAA. Huerta has served as acting chief since December 2011 and was nominated by President Obama in March to lead the agency on a permanent basis.

A Senate panel approved Huerta's nomination in July, but DeMint put a hold on Huerta's confirmation pending the results of the recent presidential election.

Robert F. Dorr
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New plans

(Continued from page 5)

Flightpath 2050: How the EC sees the future of aviation in Europe

•The air transport network will be able to cater for much greater traffic densities through new services based on ever higher degrees of automated flight management and control for all air vehicles. Within Europe the number of commercial flights is up to 25 million in 2050, compared to 9.4 million in 2011.

•There will be new types of wide and narrowbody commercial aircraft, executive aircraft, advanced rotorcraft (including tilt-rotors), specialized aircraft (quiet short takeoff and landing, or QSTOL), and remotely controlled unmanned aircraft systems (UAS). Some of these will be pilotless and autonomous. Nontransport aviation missions have increased significantly and are undertaken by remotely controlled and autonomous vehicles, particularly for missions that are simple and repetitive or dangerous, and those requiring long endurance.

•Aircraft operators, the aircraft themselves, airports, ground handlers, and the military will be integrated into global, interoperable information networks provided by a small number of organizations. These will be seamlessly connected to other modal networks, most notably rail, sea carriers, and local and regional transport. Shared information platforms and new IT tools and services will facilitate data exchange and decision-making.

•Capability for all-weather, 24/7, door-to-door operation with limited infrastructure will be developed for rotorcraft and aircraft. All types of rotorcraft will be capable of simultaneous, noninterfering approach to airports as part of regional networks including city vertiports and remote landing areas.

•Around 90% of travellers within Europe will be able to complete their journey, door-to-door, within 4 hr. Passengers and freight will be able to transfer seamlessly between transport modes to reach the final destination smoothly, predictably, and on time.

•Flights will arrive within 1 min of the planned arrival time regardless of weather conditions.

•Streamlined systems engineering, design, manufacturing, certification, and upgrade processes will address complexity and significantly decrease development costs (including a 50% reduction in the cost of certification). A leading new generation of standards will be created.

•The environmental impact of aviation will see a 75% reduction in CO_2 emissions per passenger kilometer and a 90% reduction in NO_x emissions. Perceived noise emission will be reduced by 65%. Aircraft movements will be emission-free during taxiing. Air vehicles will be designed and manufactured to be recyclable. Europe will be established as a center of excellence on sustainable alternative fuels.

•Europe will be at the forefront of atmospheric research and will take the lead in the formulation of a prioritized environmental action plan and establishment of global environmental standards.

•The European aviation industry will be strongly competitive, with a share of more than 40% of its global market.

FP7), bringing all EC research programs into a single framework, placing national industry and government technology objectives within a common strategic research agenda, and moving work more swiftly from theoretical to applied research. In this latter area Europe has made some substantial strides in recent years.

There is no substitute for cash. But early identification (by industry, governments, and EU bodies) of where the future 'breakthrough' technologies might be—those that will deliver real competitive performance benefits in the next 20 years—is an important first step to ensure Europe will have mature systems developed in time.

But there is a danger. Tying these strategic programs to the current political agenda within Europe could mean concentrating on areas such as regional information networks and environmental targets that work for Europe but are not necessarily as important to aircraft operators and airframe manufacturers in other parts of the world. It is a small danger—but one that Europe's aeronautical research communities will need to monitor over the coming years.

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Events Calendar

JAN. 7-10
Fifty-first AIAA Aerospace Sciences Meeting, including the New Horizons Forum and Aerospace Exposition, Dallas/Ft. Worth, Texas.
Contact: 703/264-7500

JAN. 28-31
Annual Reliability and Maintainability Symposium, Orlando, Florida.
Contact: Patrick Dallosta, 703/805-3119; patrick.dallosta@dau.mil

FEB. 10-14
Twenty-third AAS/AIAA Space Flight Mechanics Meeting, Kauai, Hawaii.
Contact: 703/264-7500

FEB. 12-13
Civil Space 2013, Huntsville, Alabama.
Contact: Allison Cash, Allison.Cash@peopletec.com; 256/319-3884

MARCH 2-9
IEEE Aerospace Conference, Big Sky, Montana.
Contact: David Woerner, 626/497-8451; dwoerner@ieee.org; www.aeroconf.org

MARCH 19-20
Congressional Visits Day, Washington, D.C.
Contact: Duane Hyland, duaneh@aiaa.org

MARCH 22-23
Space Weather Community Operations Workshop, Park City, Utah.
Contact: 703/264-7500

MARCH 25-27
3AF-Forty-eighth International Symposium of Applied Aerodynamics, Saint Louis, France.
Contact: Anne Venables, secr.exec@aaafasso.fr

Keith Hayward

What is the status of aviation in the U.K., among politicians, young people, and business leaders? Is the U.K. still seen as an 'aviation-minded' country, or is aviation/aerospace regarded increasingly as an environmental nuisance?

The image of aerospace in the U.K. has many facets. After a long campaign, U.K. politicians have recognized that the sector is one of the nation's crown jewels. Given that much of the U.K.'s manufacturing greatness has dwindled, or been bought by overseas interests, aerospace continues to make a huge contribution to the U.K. economy, especially its export earnings. This factor has been brought into even sharper relief by the scandals and embarrassments of the much-vaunted financial services industry.

This positive image has been reflected in the support government has made to civil projects and related aeronautical research, as well as several favorable statements from ministers, including Prime Minister Cameron. The 2012 Farnborough International Air Show was graced with a rare prime ministerial visit; but to be fair to Mr. Cameron, Mr. Blair and Mrs. Thatcher only made it once in over 20 years of combined premiership!

The success of Airbus—and the U.K. wings that keep them in the air—is especially commended, and the huge new factory complex in North Wales is the focus of numerous photo opportunities. Rolls-Royce has regained all of its historic luster as a 'blue chip' company—now badged as a high-technology propulsion multinational. And so often neglected, we need to be mindful of all of those Airbus and Boeing aircraft landing on U.K. undercarriages, as well as airliners and fighters controlled by British electronics, and lives being saved by Martin Baker ejection seats.

Not all of these U.K.-based companies are still U.K. owned; but with an extensive U.K.-owned international footprint, globalization works both ways, especially given the U.K. presence in the U.S. The space sector—something of a Cinderella in terms of public recognition—has also done (modestly) well out of recent ministerial patronage. The prime minister and his defense colleagues have also done their duty by the defense sector in promoting sales of the Eurofighter Typhoon while on overseas visits.

Arms sales are controversial—and regularly attacked by the liberal press and opinion, for sustaining undemocratic regimes. But in fairness, U.K. arms sales regulations are among the toughest in Europe. More worryingly, there is increasing concern that without new product to sell, U.K. defense exports will begin to fall. But this is part of wider issues that are addressed in answer to other questions.

Finally, there is concern about the environmental impact of aviation. On the one hand, Britons lap up air travel. The country has pioneered European low-cost aviation; its long-haul carriers are also successful. On the other, the sector has been singled out as the country's fastest growing carbon-generating transport industry; and no one wants a new runway to put aircraft over their heads. In particular, the future of London's global hub at Heathrow is the centerpiece of a political firestorm—a third runway or a completely new airport out in the Thames Estuary, and all manner of proposals in between. This is a 30-year-old public policy failure looking for an urgent solution.

"Much of the technology associated with aerospace is still incremental—the next 10 years of investment will be much like that of the last decade."

What are the key areas of aeronautical research—information management, structures, networks—that will provide the real efficiency gains in the near and far future? What scale of investments are involved, and what potential gains will be made?

An impossibly broad brief! Much of the technology associated with aerospace is still incremental—the next 10 years of investment will be much like that of the last decade. Composite materials have of course become more central and will continue to replace metals. The engine manufacturers have opted for an interim concept based on the geared fan. No one has yet put a blended wing into advanced development. Yet the combination of all three of these technological streams will be needed to meet the environmental challenge of the carbon-neutral airlines, or for airlines to live with fuel prices in excess of $200 per barrel. These are requirements for the 2030s, and they will have to be in place by the middle of the next decade.

The space sector, one of the U.K.'s major aerospace success stories, will be looking further to exploit a world-class capability in satellites, especially 'smallsats.' The latter may increasingly focus on creating constellations of platforms, becoming more capable than the sum of their parts. This implies significant developments in both hardware and software.

The military side—and we are largely talking about unmanned systems—has perhaps the most exotic new future. More autonomy and the slightly sinister-sounding 'swarming' will also drive software and IT in general. Fully integrated propulsion systems needed for long endurance and massive power generation in small spaces are an obvious source of innovation that will spill over into the civil sector. In fact, we might expect rather

Interview by Philip Butterworth-Hayes

more direct defense-civil spillover than has perhaps been evident over the last 30 years.

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Finally, we should not forget the importance of 'cyber' in its multifarious forms as a driver of innovation in the wider security dimension; this will have both direct and indirect impacts as secure communications and control will remain vital to military operations as well as civil air traffic control and other critical systems.

At what cost? Again, the exact figures are hard to predict, but certainly no less than the $10 billion required to launch a new aircraft, and not much less than a new engine. Maintaining a solid base in defense-related technology will also imply investments significantly greater than the £200 million a year spent on defense technology acquisition by the Ministry of Defence.

How can we move research faster from the laboratory to the air?

This is one of the continuing conundrums of high-technology manufacturing, and aerospace is not unique in suffering its consequences. Flexibility, adaptability, and agility have the right sounds of a solution but are easier said than done.

One can make a bid for some of the obstacles: overbureaucratization on the part of company structures that get in the way of good ideas; similar faults on the part of key customers—especially governments; general conservatism and vested interests in the old ways of doing things. An endless list, perhaps.

There are well-known counterculture examples—the Lockheed Skunk Works, of course—and many aerospace companies have created similar 'off-line' ideas factories such as Boeing's Phantom Works and the Advanced Technology Centre at BAE Systems. The trick is to retain the innovative and imaginative thinking of such creative units within the capital strength of the big company.

The U.K. research 'factory' at Qinetiq—the privatized spinoff of U.K. government defense research establishments—could be described as a boutique of several high-technology activities, including UAS and space research. It makes its living from developing new technologies and licensing or codeveloping the results. Interestingly, prohibited from manufacturing in the U.K., it has acquired a manufacturing facility in the U.S.

The UAS community is an interesting case in point. A large part of the innovative power of this community comes from the high-tech startup; but anything bigger or more complex than a model aircraft with a camera sooner or later needs a chunk of change to build and to market a product—and to develop the next generation. But the traditional prime pretty soon starts thinking in terms of an unmanned F-35—big program, big money, and decades to bring to market.

So far the most successful players have caught the middle ground here—General Atomics and several Israeli companies have stressed the importance of speed and agility of development and time to market. Rapid incrementalism appears to be the key. Again, several primes—including BAE Systems—have tried to capture this approach within dedicated units. The results so far have been promising, but the temptation in the end is to pitch a large, complex approach to capture large military development contracts, the 'comfort zone' of traditional defense industrial activity.

What impact is the current financial crisis having on research programs and industry investment in the U.K.?

So far the financial crisis has had only a limited impact on research. The government has supported the civil sector reasonably well. Defense aerospace has been affected by several program cancellations and early retirements, and there is some uncertainty

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about the future of a number of new developments. The sheer size of the civil requirement is driving both investment and returns. Longer term, the defense sector is facing some difficult times. There will be another round of severe cuts in public spending, and aerospace is not necessarily the number-one priority for future defense investment. Money is going into unmanned systems, but this too may fall victim to future cuts. A lot will depend on the pattern of future collaboration.

“Rapid incrementalism appears to be the key.”

Will the future see more cooperation in developing projects with partners in Europe and North America?

The U.K.’s aerospace industry has survived and prospered thanks to international collaboration. For decades, this centered largely on joint ventures with our European neighbors. Although not always the most economic or efficient of routes to industrial success, it brought U.K. companies full access to new technology, and effectively kept U.K. defense aerospace in being. In the case of Airbus, we also started making money from civil airliners. The U.K. rotary wing sector is also thoroughly internationalized. Space, through Astrium U.K. and links to the European Space Agency, is another quiet success story.

The U.K. has also had a good working relationship with the U.S.; AV-8B and the Goshawk were fine examples of transatlantic partnerships. U.K. membership in the F-35 program as the only level-one partner represents a vital element for the future of U.K. military aerospace. Beyond this specific project, I can only reiterate the importance of the mutual investment in each other’s industry as a benchmark for effective globalization of development and production.

As ever, the caveat is technological access: Working with the U.S. implies accepting stringent controls on core technologies that may even apply to developments of our own intellectual property. In this respect, the F-35 will offer the prospect of production, employment, and revenue for several decades, but it may constrain the development of the U.K.’s wider technical interests.

Part of the answer may be for the U.K. to work with the Europeans on unmanned systems, with a more egalitarian approach to technology. This thinking underpins the recent agreement with France. The problem is that UAS development and production does not necessarily mesh well with traditional European collaborative formats. The UAS world demands fast prototyping, flexible production systems, and an ability to make money on relatively small, sporadic production runs. These are not the sort of characteristics associated with past forms of European collaboration. The answer may be to insist on tight management, perhaps comparable to the highly effective transnational missile company MBDA.

What are the key problems for the U.K.’s aerospace sector?

Money—what else? U.K. aerospace has done reasonably well from recent government investment—and to reiterate, this is usually based on a 50-50 funding regime—no handouts here. Even harder times are just round the corner, and new programs—and the underlying technological principles to support them—are no cheaper than former programs. Sustaining this successful public-private partnership will be increasingly difficult.

“Working with the U.S. implies accepting stringent controls on core technologies that may even apply to developments of our own intellectual property.”

We also share with the U.S. problems in attracting and sustaining our share of scarce engineering and scientific talent. The [Royal Aeronautical] Society is also well aware that bringing more women into engineering must be a top priority. In both respects the society has launched a number of schemes designed to promote aerospace in schools and show that it is not a gender-specific industry.

More generally, there is also the hovering question of how to respond to the WTO [World Trade Organization] ruling against Airbus and the form of government investment adopted in the U.K. and by the other Airbus partners. I am not going to join in the ‘subsidy’ battle, other than to suggest that, from a European perspective, this approach is consistent with an economically justifiable public policy of support for advanced technology. But rulings are rulings, and over the next few years, we will have to rethink our approach to support for new civil programs, and not just about airframes.

The U.K. will also have to face the fallout from the recent failure of the BAE Systems-EADS merger. I believe that EADS, and especially its defense subsidiaries, will have a harder task in putting together a viable business strategy than BAE Systems, but neither party have done themselves a favor in exposing the still-powerful political forces that affect European aerospace. Whether BAE Systems is still in ‘play,’ as the London financial center analysts might say, is debatable. There may be a U.S. bid, but there may be another European combination to come forward.

However, the affair has underlined the fact that the European defense sector has limited prospects, and powerful political interests are still reluctant to accept rationalization of either supply or demand.

European defense industries are facing a bleak future. The failure to sort out the ‘domestic’ structures of supply and demand is now a chicken coming home to roost. China and especially Russia (having learnt lessons about after-sales support) are taking sales at the bottom end of the market. In

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richer, high-growth markets, especially in Asia-Pacific, U.S. industry is well entrenched and will benefit from the security cordon projected by U.S. foreign and defense policies.

In this respect, the fact that while the U.S. defense market may face some local difficulties over the next couple of years, it is still the place to be, and the U.K. is better placed than most of our European neighbors. On the other hand, the U.K. will have to work hard to maintain its place in the Airbus partnership. The U.K. is politically outmatched in EADS decision-making, and if push does come to shove, British interests could be traded away for German and French benefit, or to satisfy a global investment strategy in China and the U.S.

"The failure to sort out the 'domestic' structures of supply and demand is now a chicken coming home to roost."

How do you consider the threat of new aerospace powers, especially in China?

"Seriously" is the short answer. Aerospace has long been recognized as a strategic industry, for military and economic reasons. But the barriers to entry are high and expensive to breach. Many states have tried, and many have failed (or, at least, have only partially succeeded). But for collaboration in the 1960s onward, most of the European national capabilities would have disappeared. Japan has strived to create a viable independent aerospace industry at great cost and with only partial success.

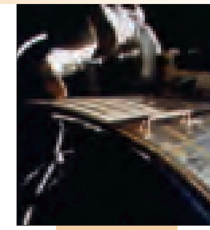
In fact, there are few countries that can boast of a comprehensive aerospace capability, or any that now have full autarchy of development and production. I include the U.S. here. Even where there is a notional comprehensive capability, such as Russia, there are critical qualitative deficiencies. Nevertheless, countries such as Brazil have already carved important niches in civil and military markets. You do not need a comprehensive aerospace industry if you can access the right engines or systems with a well-chosen and competent platform.

But where does China stand in all of this? Well, still some years, if not decades, away from matching generally current Western capabilities. There are some splendid photos of new combat aircraft and an impressive civil ambition. But engines and avionics, and perhaps integration competencies, are much more limited. Yet Chinese space capabilities are rapidly achieving parity in areas where it matters strategically. Missiles are also on the verge of threatening area denial out beyond Japan.

China is the one to watch precisely because of its domestic geography, and its economic growth rate will support a huge demand for civil products. Its regional power ambitions (if not yet those of a putative global superpower) will fuel a defense industry and successive generations of technological investment.

The answer is not another arms race; nor is it to isolate China's civil industry. In the latter case, a horse has already bolted given the level of collaboration already evident between China and the West. The rational response is to invest in the natural dynamics of technological innovation, especially in the more 'difficult' areas of propulsion and sophisticated electronics. This of course comes back to the perennial problem of investing in technology acquisition and in people with the ideas and skills to do the job.

"China is the one to watch precisely because of its domestic geography, and its economic growth rate will support a huge demand for civil products."



Bridge to deep space

In a fishing village off the remote north coast of Papua, New Guinea, U.S. astronaut Neil Armstrong is a household name. A young villager named Luke, who makes his living fishing and farming for his family on Wanam, one of the tropical Tami Islands, had heard the news of Armstrong's August 25 passing.

"He was first to go to the Moon," said Luke, who was born about 20 years after the Eagle landed. Questioned about my own space voyages, I had to admit that Neil, Mike Collins, and Buzz Aldrin had gone a thousand times farther into space than I had. But that didn't matter to Luke or the villagers I spoke to: I was an American 'space man,' the same as Neil. The idea that the U.S. is a nation of explorers is a concept still current in the most distant corners of the globe.

Between now and 2015, we will decide if we are to continue or abandon that premise. The space talk at the close of the year has centered on whether NASA has a new plan to match those heroic Apollo feats. The president's reelection and looming sequestration mean NASA—at best—can expect no increases in its human spaceflight budget.

ISS troubleshooting and success

Before NASA can talk of returning to deep space, it must first preserve and then build on its investment in the ISS. The closing months of 2012 saw NASA and its partners deal successfully with unexpected repairs, new cargo deliveries, and an increased operations tempo.

In September, the Expedition 33 crew—Suni Williams, Aki Hoshide, and Yuri Malenchenko—performed two unplanned EVAs to remove and replace a failed main bus switching unit (MBSU). Located on the station's S0 truss, just above the U.S. Destiny lab, the MBSU suffered a failure that took down 25% of the station's solar power capacity.

During the first EVA, Williams and Hoshide removed the failed MBSU box, about the size of a dishwasher, and replaced it with a spare delivered earlier by shuttle. During the spare installation, however, the spacewalkers were unable to drive home the long bolt that engages mechanical and elec-

Expedition 33 commander Sunita Williams participates in a 6-hr 38-min spacewalk outside the ISS on November 1, 2012. During the spacewalk, Williams and JAXA's Akihiko Hoshide ventured outside to support ground-based troubleshooting of an ammonia leak.

trical connections between the truss and the new MBSU. Mission Control in Houston had them temporarily strap down the box, reenter the airlock, and regroup for another try.

Within a week, controllers working with the crew had Williams and Hoshide back outside to try a new approach. Working at vacuum, they used a spare bolt coated with grease to capture and remove metal shavings from the threaded MBSU receptacle on the truss; engineers think the shavings were the result of galling that occurred when the MBSU was bolted onto the truss in 1-*g* during original assembly. With the threads now lubricated and clear of debris, the crew used a manual torque wrench to carefully hand-drive the bolt, securing the MBSU to the truss and engaging electrical and cooling interfaces. Flight controllers soon had full power restored.

On November 1, Expedition 33 commander Williams ventured outside with Hoshide once again, this time to isolate a minuscule leak in one P6 solar array's ammonia coolant loop. Flight controllers believe a micrometeorite or orbital debris impact punched a tiny hole in the channel 2B thermal radiator lines. To avoid a low-ammonia-coolant shutdown of the 2B power channel, Williams and Hoshide bypassed the radiator with a spare jumper line, handing over cooling duties to a long-stowed P6 radiator used during early ISS construction.

Both the bypass operation and radiator redeployment were successful.

The SpaceX Dragon commercial cargo craft is ready for release by the ISS's Canadarm2 robotic arm on October 28 to allow it to head toward a splashdown in the Pacific Ocean.

ISS controllers will look now for stable coolant levels to verify that the leak was in the bypassed radiator. If the leak persists, further EVA troubleshooting and repairs might be needed.

New cargo era

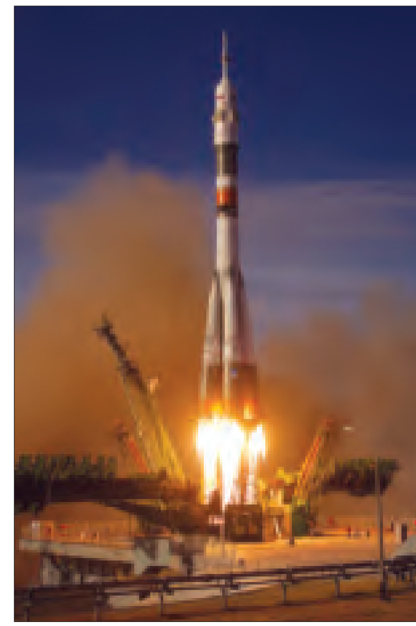
SpaceX's second Dragon cargo vehicle successfully reached the station in October, delivering 900 lb of cargo. Although Dragon's Falcon 9 booster suffered a Merlin engine shutdown during its October 7 launch, the eight remaining first-stage engines fired longer than planned and inserted Dragon into a safe orbit. After its October 10 rendezvous and berthing, the crew packed the capsule with 1,700 lb of scientific samples, obsolete gear, and trash. On October 28, Dragon departed the station and executed a successful reentry and splashdown.

Analysis of the engine failure, which shattered an aerodynamic fairing on Falcon 9's first-stage engine skirt, may delay SpaceX's next cargo run until May. NASA hopes the firm will soon be joined on cargo runs by Orbital Sciences and its Cygnus cargo spacecraft. A first test flight of Orbital's new Antares rocket is due this spring, and the company hopes to demonstrate a successful Cygnus cargo delivery to the ISS within six months.

The Dragon deliveries and a Progress cargo shipment supported the arrival of the Expedition 34 crew. Commander Kevin Ford and flight engineers Oleg Novitskiy and Evgeny Tarelkin docked their Soyuz TMA-06M at the ISS on October 25. Ford assumed command from Williams as she returned to Earth with Hoshide and Malenchenko on November 18.

In early December, the second trio of Expedition 34 astronauts was scheduled to launch from Baikonur on Soyuz TMA-07M. Chris Hadfield, Tom Marshburn, and Roman Romanenko would inaugurate Expedition 35 in March and remain on station until May.

The administration has not moved to accelerate NASA's plans for commercial astronaut transport to the outpost. The agency will remain dependent on the Soyuz, at least until 2016, to rotate expedition crews, who have maintained a continuous presence at ISS for over 12 years.

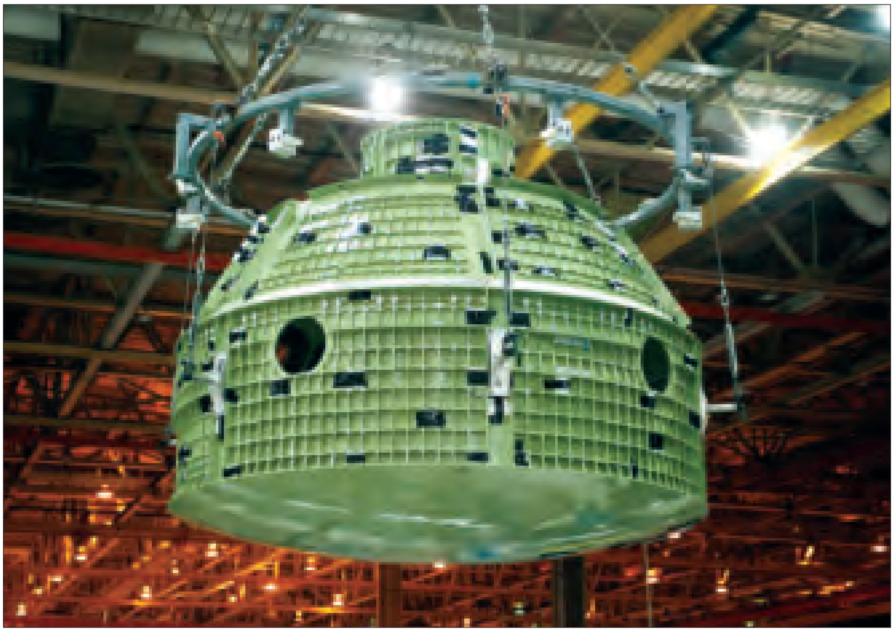


The Soyuz rocket with Soyuz commander Oleg Novitskiy, flight engineer Kevin Ford of NASA, and flight engineer Evgeny Tarelkin of ROSCOSMOS launches to the ISS on October 23, 2012, in Baikonur, Kazakhstan, on Expedition 33/34. Credit NASA/Bill Ingalls.

Scientific research aboard ISS is growing, although slowly (see www.nasa.gov/mission_pages/station/research/news.html). Talented, adaptable crews, along with a well-chosen array of tools, spare parts, and robotic capabilities, have enabled astronauts and cosmonauts to overcome every systems failure and challenge encountered so far. The ISS is an invaluable asset in LEO, well positioned to serve as an exploration testbed while the partners discuss possible ventures into deep space.

Glimmers of an Earth-Moon architecture

Press reports in September revealed that NASA is evaluating a new strategy to send astronauts to the lunar vicinity and beyond. Using the Orion crew vehicle and the initial, 70-metric-ton capability of the Space Launch System (SLS) heavy lifter, the agency could



Exploration Flight Test 1 Orion, currently at Michoud Assembly Facility, will fly in 2014 to an altitude of over 3,600 mi, more than 15 times farther away from Earth than the ISS. Orion will return home at a speed of 25,000 mph, almost 5,000 mph faster than any human spacecraft. Heat shield temperatures will reach 4,000 F, higher than any crew vehicle since Apollo. Photo credit: NASA/Eric Bordelon.

reach lunar orbit or the Earth-Moon Lagrange points shortly after 2020. While not as profound an achievement as establishing a new Tranquility Base or cruising to an asteroid, the concepts under discussion offer NASA a path beyond the space station without dramatic expansion of its budget.

First come several key tests of NASA's Orion crew vehicle. Its first unmanned flight is scheduled for September 2014, atop a Delta IV-Heavy. The EFT-1 mission will test Orion systems during two high-apogee Earth orbits, ending in a reentry trajectory that will subject the guidance, heat shield, and recovery systems to the speeds and temperatures they will encounter on a future deep space return.

The second uncrewed Orion will fly atop the SLS on its first flight, late in 2017. Under current plans, astronauts would not fly an Orion until after 2020. That's just a few years before NASA is to execute a piloted mission to a near-Earth asteroid (NEA). It's hard to see how, with just a handful of deep space tests, NASA could be ready by 2025 to send astronauts several million miles beyond the Moon.

To change that calculus, the space agency appears to be seeking White House approval for an ambitious series of missions that build methodically toward a versatile deep-space capability. The building blocks of the plan come from existing, proven ISS hardware, commercial vehicles, and spacecraft in development. These include the Orion multipurpose crew vehicle, SLS, Atlas V, Delta IV-Heavy, Ariane, Proton, Dragon/Cygnus cargo vehicles, ATV/HTV cargo vehicles, spare ISS modules, build-to-print ISS structures, and inflatable habitats.

As a first step, an Orion crew would circumnavigate or orbit the Moon, as Apollo 8 astronauts did in 1968, but with an eye toward more ambitious voyages. A key piece of hardware would be a small habitat, based on Alenia's ISS MPLM cargo canister, or perhaps a new inflatable design. The SLS's interim cryogenic stage, based on the RL-10-powered Centaur, would power Orion and habitat on a lunar trajectory. Instead of a lunar orbit or landing profile, however, this bare-bones vehicle would conduct a weeks-long mission beyond the Moon to the L2 Earth-Moon Lagrange point.

L-what?

Why EM-L2? This gravitational equipotential point in the rotating Earth-Moon coordinate frame enables a spacecraft to hover some 60,000 km beyond the Moon using minimal propellant. Looping around EM-L2 for several weeks in a long, lazy halo orbit, visiting astronauts would have a direct view of the lunar far side, and could conduct intensive remote sensing investigations of that rugged hemisphere. They could also take direct 'telepresence' control of lunar farside surface rovers, taking advantage of the slightly shorter radio time delay from L2 compared to terrestrial controllers. This virtual exploration presence on the lunar surface is similar to what would be possible for Mars from a future astronaut outpost on the Martian moon Phobos.

The most challenging activities for astronauts at L2 would be rendezvous with and wide-ranging investigation of a captured NEA. A team funded by the Keck Institute for Space Studies has proposed a robotic, ion-driven spacecraft that would snare and then return a 7-m, 500-metric-ton NEA to cislunar space within a decade. The asteroid, placed into an EM-L2 halo orbit, would be available for astronaut inspection, sampling, dissection, grappling and anchoring demonstrations, and resource extraction.

International and commercial entities could send their own robotic craft to sample and process the water, metals, and other light elements in the asteroid. This accessible resource, similar in composition to carbonaceous chondrite meteorites, could kick-start an entire venture into using asteroidal material to lower the cost of future exploration. The NEA exploitation would thoroughly prepare astronauts and flight controllers for expeditions to larger, more distant asteroids.

The proposed deep space transportation system, modest at first but growing as budgets and partnerships expand, would be flexible enough to take on other cislunar missions. Astronauts could rendezvous with robotic sample return missions from the Moon, asteroids, and Mars, using

Orion to shepherd the samples on the final leg to terrestrial laboratories.

Should human explorers return to the Moon, astronauts could use the EM-L2 or L1 halo orbits to outfit, check out, and dispatch a lander down to the surface. A returning lander could also rendezvous with Orion there to return the crew to Earth, and to be serviced for another lunar sortie. Commercial services would play a key role, providing much of the logistical, consumable, and propellant support needed for L2 halo, robotic lunar, and captured NEA missions. This deep space activity would also open up commercial opportunities for robotic NEA prospecting and commercial-scale water, volatile, and metal resource extraction.

ISS as testbed

The international space station, used wisely, should be a bridge to these deep space ambitions. Habitats, life support, and power systems for the deep space vehicles should be evaluated and proof-tested at the ISS. Prototype resource extraction processors, using simulants or actual meteoritic material, could blaze a path toward eventual large-scale propellant production in cislunar space.

Upgraded spacesuits could be phased in to replace the 1980s shuttle version currently in use. Rugged yet flexible, the new models would then be ready for work at a captured asteroid or L2 halo activities. NASA should also develop and test-fly at the ISS a prototype space exploration vehicle, a one- or two-person space pod for inspection, maintenance, and NEA surface exploration.

Such testing at ISS would engage the attention of taxpayers and policymakers, showcasing the station as a knowledge-driven springboard to deep space. It's *the* place to demonstrate that NASA and its partners are serious about moving beyond LEO.

Deep space

In his autobiography, *Falling to Earth*, Apollo 15 astronaut Al Worden describes the first-ever deep space EVA, 196,000 mi. from Earth, as the command and service module Endeavour coasted homeward following the fourth lunar landing in August 1971. Worden, retrieving film magazines in the harsh sunlight slanting across the module's instrumentation bay, stole a few seconds to take in the view.

"All around me, there was—*nothing*.…This wasn't deep, dark water, or night sky, or any other wide open space that I could comprehend. The blackness defied understanding, because it stretched away from me for billions of miles.

"…I could see the entire Moon if I looked in one direction. Turning my head, I could see the entire Earth. The view is impossible to see on the Earth or on the Moon. I had to be far enough away from both. In all of human history, no one had been able to see what I could just by turning my head."

Al Worden experienced what all of us would hope to see, if only vicariously. He lived suspended between worlds, just as NASA now seems suspended between its brilliant past and an uncertain future. If the U.S. can take small but real steps now toward exploring and exploiting cislunar space, we can turn a glimmer of deep space travel into a limitless reality. And people around the globe would learn the names of a new generation of explorers.

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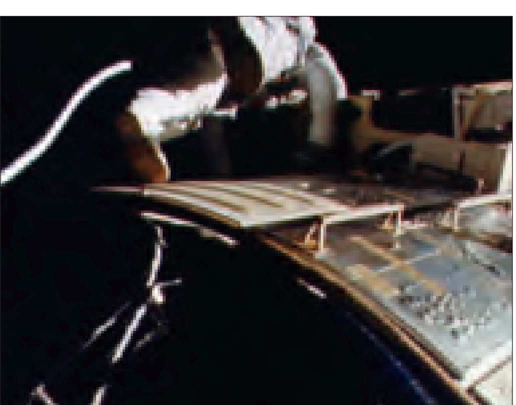

On August 5, 1971, Apollo 15 command module pilot Al Worden carried out the first deep space EVA from the Endeavour crew module. His all-too-brief EVA lasted 38 min 12 sec. Photo credit NASA.

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Aircraft finance: Drought and flood?

The post-2007 economic downturn has affected civil aero markets in wildly different ways. Most civil markets have suffered exactly the kind of cyclical downturn that could be expected from a serious drop in economic growth. Regional transports, civil rotorcraft, and most of all business aircraft have all fallen by 20-30% since their 2008 market deliveries peak.

Yet commercial jetliners, by far the largest civil aero segment, have actually seen 2008-2011 compound annual growth rates (CAGRs) that are roughly in line with what they achieved in the 2003-2008 market boom. In fact, deliveries in 2012 expanded by a near-record 18% by value over 2011.

This remarkable divergence between jetliner market fortunes and the rest of the civil aircraft industry revolves around third-party financing. External sources of capital have come to regard jetliners as a safe and mobile asset. They have also come to regard business jets as risky assets, in a time when risk is to be avoided.

The pleasures of jetliner finance

The key distinguishing characteristic of the post-2007 economic downturn was the collapse of commercial credit. Banks became increasingly risk averse after the high-profile collapse of several key financial institutions. In addition, the increased reserve requirements that were a regulatory reaction to the crisis meant that banks needed to build up their cash base before they could resume lending, which also produced risk aversion.

Meanwhile, for many investors, large commercial jetliners have come to embody an ideal combination of safety and profit. As hard assets, they are also a solid hedge against the threat of inflation. This desire for a safe asset has tracked a broader economic trend termed ‘excessive demand’ for safe assets, such as U.S. government debt. However, financiers’ demand for jetliners arguably has not yet risen to excessive levels.

Also, there is a lack of other global investment opportunities. As the satirical newspaper *The Onion* put it, “Recession-Plagued Nation Demands New Bubble To Invest In.” In other words, it’s not just that cash is cheap. It’s also that there are no other good places to earn decent returns with that cash.

The role of low interest rates in driving strong jetliner demand has been augmented by high fuel prices. The current ratio between the two trends (fuel prices and interest rates) is unprecedented.

Yet it does not look as though fuel prices will return to low, or even moderate, levels any time soon. This implies a continued market preference for new equipment and a willingness to dispose of older jets, even at premature ages. With high fuel prices it makes sense to replace older planes with newer ones, because the fuel and maintenance savings for airlines can be greater than the lease payments on the new airplanes.

And government-backed finance further complicates the picture. Export credit agencies, or ECAs, are backing a record number of jetliner transactions, helping to eliminate any finance risk that remains in the world jetliner business. Since the economic crisis began in 2008, the ECA role in backing jetliner transactions has risen from about 15% to about one-third today.

The U.S. Export-Import Bank, of course, is the largest such agency. Through the third quarter of the year, Ex-Im authorized a record $35.8 billion in financing, a 9% increase over 2011’s first three quarters. Looking at year-end 2011 numbers, about 40% of this goes to aircraft financing, mostly Boeing jetliners. Added to this is the global rise of government-owned airlines and government-owned banks. Together, the overwhelming majority of jetliner transactions today involve one or more governments acting in a financial role (as either buyer or financier).

This combination of easy third-party financing and government cash has created a recipe for market distortion. And of course the recent jetliner boom is out of line with passenger traffic. Although 2011 saw respectable growth rates, with revenue passenger kilometers up 6.9% over 2010, traffic growth has slowed in the past few months to around 5%.

As more cash comes in to the jetliner finance business, and as industry capacity continues to increase at a considerably faster pace than airline traffic growth, returns on this cash are falling, even if they are still healthier than most other investment opportunities. This would explain the notable return of Japanese banks to the jetliner finance arena. Japanese banks have long been in the position of being cash rich, yet with a very limited set of investment options that earn any kind of returns. Even with shrinking returns, jetliner finance is still more attractive to Japanese banks than most of their other available options.

737 MAX

Most financial company demand for jets over the past few years has focused on just two single-aisle aircraft families, Airbus's A320 and Boeing's 737. These are consistently rated the two most appealing jets by investors. In both absolute and relative terms, their production has reached record levels, equating to over 50% of all jetliner deliveries by value for the past five years.

The biggest challenge for the market, therefore, is that the new single-aisle generation is coming, with serious consequences for the current models. Up-front pricing indicates that there will be little or no premium paid for A320neos and 737 MAXs. They will likely sell at the same price, implying a relatively fast and painful impact on current A320 and 737NG values. It is difficult to imagine why customers would line up to take record numbers of the last copies produced of the older models, particularly if traffic growth remains anemic. Ramping up right until the new models enter service in 2015/2017 makes little sense for anyone involved.

In short, there is likely to be a day of reckoning, with new models and weak traffic forcing some kind of jetliner production rate reduction in a few years. But this impact is unlikely to be nearly as severe as the notional impact of a rise in interest rates, and/or a fall in fuel prices.

Bottom-half business jet horrors

While the story of the business jet market over the past four years reflects sluggish demand, it also reflects changed financing terms. The best way to prove this assertion is to look at the market as two completely different segments.

Historically, the business jet market could be divided in half by value. The top half consists of jets costing $25 million plus (in today's money). The bottom half consists of jets costing less than $25 million. Also historically, these two halves usually rose and fell in tandem. In fact, in the 2003-2008 market boom, bottom-half jets actually outperformed the market for top-half ones, with deliveries growing at a 20.2% CAGR (top-half jets grew by a 15.7% CAGR). Still, between the mid-1980s and 2008, in aggregate, both halves stayed roughly equal in size.


A320neo

Yet this market downturn has seen a serious split between these two segments' fortunes. The lower half fell by a record-breaking 56.4% by value in 2008-2011. The top half of the market, by contrast, is holding up reasonably well, finishing the same period with virtually no change (0.3% growth by value). When we discuss business jet market dynamics, we are effectively discussing two very different markets. One is large and doing well, while the other is shrunken and dormant.

Corporate profits are historically the most important driver behind business jet demand. These fell in 2008-2009, but in 2010-2012 they have made a strong recovery. In fact, U.S. corporate profits in the first half of 2012 set a record, reaching $2.1 trillion on an annualized basis. This has helped maintain top-half business jet deliveries at record levels. Yet lower-half deliveries are still scraping the bottom of the market trough, with no sustainable deliveries increase in sight.

The most likely explanation for this persistent market bifurcation revolves around differing finance requirements. Transactions for larger business jets are more likely to be self-financed, either from a large corporate balance sheet or a very wealthy individual's checking account. By contrast, the strong majority of small/mid-sized (bottom-half) business jet purchases are dependent on third-party finance.

These bottom-half workhorse jets typically go to mid-sized enterprises that continue to face difficulties getting credit at reasonable terms. But it's not just the nature of the customer that is hobbling business jet finance. It's also the jets themselves. Jetliners can be deployed around the globe to earn money in airline service. Business jets are a form of private transportation, and asset values often drop fast after the original customer sells them.

Also, jetliner types are relatively homogenous, with few models and a manufacturer emphasis on commonality to enable easy remarketing. Business jets tend to have more options,

WORLDWIDE DELIVERIES BY 2012 $ VALUE

	CAGR 2003-2008	CAGR 2008-2011	Change 2008-2011	Change 2010-2011
Large jetliners	7.4%	6.8%	21.7%	8.2%
Business aircraft	17.3	-10.5	-28.4	-1.0
Regionals	4.1	-10.1	-27.3	3.3
Civil rotorcraft	17.1	-7.6	-21.2	4.2
Military rotorcraft	8.7	13.5	46.2	11.2
Fighters	2.0	6.7	21.4	10.1
All civil	9.7	0.6	1.7	5.8
All military	3.7	7.5	24.3	7.7
Total	**8.1**	**2.3**	**7.1**	**6.3**

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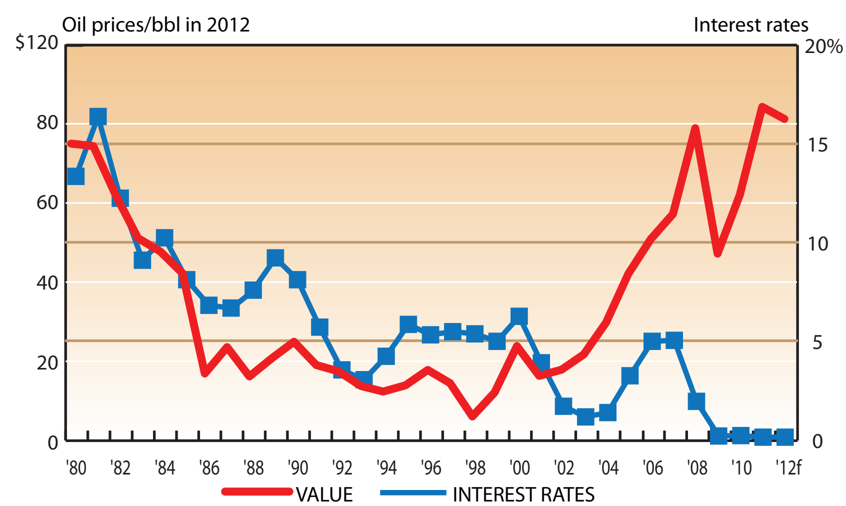

and come in many more models. For comparison, the top two jetliners today, Airbus's A320s and Boeing's 737s, make up 54% of 2012 industry output by value. The five top-selling business jet series represent just 52% of 2012 industry output by value.

The age of missing forecasts

Clearly, the two biggest civil aircraft market segments have been affected profoundly by the question of finance. The jetliner market has been artificially distorted in an upward direction by a flood of near-free credit. Conversely, the bottom half of the business jet market has been artificially distorted in a downward direction by a profound credit drought.

These trends greatly complicate market forecasting. Forecasters can make educated long-term assumptions about the traditional drivers of civil aircraft markets, such as economic growth or fuel prices. But the future of the new market drivers—interest rates, competing investment opportunities, and investor tolerance for asset risk—is anyone's guess. Meanwhile, those traditional market drivers, economic growth and fuel prices, have grown ever more volatile.

The next step in understanding this complicated finance dynamic may well be the Federal Reserve Bank's plans for a third quantitative easing program. QE3, as it is known, is the most ambitious U.S. QE program yet. It is designed to spend $40 billion per month in the U.S. home mortgage market. While that is a relatively small amount for a $10-trillion mortgage market, the Fed is hoping to use its influence to 'crowd out' private investors from this market. The Fed thereby hopes to encourage these investors to move on to more risky (and, the Fed also hopes, more productive) investments, which should stimulate the economy.

As a consequence, if QE3 works as planned, investors would shift to financing riskier assets such as bottom-half business jets. QE3 success would stimulate that market as business jet buyers see financial terms and options improve for these jets. Greater availability of credit could further help the market by encouraging buyers psychologically. Even if they do not need credit, buyers will not want to be last in line for new jets in a boom market.

But if QE3 produces unintended and undesirable consequences, risk-averse investors will merely take their cheap cash away from houses and put it into any other low-risk assets they can identify. That could just translate into further market inflation for new-build commercial jet transports.

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A fuel-efficiency revolution?

The NASA Fixed Wing Program (FWP, formerly the Subsonic Fixed Wing Program) has resolved to meet a key goal by 2030: Demonstrate transport aircraft technology that would reduce total energy consumption by at least 60% compared with current best-in-class aircraft. An earlier, equivalent goal was a 70% reduction in fuel burn.

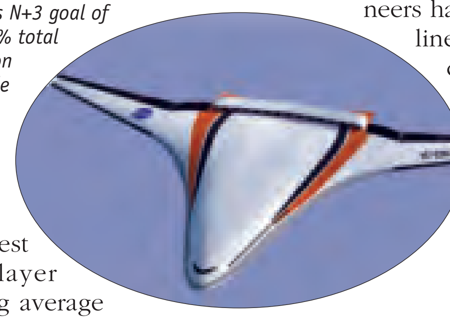
NASA intends that such 'N+3' technology—meaning three generations beyond current commercial transports—should have a technology readiness level of 4-6 by 2030. This would enable the agency to hand over its research findings to industry, which in turn would incorporate the suite of energy efficiency technologies into production aircraft. Those aircraft could enter service in the 2035-2040 period.

Breakthroughs needed

But reaching this energy efficiency target will require changes in aircraft and propulsion design. NASA aerospace engineer James Felder notes that while larger, lower pressure ratio fans yield higher propulsive efficiency, fans in traditional podded turbofan designs cannot get much bigger before the increased area of their larger nacelles creates enough drag to offset any benefit arising from improved propulsive efficiency. For underwing-mounted engines, larger fans also mean greater landing gear length, and this would add substantially to the aircraft's overall weight.

Future large aircraft could use greater numbers of smaller engines to generate the needed thrust, but these would probably have lower overall pressure ratios than large engines and would be less thermally efficient. In addition, maintenance costs would grow. Designers could do away with nacelle drag by embedding engines—large or small—inside the fuselage or wing. Embedded engines potentially could ingest boundary-layer air, reducing average inlet velocity to less than that of freestream air; but while this would reduce inlet drag, it could also easily lead to engine cores losing thermal efficiency.

NASA Glenn's N3-X transport aircraft study makes use of turboelectric distributed propulsion and supercooled transmission of electricity to reach NASA's N+3 goal of achieving a 60% total energy reduction over comparable aircraft today.



Another concept involves distributed power—using, say, two large turbine engines to power a large number of smaller fans, distributed as required round the airframe. However, trying to distribute power mechanically would entail huge complexity in terms of gearboxes (these would probably have to be the largest ever built) and required numbers of drive shafts. Not only would there be extensive power losses, but the machinery involved would add to the aircraft's weight. There would also be a significant maintenance burden.

NASA-funded research has shown that a podded, geared-turbofan 'N3-A' version of Boeing's hybrid wing body (HWB), coupled with advances in materials and turbofan engine design, could produce fuel-burn savings of just over 50% compared with a current equivalent tube-and-wing transport.

Building on this foundation, engineers at NASA Glenn reckon it is possible to achieve the N+3 target reduction of 60% in total energy by using a different form of distributed propulsion—with engine power distributed not mechanically, but electrically. The research focuses on using turboelectric distributed propulsion (TeDP), rather than turbofan engines to power a hybrid wing body aircraft that engineers have dubbed N3-X. The baseline against which the team is comparing the N3-X's efficiency is a Boeing 777-200LR operating a 7,500-n.mi. mission at a Mach 0.84 cruising speed and carrying a 300-passenger payload.

Propulsion

Felder is lead simulation engineer for the TeDP project, which is part of the FWP. As he and others on the NASA Glenn team envision it, TeDP will use turbine engines not to generate thrust but to drive the rotating parts of superconducting generators, which would be mounted on each wingtip of an HWB so they would ingest freestream air. These turbogenerators would make extensive use of advanced ceramic matrix composites to allow turbine inlet gas temperatures of over 3,000 F.

While each engine's power turbine would extract most of the energy from the gas stream to drive the superconducting generator, the exhaust nozzle of each turbogenerator would be shaped to produce enough jet velocity during cruise to create a small amount of thrust, negating the drag produced by the turbogenerator's nacelle.

If the wingtip-mounted arrangement were found unsuitable for aeroelasticity reasons, the turbogenerators could be placed elsewhere on the aircraft, according to Felder. Should this happen, Felder proposes that a small, electrically powered propulsor unit be located on each wingtip: NASA research from as far back as 1970 has shown that thrust at the wingtip can disrupt the wingtip vortex, thereby reducing drag. NASA Glenn has not yet included in its N3-X calculations the efficiency benefits from wingtip-vortex suppression, but Felder reckons this could remove 20% of the total induced drag on the aircraft.

The AC current produced by the turbogenerators would be inverted to create DC current, which suffers practically no power loss in transmission along a superconducting electrical line. This DC current would be cross-fed to an array of superconducting motors encased in a single, full-span but axially short V-shaped nacelle on top of the rear fuselage of the HWB, at the 85%-chord position. Inverters at each superconducting motor would convert the current to AC again, to allow each motor to drive a relatively small fan, approximately the same size as that of a CFM56-3. In all there would be 14 or 15 fans within the nacelle.

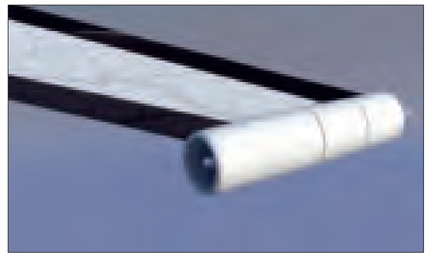
Each fan and motor would represent a separate, independently driven propulsor. Each propulsor would have a 2D inlet and nozzle. Collectively all the inlets and nozzles would form a continuous, 'mail-slot' inlet and nozzle. Thus there would be no possibility of air channels being created between any adjacent fans—and no possibility of accelerated channel air reaching supersonic speed and creating drag-causing shockwaves.

While each propulsor would be short, each nozzle could be given a variable area for greater efficiency simply by adding a hinged nozzle flap. Cross-feeding of the propulsor motors through the superconducting electric lines would do away with any problem of asymmetric thrust if a turbogenerator were to fail.

Nacelle placement

The embedded V-shaped nacelle would mimic the shape of the trailing edge of the fuselage of the HWB, while reducing the additional, drag-producing wetted area of the propulsor to just its sides. According to Felder, the rear-fuselage-top, inverted-V nacelle arrangement would stagger the fan line so that the failure of any one fan could not create a 'zipper effect' and cause others to fail.

On a TeDP-powered HWB, the nacelle's far-back location would also allow boundary-layer ingestion (BLI) from the upper fuselage surface, slowing inlet air velocity and thus increasing each propulsor's efficiency. The nacelle's location would also allow the propulsors to benefit from the fact that, by 80% chord, diffusion of the inviscid portion of the airflow over the HWB's upper fuselage would slow the air down to less-than-freestream velocity, reducing inlet air velocity further than would BLI alone.



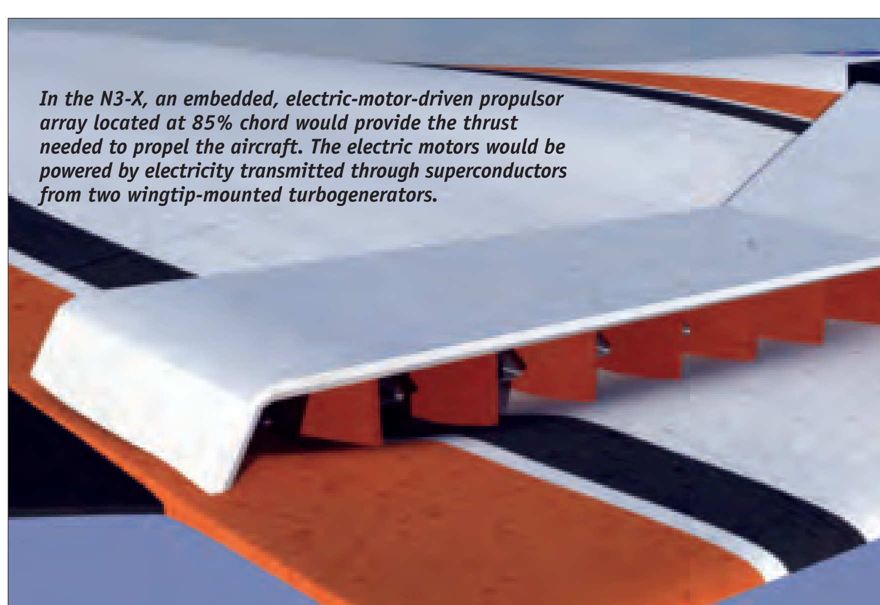
The N3-X would use two wingtip-mounted turbogenerators to create enough electrical power to drive an array of propulsor fans. These would be located in a common nacelle placed near the rear of the aircraft's upper fuselage.

Because of the short axial length of the nacelle and propulsors, the propulsor-nozzle plane would be well forward of the fuselage's trailing edge. During takeoffs and landings, this would maintain the noise-shielding benefits produced by the fuselage being between the thrust airflow and the ground. The nacelle location would also be close enough to the rear of the aircraft for the thrust airflow to fill in the low-pressure area immediately behind the fuselage. This would help reduce the pressure differential between the air ahead of the aircraft and the air in its wake, thus reducing drag on the aircraft.

Keeping cool

The whole TeDP concept, relying on superconductors as it does, also requires technology that can cool nearly to absolute zero the superconducting filaments in the generators and the electric motors, as well as the electrical transmission lines. In making assumptions about likely technological progress in the next 18 years, Felder and his colleagues have reviewed the current state of the art regarding refrigeration for superconductors. Their calculations show that two refrigeration technologies are potentially suitable.

Use of superconducting materials is central to Glenn's TeDP concept. One material that potentially could be used is bismuth strontium calcium copper oxide (BSCCO). This has the advantage of operating optimally as a superconductor at the relatively high temperature of 58 K. As things stand today, AC power losses from BSCCO



In the N3-X, an embedded, electric-motor-driven propulsor array located at 85% chord would provide the thrust needed to propel the aircraft. The electric motors would be powered by electricity transmitted through superconductors from two wingtip-mounted turbogenerators.

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The turboelectric distributed propulsion concept proposed in the N3-X study could also be used to power a more conventional tube-and-wing aircraft configuration, according to the NASA Glenn engineers who are conducting the research.

are unacceptable for TeDP use, but Felder's team assumes that developments in BSCCO research over the N+3 timeframe will reduce AC losses to acceptable levels.

For the TeDP study, BSCCO was paired with a reverse Brayton cycle refrigeration system, generally known as a cryocooler, to lower its temperature to the required level. This equipment—powered by its own electric motor, using a little of the electrical power produced by the turbogenerator—would be heavy, but the superconduction it allowed could produce a TeDP-powered HWB design that would meet NASA's overall 60% energy reduction goal.

The other option Glenn has studied—one the engineers reckon makes a more compelling case—is to use magnesium diboride as a superconducting material. MgB_2 has the disadvantage of requiring a working temperature of just 28 K, which would increase the weight and power of required cryocoolers compared with those used to cool BCSCCO. However, MgB_2's AC power losses with current-technology 40-50-µm filaments are still low enough to reach the N+3 energy reduction goal using cryocoolers. But the engineers reckon the MgB_2 refrigeration challenge can be turned into a strength by using liquid hydrogen—which boils at 21 K—rather than cryocoolers to cool the superconductors.

Felder notes that existing HWB designs have lots of void space in their wing-fuselage joints. This space cannot easily be used for payload, but could easily hold small dewars (which would weigh much less than the cryocoolers required for BSCCO), which would act as containers for the liquid hydrogen required. Another important benefit would be that slightly warmed liquid hydrogen, after being used as a refrigerant for MgB_2 filaments, could be used as fuel for the aircraft. When burned, 1 lb of liquid hydrogen produces as much power as about 2.8 lb of jet fuel. Felder calculates the aircraft's fuel weight would be reduced by more than 2 tons.

Efficiency and control

Felder's team says the N3-X TeDP configuration would be at least 20% more fuel efficient than the N3-A HWB design, so the N3-X could be made smaller and lighter for a given payload. The TeDP system would not require as high a takeoff thrust rating as the turbofans in the similarly sized N3-A. Increased use of liquid hydrogen as fuel could make the N3-X even lighter, and yet more fuel efficient.

Felder says another potential advantage of TeDP propulsion is that each propulsor would act independently and would be driven by a fast-response electric motor that would offer instant control over the propulsor's entire thrust range. This would mean the N3-X's propulsors could be used to provide a significant degree of yaw control. One or more propulsors on one side could be spooled up, while others on the other could be idled, for instance. This would negate the need for vertical control surfaces, further reducing aircraft weight.

While Felder's team believes TeDP would generate particularly high energy efficiency benefits when paired with an HWB, Felder reckons the system could achieve substantial efficiency benefits for other aircraft design configurations as well.

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SST research

Breaking new

Although manned supersonic flight was first achieved over a half-century ago, the goal of creating a commercially viable SST has proven elusive. Only two such aircraft saw regularly scheduled passenger service, but technical problems and environmental concerns put an end to them. Recent progress in addressing the main problem, noise, means a successful SST could be within reach.

Supersonic manned flight officially began with Air Force test pilot Capt. Chuck Yeager's October 14, 1947, flight of the experimental Bell X-1 research rocket plane over what is now Edwards AFB, California. Generations of increasingly fast and capable military aircraft followed, culminating in the 'supercruise' capabilities of the fifth-generation F-22 Raptor and F-35 Lightning II.

Bringing supersonic flight to commercial transport, however, proved far more difficult. Only two aircraft have flown regular commercial schedules—the Tupolev Tu-144 and the Aérospatiale (now EADS)/BAC (now BAE) Concorde.

Early struggles

The Tu-144 first went supersonic on June 5, 1969, and 10 days later became the first commercial transport to exceed Mach 2. What had seemed an edge for the Soviet Union turned sour with a crash at the 1973 Paris Air Show. This delayed its introduction into passenger service until November 1977, two years after Concorde. The next May, a Tu-144D crashed during delivery, and the passenger fleet was permanently grounded after only 55 scheduled flights.

The aircraft remained in use as a cargo plane for six years before being taken out of commercial service after only 102 flights. It found limited use as a cosmonaut trainer in the Soviet space program, and for supersonic research by NASA, which conducted the Tu-144's final flight in 1999.

The first supersonic flight of the Concorde was on October 1, 1969, although it did not begin regular commercial flights until January 1976. The Tupolev's problems significantly reduced airline interest in supersonic transports, however, as did a major spike in fuel costs. And with environmental concerns about sonic booms soon leading to a ban on overland flights, the market essentially vanished.

The only U.S. operator was Braniff International Airways, which leased 10 Con-

by J.R. Wilson
Contributing writer

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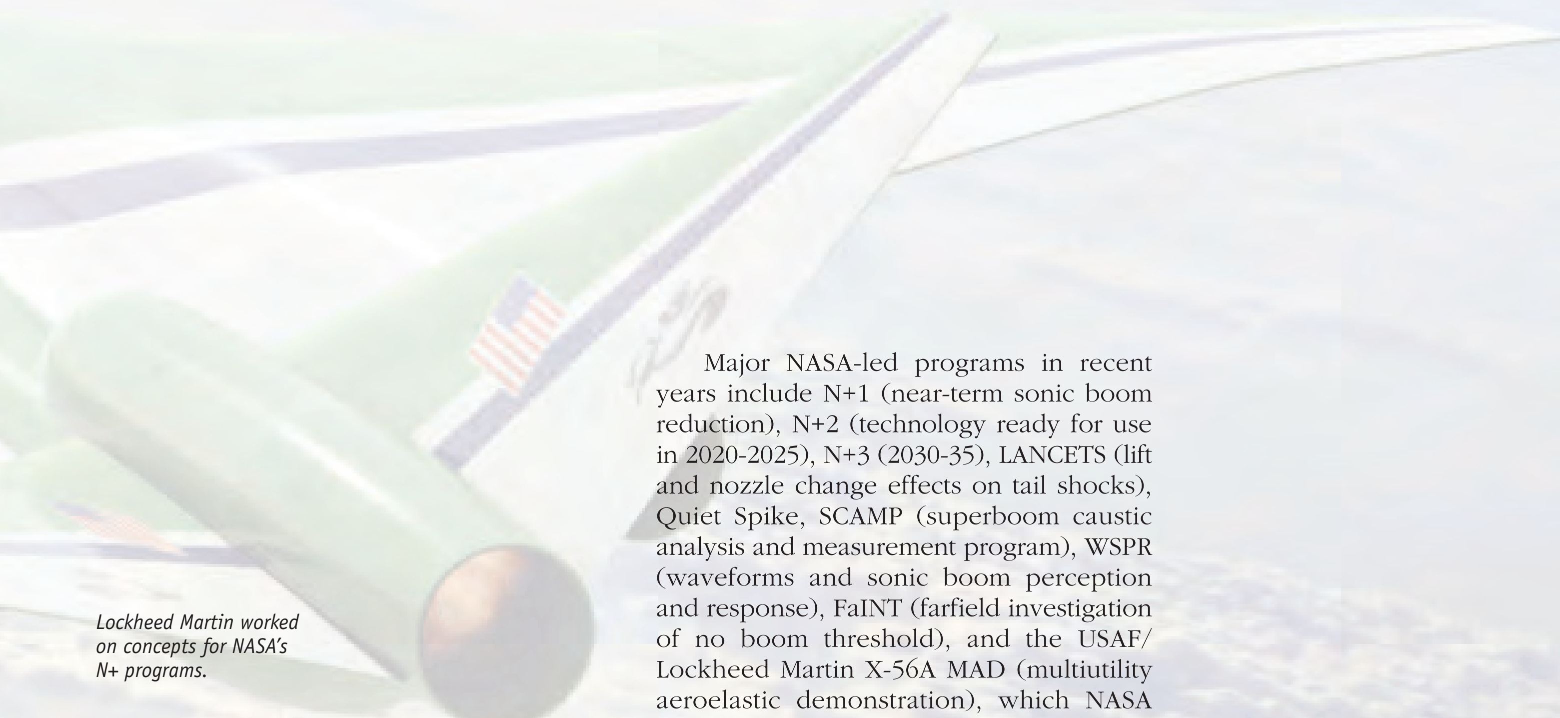
barriers



Lockheed Martin worked on concepts for NASA's N+ programs.

cordes—five each from British Airways (BA) and Air France—for subsonic flights between Dallas and Washington, D.C., with the European airlines then continuing the flights supersonically across the Atlantic. This lasted from 1978 to 1980, ending when the plan proved unprofitable, leaving BA and Air France as the only full-service operators. The two announced simultaneous plans to retire the Concorde in 2003—Air France in June and BA in October.

Progress at last

Now, nearly a decade after the last SST passenger flight, research into resolving Concorde's major problem—noise—is beginning to show significant progress.

Major NASA-led programs in recent years include N+1 (near-term sonic boom reduction), N+2 (technology ready for use in 2020-2025), N+3 (2030-35), LANCETS (lift and nozzle change effects on tail shocks), Quiet Spike, SCAMP (superboom caustic analysis and measurement program), WSPR (waveforms and sonic boom perception and response), FaINT (farfield investigation of no boom threshold), and the USAF/Lockheed Martin X-56A MAD (multiutility aeroelastic demonstration), which NASA took over for supersonic research in 2012.

The Air Force, the Navy, and industry also have been working to improve supersonic aircraft, though military requirements only partially mesh with the commercial work at the heart of NASA's programs.

"There have been a number of collaborative efforts in terms of CFD tool development and design system development that share information between the Air Force and NASA," says Peter Coen, project manager for NASA's Supersonic Fundamental Aeronautics Program (FAP). "In addition, low-complexity, highly efficient stable inlets are applicable for both supersonic military and commercial aircraft, although the eventual shape will be different," he says.

"Another overlap developing a little momentum is [that] both the Air Force and

Boeing offered the 2707 as competition for the Concorde, but interest in supersonic travel fell by the wayside.

Navy are taking into consideration takeoff and landing noise, not just in terms of community compatibility, but also long-term effects on military personnel. So we're working with the Navy on a basic understanding of the application of some noise reduction technologies to supersonic jet flow," Coen tells *Aerospace America*.

Both Lockheed Martin Skunk Works and Boeing Research and Technology (formerly Phantom Works), where the two conduct advanced research, have worked with NASA on the N+ programs, drawing on (or in some cases continuing) their own internal research as well as previous military and commercial supersonic programs.

The future SST

While Lockheed Martin's recent efforts date back to the early 1990s, N+2 program manager Mike Buonanno says that his is the only supersonic research the company currently has under way.

"The research we're doing now is in support of a future SST," says Buonanno. "Under the N+2 contract, one of the things we are doing for NASA is a conceptual design study for a future SST and what technology needs to be matured to make such a vehicle viable economically, so that it has useful range and fuel consumption and has sonic boom characteristics that can allow it to operate over land.

"We selected Mach 1.7 as our target [compared to Concorde's Mach 2.1]. We were given a range of passengers—at least 30 or more. Based on our research, we thought 80 would be a good number to target. We're designing to be compatible with international airports, in terms of runway length and a range of over 5,000 n.mi. That would allow some transpacific routes, which would not require sonic boom compliance. For low-boom cruise, we're designing for at least a 4,000-n.mi. range, although we think we can do better than that."

Boeing completed its N+3 studies in 2010 and more recently has concentrated on pushing the N+2 technology readiness level (TRL).

"We've continued to conduct research into low sonic boom supersonic aircraft concepts to reduce the noise levels to the point where supersonic operations over land would be possible. In addition, we are continuing to investigate future market opportunities relative to our product line, as well as technology research in structures, materials, propulsion, and systems," says Robert Welge, Boeing senior technology fellow. "The N+2 and N+3 studies are focused on concepts that potentially could be feasible in 2020-2035, but it's unknown if any of these concepts will ever actually become new airplanes.

"There are at least 15 years until there could be any notional introduction of any of these concepts into service. In that time, Boeing and other market participants will continue to develop and market new concepts. For our part, Boeing is always interested in expanding the technology base for our future products, and we are continuously engaged in studying a variety of future 'concept planes' to help guide technology development and understand potential future products and markets."

Both U.S. companies were part of the nation's early effort to compete with the European Concorde, offering the Lockheed L-2000 and Boeing 2707 into competition for a congressionally funded American SST. Boeing won that competition, but in 1971 Congress halted funding and banned all overland supersonic transport flights. Neither company opted to pursue an independent development.

"We're working on it, so we're interested in the technology and moving it for-

An ironic record

In 27 years of passenger flights, the 14 Concordes in regular passenger service recorded 4,358 flights with only one accident: the July 2000 crash of an Air France flight on takeoff, attributed to a tire blowout caused by a piece of metal that had fallen off another aircraft as it took off just ahead of the Concorde. With neither of the Tupolev crashes having involved passengers, that record leaves SSTs with the safest flight record (in miles per passenger) of any commercial jet transport, an ironic legacy considering airline safety concerns in 1977.

ward," Welge says. "NASA is currently targeting a date of 2025 with N+2 and, based on the TRLs, that's still the date we're looking at for this type of aircraft. No one technology by itself will get us where we want to be, but by integrating them all we can come up with a vehicle that is more than double the speed of today's subsonic airliners and still environmentally responsible."

Current focus

"The technology exists to make an SST today—it existed 60 years ago," says Welge. "There are no showstoppers now, and the level of environmental impact and efficiency will improve with time. On N+2, we're really focused on a jetliner similar to today's commercial airliners. We think there is a large domestic market for this type of aircraft, which would be a big enabler compared to Concorde. You could fly coast to coast with an acceptable low boom level and get from L.A. to New York in about 2.5 hr; we think there would be a big market for that as well as the international traffic."

Gulfstream, which has been doing supersonic research since the 1980s, is most interested in the potential for a supersonic business jet—which all parties involved believe to be the most likely first application of the technologies NASA is investigating. As with a larger SST, however, the current emphasis is on resolving the sonic boom.

"We do supersonic research because speed is likely the next technological step in air travel," says Robbie Cowart, director of supersonic technology development at Gulfstream. "There's been an industry push to bring supersonics to the forefront of research to develop a sonic boom standard and a rule governing environmentally efficient supersonic flight over land.

"Gulfstream, NASA, and the rest of the industry continue to conduct research into sonic boom mitigation. A supersonic jet won't be introduced until the current regulations prohibiting supersonic flight over land change. If a rational rule could be put in place a supersonic airplane could come into existence in the next 20 years or so.," says Cowart.

Boeing too sees the likely future of supersonic passenger transport as an evolution beginning with business jets.

"Many factors have to be considered, including whether or not the current pace of research can be maintained and whether sonic boom levels are considered to be acceptable for the public. The ongoing NASA technology studies we and several other industry teams are supporting have been looking at several technologies that could be available in 2020-2035," Welge says.

"From a technical standpoint, low sonic boom supersonic business jets could be feasible around or shortly after 2020, and low sonic boom airliners could be feasible around 2030-2035. Boeing has a continuing interest in technologies that could eventually enable a next-generation supersonic airliner that would be viable economically, environmentally, and operationally."

NASA's F-15B testbed aircraft flew in the first evaluation flight of the joint NASA/Gulfstream Quiet Spike project, which seeks to verify the structural integrity of the multisegmented, articulating spike attachment designed to reduce and control a sonic boom. Credit: Lori Losey.

Chicken or egg

As research toward future SSTs continues, some see it becoming a 'chicken or egg' situation, with industry reluctant to build a true supersonic demonstrator until the FAA sets out regulatory standards for overland flight, and the FAA apparently waiting for industry to demonstrate what can be done to mitigate the problem.

"The first step is a demonstrator, and most projections have it flying in the next 5-10 years. We've done a lot of testing already with military aircraft; with a demonstrator, we would want to do many of the same tests, such as the air-to-air probes. We're working on all the individual components now, but need to bring those together and get something flying," says Larry Cliatt II, principal investigator in the FaINT program at NASA Dryden.

"It would be more difficult to predict when we might actually see a production aircraft flying. The first probably would be a business jet, probably at least five years before a jetliner. How big can you get, how fast can you fly, with what level of boom on the ground, and still be profitable? But will the FAA set a standard first and industry design toward it, or will the FAA wait until there is a demonstrator and base a regulation on what results come from it?"

Anatomy of a boom

One outcome of research in recent years has been the need to understand the vari-

Chuck Yeager

ability of sonic booms, and that a resolution to one type might not mitigate—or might even worsen—other boom elements. FaINT is designed to investigate some of those factors, from cause to intensity to 'shape.'

"Overall, the project is investigating the different sonic boom phenomena. One is Mach cutoff, where the sonic boom is fragmented above the ground, but right below the fragment line you still get waves that propagate to the ground—usually as a distant rumble, like thunder. So we wanted to correlate that with different flight conditions, as well as validate future computer codes using that data," Cliatt says.

"Another phenomenon is lateral cutoff related to the sonic boom carpet, which is the primary sonic boom, with the boom being lateral to that even if the carpet does not actually hit the ground. The carpet is what people typically hear—an in-wave sonic boom, which depends on the size of the aircraft, altitude, speed, etc."

FaINT used a specially equipped F/A-18 flying different supersonic profiles over a large field of 120 microphones laid out on the lake bed at Edwards AFB. Thirteen flights, averaging six sonic boom passes each, took place between October 29 and November 7, 2012, in the program's Phase 2. A second aircraft, a TG-14 motorglider, recorded midfield booms above the atmospheric turbulence between 5,000 and 10,000 ft msl (mean sea level). An additional vertical component was provided at about 3,000 ft by a blimp from Cessna.

Phase 1 project design, Phase 2 flights, and final Phase 3 data analysis have recently drawn wide support from both domestic and international partners, including Gulfstream, Boeing, Cessna, Penn State, NASA Dryden and Langley, and aviation agencies in Japan and France. Their intent was to measure not only the boom most people recognize below the aircraft, but also booms that may develop above the plane and hit the ground hundreds of miles downrange, and also to study how variable factors can impact different forms of boom.

"I think we can say with confidence that the sensitivity of these Mach cutoff cases is very high. We were looking at what boom levels were heard on the ground, depending on what the aircraft was doing, and we found that very slight changes could impact the kind and level of boom. If the F-18 was flying at Mach 1.1, all we might hear on the ground was a low rumble. However, if the pilot did the same maneuver, only flying 4 kt faster, we might get a full boom," Cliatt points out.

"Atmospheric conditions also have a very big effect. If we did a flight at 7 a.m., the boom might not hit the ground; fly the same maneuver 2 hr later and the boom might hit the ground or be louder. So as we move forward, we have to take that and other factors into account in real time for any kind of sonic boom mitigation technology," he notes.

While FaINT and other programs using existing aircraft have revealed a great deal, he says, they cannot do all that is needed to move from basic experiments to TRL 6 (system/subsystem model or prototype demonstration in a relevant environment) and TRL 7 (system prototype demonstration in an operational environment).

"We always have more research to do: turbulence modeling, how turbulence in the atmosphere affects sonic booms, and over-the-top sonic boom research. The primary carpet is produced by shock waves beneath the aircraft, but you also have some that go up into the atmosphere, then come back down hundreds of miles from where the aircraft might be. For example, the Concorde would slow down to subsonic when approaching land, but the over-the-top boom still might hit the ground hundreds of miles ahead of the aircraft," he says.

NASA's F/A-18B mission support aircraft 852 flew over the high desert near the Tehachapi Mountains northwest of Mojave as part of a series of low-supersonic, high-altitude flight profiles during the FaINT flight research project at NASA Dryden. Credit: NASA/Jim Ross.

Need for a demonstrator

"There are different ways of dealing with booms, but until someone builds a low-boom demonstrator, we might not know for sure the best way to address it. Certainly aircraft shape can be changed to lessen booms hitting the ground; there also are real-time changes that could be made. For example, NASA is working on a sonic boom cockpit display that would show the pilot, in real time, what kind of booms the aircraft is producing, so he could tailor his flight profile," Cliatt explains.

And that, NASA and industry agree, is the level of technology development now needed to move supersonic research to the next level, making any form of SST viable.

"Right now, I think we have the tools and knowledge to move forward and build aircraft that have lower sonic boom levels. We've done engine research and shaping the aircraft to manipulate the boom on the ground," Cliatt says. "The next step is to make something at scale and fly it.

"Most of the industry is trying to determine acceptable levels for sonic booms on the ground. Right now there is no FAA or ICAO [International Civil Aviation Organization] legislation regarding a threshold. So a lot of what we are doing now is building a data set to help determine that. That is one of the problems—no one wants to build a demonstrator until they know what levels the FAA wants."

While various research efforts are expected to continue, the ultimate future for development of a production SST in the next two or three decades now appears to rest heavily on a specially built supersonic demonstrator.

"If we can't solve the boom problem, there is no sense working the other issues, because the airlines won't buy an aircraft they can't fly wherever they want to," FAP's Coen points out. "If and when we start flying a low-boom demonstrator, I believe the boom noise in urban environments won't be a problem, but it will be more so in rural environments, and especially in the extreme quiet environments like the Grand Canyon and national parks. Which is where the regulators will step in and determine if there is sufficient value to override any of that.

"The N+2 time frame, at the rate we're going, doesn't give us all the technologies we need to achieve a completely acceptable level of boom, efficiency, and affordability. I don't think we really have to wait until 2035, but 2030, if we continue at the current rate, is possible. And I think the business jet market, even with technologies available in the 2025 time frame—provided we can resolve the overland boom—could see a product built. The boom is key. We've made progress and are getting to the point of a flight demonstrator to develop the data for a regulatory process. That is the goal of the project now and, funding willing, we'll get there," Coen says.

Icon II is Boeing's concept for an N+3 SST configuration. Boeing research concluded that N+2 SST concepts are unlikely to meet fuel efficiency and sonic boom mitigation goals at the same time, so they identified a preferred N+3 concept that shows the potential to meet or exceed nearly all the NASA goals for N+3.

Change and restructuring

NASA's research continues to focus on sonic boom mitigation, takeoff and landing noise, high-altitude emissions, lightweight and durable structures and materials for engines, and aeroelasticity for long, slender SSTs. But the future of NASA-sponsored research, he adds, will see some significant changes as the agency undergoes yet another reorganization.

"Starting in FY13, there will be restructuring within the FAP, and a lot of the work in supersonics will become part of the High Speed Project. The primary reason for that was a decision for NASA to ramp down its hypersonics research and create projects with a little more procurement available for testing and higher TRL effort. So we created an Aeronautical Sciences Program that deals with a lot more cross-cutting technologies applicable across the speed regime and multiple vehicle types," Coen says.

"FAP is doing the fundamental, lower TRL research to enable new concepts, technologies, and vehicles for atmospheric flight. We are not doing a lot of the higher TRL demonstrations, but are focused on removing the barriers to practical civil supersonic flight. Most of our recent work is more focused on the N+2, but the more foundational work primarily addresses the N+3. We are working on technologies such as shaping the aircraft to reduce sonic booms, nozzle concepts for low takeoff and landing noise, and some CFD-based design methodology that would allow us to address boom reduction and efficiency enhancement simultaneously, by modeling and designing the full 3D shape of the aircraft." ▲

Lunar Reconnaissance Orbiter

Changing the face of the Moon

by Craig Covault
Contributing writer

After the Apollo 17 astronauts returned to Earth 40 years, ago ending the final manned lunar landing mission, the science community quickly arrived at a consensus: The Moon was dead.

From 1964 to 1972, NASA distributed to the science community thousands of photographs taken by three Ranger hard landers, five lunar orbiters, five Surveyor soft landers, seven lunar orbiting Apollos, and 12 U.S. astronauts working (not just walking) on the Moon.

An international effort was under way to unravel the secrets contained in the images and in 840 lb of lunar rock and soil carried back by the six Apollo missions that landed successfully.

The USSR had its own research efforts, using thousands of images from its Luna spacecraft and a half-pound of lunar soil returned to Earth by three Soviet robotic sample return missions.

Many secrets were unlocked, but all of the analysis indicated that the Moon was indeed a profoundly dry geologic corpse, having been dead for at least the last billion years of its 4.5-billion-year history.

During nearly 20 years of study following Apollo, nothing changed in this regard. As respected Brown University lunar scientist Peter H. Schultz put it in 1991, "The 'Dead Planet Paradigm' is well established in lunar science."

The 1994 Clementine and 1998 Lunar Prospector missions returned minerology data from lunar orbit but did not address active geologic activity. Prospector, however, found preliminary evidence for water ice.

It's alive!

And now, just over a decade into the 21st century, interest in the Moon has been resurrected by NASA's Lunar Reconnaissance Orbiter. LRO images of the Moon show: It's alive!

"Many, many people have felt that the Moon is geologically dead. What we are finding is that this is totally wrong. The Moon appears to be geologically active—now!" says Thomas R. Watters, a senior scientist and planetary geologist at the Smithsonian National Air and Space Museum in Washington, D.C.

"One of the really, really exciting returns from the LRO mission is that we are now seeing growing evidence of very young geologic activity on the Moon,"

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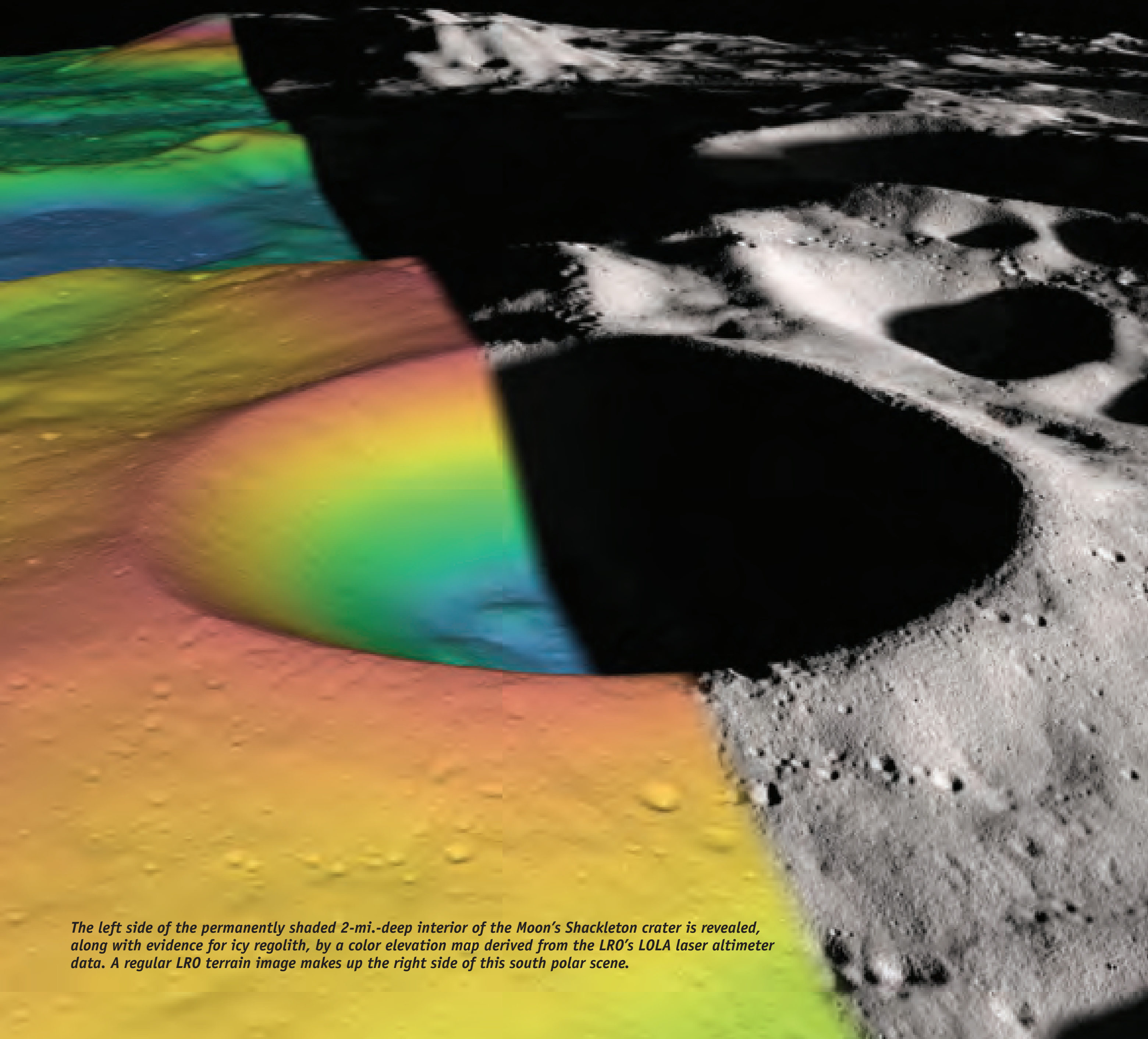
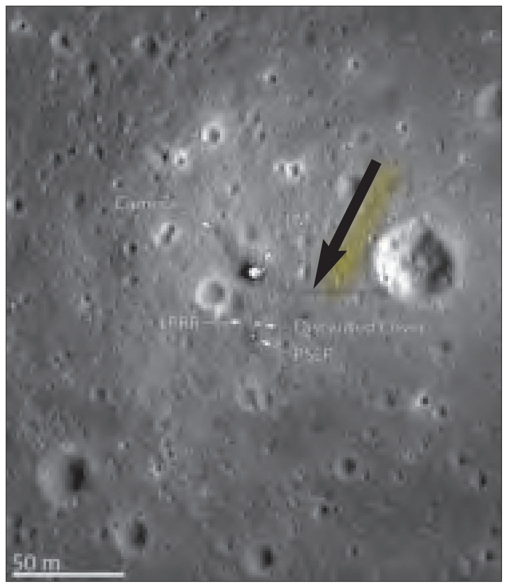
NASA's Lunar Reconnaissance Orbiter is aptly named, uncovering long-held secrets not just about the Moon but also about the lunar programs of former earthly space rivals. The myriad images it has produced have led to one block-buster revelation that is breathing new life into lunar science. Details provided by LRO's advanced suite of instruments are literally putting a new face on 'the man in the Moon.'



The left side of the permanently shaded 2-mi.-deep interior of the Moon's Shackleton crater is revealed, along with evidence for icy regolith, by a color elevation map derived from the LRO's LOLA laser altimeter data. A regular LRO terrain image makes up the right side of this south polar scene.

On landing day 42 years ago Neil Armstrong took this shot after he had walked to the crater rim and looked back west to the lunar module. Credit NASA Goddard/Arizona State.



LRO image of the Apollo 11 landing site from an altitude of only 12 mi., with an 8-in. resolution, shows the tracks of Neil Armstrong (dark arrow) created when he walked 200 ft each way to the 80-ft-diam. Little West crater. Visible are Eagle's descent stage, the lunar ranging retroreflector, and the passive seismometer experiment.

says Watters, who is also a member of the LRO camera team. He points out that the new features that LRO is spotting could have been formed as recently as 50 million years ago or even more recently—a very short time relative to the 4.5 billion-year age of the Moon.

That was just the beginning for this 2-ton marvel. Developed by NASA Goddard, the $504-million LRO was launched in June 2009 from Cape Canaveral on board a United Launch Alliance Atlas V rocket. LRO's other major achievements include:

•Extremely high resolution imagery that sheds new light on human lunar exploration and the U.S./Soviet race to the Moon, including unmanned Soviet Moon lander mysteries. LRO has focused in on all six of the Apollo landing sites, discovering among other things Neil Armstrong's specific footprints on the Moon and the still-'flying' American flags of Apollo 12, 16, and 17—the final flag, planted by Gene Cernan and Jack Schmitt on December 12, 1972.

•Transmitted data indicating the Moon has at least 6.6 billion tons of water ice. Future explorers could use the ice for drinking water, radiation shielding, or oxygen for breathing, and use the hydrogen for rocket propellant by combining it with oxygen.

•Location and mapping of very specific places where major deposits of the important mineral lunar ilmenite can be found. This titanium-iron oxide mineral is highly enriched with magnesium and would be critical in the development of a Moon base, scientists believe. Oxygen can be easily extracted from lunar ilmenite, which would also be used to fashion building materials for permanent structures. The mineral's earthly version is mined in 13 countries.

•The discovery of titanium fields on the Moon, with concentrations of the mineral 10 times higher in lunar ore than in titanium ore on Earth. In studying LRO images, scientists noticed that some areas of lunar seas are reddish and some are blue. The color variations point to concentrations of titanium and iron.

•The finding that the Moon's north polar region is home to one of the coldest places in the entire solar system, at nearly -415 F.

•Images and terrain elevation data that are being forged into new maps of unprecedented detail, for human and robotic mission landing sites and for pinpointing the Moon's diverse geologic features and resources. The spacecraft is returning so much high-resolution data that the LRO team believes it could map much of the lunar surface at a resolution of 19.7 in./pixel.

Preserving the mission

The LRO mission was approved as a precursor to the Constellation manned lunar program, conceived in response to the Vision for Space Exploration. President George W. Bush had announced the vision in 2004 as a way to transition NASA back to flights beyond Earth after completion of the ISS and the phase-out of the space shuttle.

LRO's mission at that time was to create new high-resolution lunar maps, pinpoint water and mineral resources that could support manned outposts, and scope out the best new sites for renewed manned lunar landings and habitation, starting in 2020 under Constellation.

But on Feb. 1, 2010, President Barack Obama announced his intent to cancel the foundering Constellation program. It was just seven-and-a-half months after the $504-million LRO had been launched on a mission specifically to support Constellation.

NASA decided to continue LRO's mission in its originally planned Exploration Phase lunar polar orbit for a year at 31 mi. altitude, to support future landings whenever they might resume. LRO took images with resolutions as good as 19.7 in./pixel from this orbit.

A wider audience

Ironically, the first major user of such publicly available advanced maps and landing site products may well be China. It has launched its own Chang'e lunar orbiter, which is far less capable than LRO.

For launch later this decade, China and India are both developing robotic lunar rovers that likely will make use of LRO data. China will decide in the next five years whether to pursue a manned lunar program that would also use key LRO-discovered lunar resources and terrain data for the landing of Chinese astronauts on the Moon around 2030.

In addition, LRO data will be used for planning by nearly two dozen U.S. and international ventures competing for the $30-million Google Lunar X Prize to send privately developed rovers to the Moon.

Under a new Science Phase plan begun in 2010, the LRO orbit was dropped down to about 12-mi. altitude to achieve image resolutions of 8 in. above key targets such as Apollo landing sites, and to search for important missing or crashed Soviet lunar spacecraft.

Instrument suite

Though its original justification for approval had been cancelled, during both its Exploration and Science mission phases LRO began making breakthrough discoveries. Lunar and planetary scientists in general, as well as future mission planners, will use information from the entire LRO instrument suite, which includes:

•CRaTER (cosmic ray telescope for the effects of radiation). This Boston University/MIT instrument is characterizing the lunar radiation environment, allowing scientists to determine potential impacts for future astronauts and the materials used to protect them.

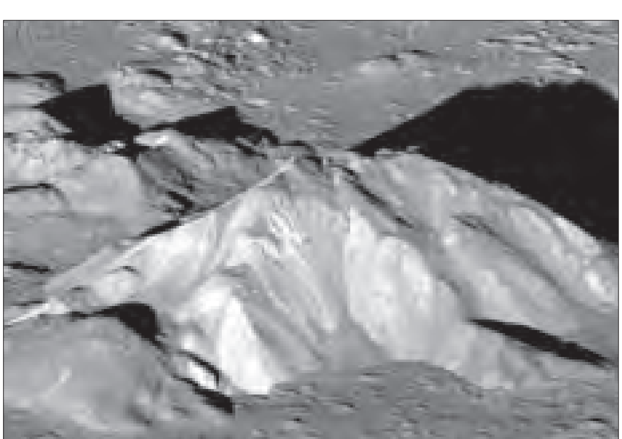
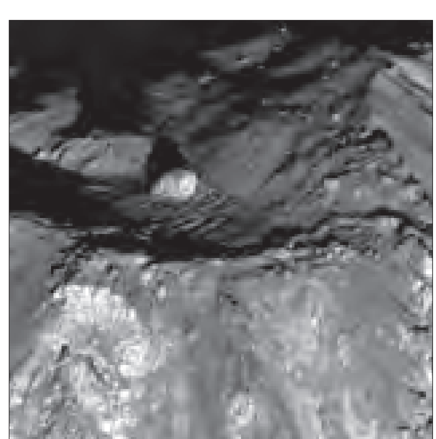
•LAMP (Lyman-Alpha mapping project). The LAMP instrument has found surface water ice in south polar regions. It is also providing images of permanently shadowed regions illuminated only by starlight and the glow of interplanetary hydrogen emissions, the Lyman-Alpha line. The instrument was developed and built at the Southwest Research Institute in San Antonio, Texas.

•DLRE (diviner lunar radiometer experiment). The DLRE has identified areas cold enough to preserve ice for billions of years, as well as rough terrain, rock abundances, and other landing hazards. Diviner was developed and built by UCLA and JPL.

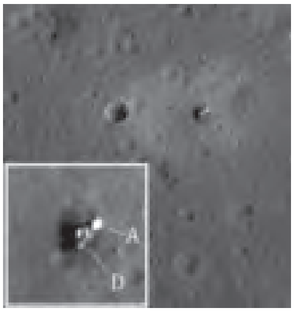
•LEND (lunar exploration neutron detector). This instrument is creating high-resolution maps of hydrogen distribution and gathering information on the neutron component of the lunar radiation environment. These data have also been used to identify water ice near the Moon's surface. LEND was developed and built by the Russian Institute for Space Research in Moscow.

•LOLA (lunar orbiter laser altimeter). LOLA has been measuring the slope of potential landing sites and lunar surface roughness. It also has been generating a high-resolution 3D map of the Moon.

•Mini-RF. This Goddard instrument is a small synthetic aperture radar that helps to find ice deposits.

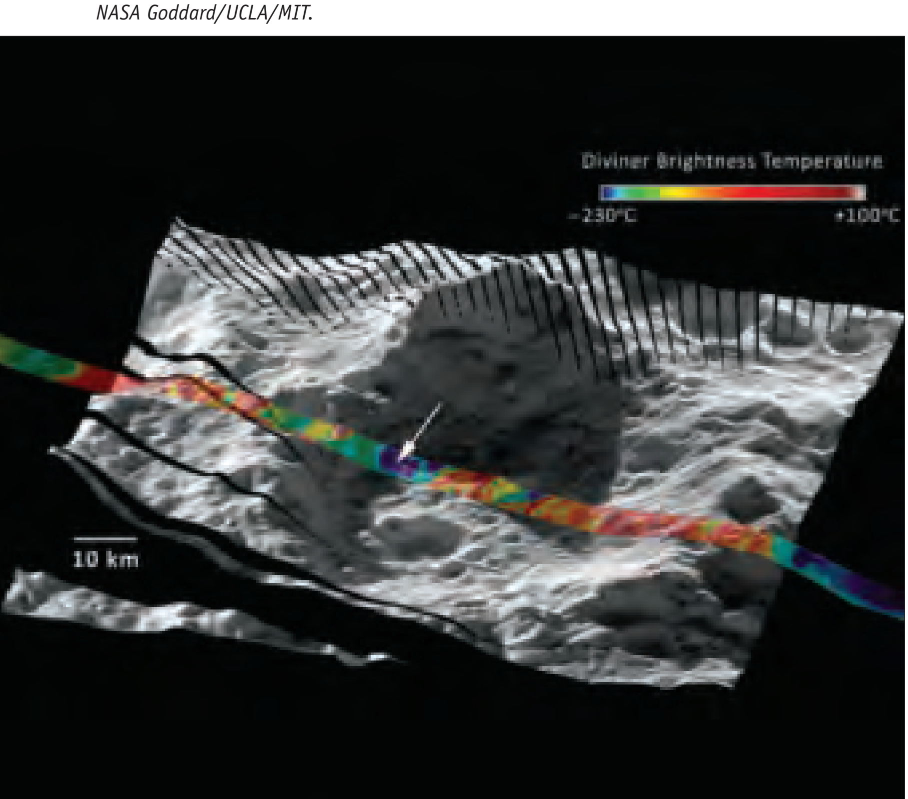



The LRO camera system captured the spectacular 6,500-ft central peak of the giant rayed crater Tycho (left). The peak was formed by the rebound of the lunar surface moments after an asteroid gouged out the crater 108 million years ago. Closer examinations (right) found the dot visible atop the central peak turned out to be a 400-ft-diam. lunar boulder—that would squash the Rose Bowl—sitting in rippled and hardened lava melt formed at the moment of impact then rained down on the peak moments after its thrust upward. Credit: NASA Goddard/Arizona State.



LRO geologists used lobate scarps, like this one on the Moon's far side, to help confirm that the Moon is still geologically active. In this particularly dramatic example, a thrust fault pushed crustal materials (arrows) up the side of Gregory crater, indicating that the Moon's crust was contracting in recent geologic time. Other features showed that the Moon's crust is expanding. Image courtesy: NASA Goddard/ Arizona State.

The LCROSS/Centaur impact location (arrow) is seen on an LRO digital terrain model created by the spacecraft's LOLA laser altimeter. Atop that has been overlaid a multicolor Diviner radiometer temperature swath acquired about 90 sec after impact, which launched a 12-mi.-high plume containing evidence of water ice. Credit: NASA Goddard/UCLA/MIT.



•LROC (lunar reconnaissance orbiter camera). There are actually two narrow-angle cameras on the LROC system taking high-resolution black-and-white images of the surface and capturing images of the poles with resolutions down to about 3.3 ft. A third, wide-angle camera is taking color and ultraviolet images over the surface at 330-ft resolution. The LROC system was developed at Arizona State University in connection with Malin Space Science Systems, San Diego. Narrow-angle camera image resolutions of 8 in. are being taken from as low as 12-mi. altitude.

By mid-2011, at a point where LRO operations transitioned from the Exploration Phase to the Science Phase, the LROC team at Arizona State University issued a new lunar global map with a resolution of 328 ft per pixel. To enhance the topography of the Moon, this map was made from images collected when the angle of the Sun was low on the horizon.

"Because the Moon is so close, and because we have a dedicated ground station, we are able to bring back as much data from LRO as from all the other planetary missions combined," says LRO project scientist Richard Vondrak of NASA Goddard. LRO's DLRE is providing new data sets regarding the Moon's surface. These include maps of visual and infrared brightness, temperature, rock abundance, nighttime soil temperature, and surface mineralogy. The data are in the form of more than 1,700 digital maps at a range of resolutions that can be overlaid easily on other lunar data sets.

LAMP, which collects information to help identify surface water ice deposits, especially in permanently shadowed regions of the Moon, also has new data. Among its new products are maps of far-ultraviolet brightness, albedo, and water ice data, as well as instrument exposure, illumination, and other conditions. As a complement to the high-resolution digital elevation maps, representing 3.4 billion measurements that the LOLA team has already released, the team is also delivering new maps of slope, roughness, and illumination conditions.

"All these global maps and other data are available at a very high resolution," says Goddard's John Keller, the LRO deputy project scientist. "With this valuable collection, researchers worldwide are getting the best view of the Moon they have ever had." The complete data set contains the raw information as well as high-level products such as mosaic images and maps. It also includes more than 300,000 calibrated data records released by the LRO camera team.

The data that prove the Moon is still geologically alive involve images showing that the lunar surface is both expanding and contracting.

How LRO made its key discovery

In August 2010, the LRO camera team identified physical signs of contraction on the lunar surface, in the form of lobe-shaped cliffs known as lobate scarps. The scarps are evidence the Moon shrank globally in the geologically recent past and might still be shrinking today. The team saw these scarps widely distributed across the Moon and concluded it was shrinking as the interior slowly cooled. The features were seen during Apollo, but their implications were not recognized.

Then in late 2011, additional LRO images revealed something totally different. This time the images showed the Moon's crust was also being stretched, a completely opposite process that formed tiny valleys in a few small areas on the lunar surface. Research analyzing high-resolution images obtained by the LRO cameras show small, narrow trenches typically much longer than they are wide. This indicates the lunar crust is being pulled apart at these locations. These linear valleys, known as graben, form when the Moon's crust stretches, breaks, and drops down along two bounding faults.

The graben were an unexpected discovery. They provided contradictory evidence that, in addition to regions contracting as shown by the newly discovered lobate scarps, other regions of the lunar crust are also being pulled apart, as indicated by the graben. "This pulling apart tells us the Moon is still active," Vondrak points out. "LRO gives us a detailed look at that process."

Striking water

The search for water resources, a major part of LRO's mission, got under way with a bang, literally.

Carried as a piggyback payload on the same launch with LRO was the $79-million LCROSS (lunar crater observation and sensing satellite) developed by NASA Ames in Mountain View, California.

Major new data about the presence of large quantities of water ice on the Moon were obtained by the targeted impact of the Atlas V's spent 2.5-ton Centaur upper stage, which struck a permanently dark south polar crater. That 6,200-mph impact was equivalent to detonating 2 tons of TNT on the lunar surface.

The resulting 5-mi.-high plume was followed just minutes later by the highly instrumented 1,370-lb LCROSS spacecraft, which flew through the plume, transmitting data before it too hit the lunar surface nearby. LRO also collected data from both plumes as it flew overhead.

LCROSS found an estimated 350 lb of water ice or water vapor within the debris cloud, and nine water-related chemical compounds, according to NASA Ames scientist Tony Colaprete and other LCROSS researchers. This was a major success for the program, even though no U.S. mission to use such resources is currently planned.

Exploring a crater

In another example of LRO finding water ice, the spacecraft has returned data that indicate ice may make up as much as 22% of the surface material in famous Shackleton crater at the lunar south pole.

Named after Antarctic explorer Ernest Shackleton, the crater is 2 mi. deep and over 12 mi. wide. Its floor has been in shadow for billions of years, making it extremely cold—and likely to have trapped multibillion-year-old ice delivered to the Moon eons ago via impacting comets and asteroids.

A team of NASA and university scientists using laser light from LRO's laser altimeter examined the crater floor. They found it to be brighter than those of other nearby craters, which is consistent with the presence of ice. "The crater's interior is extremely rugged," says Maria Zuber, the team's lead investigator from MIT.

While the crater's floor was relatively bright, Zuber and her colleagues observed that its walls were even brighter. The finding was at first puzzling—scientists had thought that if ice were anywhere in the crater, it would be on the floor, where no direct sunlight penetrates. The upper walls are occasionally illuminated, which could evaporate any ice that accumulates.

A theory offered by the team to explain this puzzle is that 'moonquakes'—seismic shaking brought on by meteorite impacts or gravitational tides from Earth—may have caused Shackleton's walls to slough off older, darker soil, revealing newer, brighter soil underneath. An ultra-high-resolution map created by Zuber's team provides strong evidence for ice on both the crater's floor and walls.

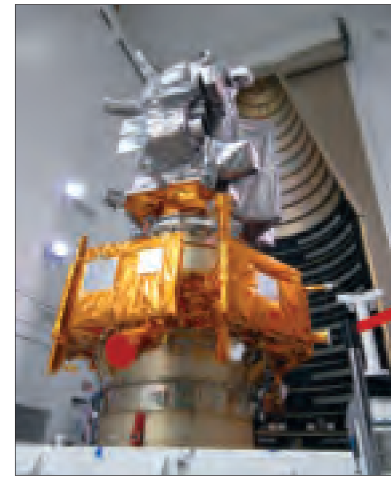
Zuber also leads the GRAIL (gravity recovery and interior laboratory) lunar mission, which has two other spacecraft in lunar orbit mapping gravity variations. The two craft have worked perfectly in tight formation flight, and the $496-millon GRAIL project is being completed well within budget with margin to spare, Zuber says.

Historic shots

While all of LRO's images of the lunar surface are striking, its pictures of the Apollo landing sites with the lunar module descent stages, astronaut footprints, and rover tracks are historic and poignant.

Vondrak notes that detailed examination of the Apollo descent stages shows no dust accumulations, indicating scant dust transport on the airless Moon. "This should allow the human hardware of Apollo left on the Moon to remain intact for 10 million-100 million years," he says.

The new LRO data that prove the U.S. flags at the Apollo 12, 16, and 17 landing sites still fly were assembled by the "Moon Zoo" citizen science project. The flags themselves are not visible. Moon Zoo participants linked then animated numerous LRO high-resolution images of each landing site with different Sun angles. This shows



The Lunar Reconnaissance Orbiter, wrapped in silver insulation, sits atop the gold insulation wrapped LCROSS impact spacecraft before both were attached to Atlas V Centaur upper stage at Cape Canaveral. Credit: NASA KSC.

December marks the 40th anniversary of Apollo 17's last Apollo landing on the Moon. In this LRO image of the Taurus-Littrow site note the tracks of astronauts Gene Cernan and Jack Schmitt to the left of the lunar module and the four-wheeled lunar rover tracks to the right. Credit: NASA Goddard/Arizona State.

that shadows of each flag move as daytime Sun angles change. The fate of the Apollo 14 and 15 flags remains unknown and Apollo 11's flag was blown over by that crew's liftoff from the Moon.

The 8-in., highest resolution imaging of the Apollo sites came as LRO was periodically maneuvered down to only 12-mi. altitude to see lunar geology in extreme new detail. Two things are especially evident at the Apollo 11 site where astronauts Neil Armstrong and Buzz Aldrin touched down on July 20, 1969. One is that Armstrong's footprints are distinctly visible where he trotted behind the Eagle lunar module to look into Little West crater and then photographed the module from that vantage point. The other, taking in LRO's overhead view as a whole, is what a tiny, temporary, and delicate human foothold on another world Tranquility Base is.

Solving other mysteries

The LRO spacecraft is also bringing back to life some historic Soviet missions, including

Missing on the Moon for 42 years, the Lunokhod 1 lunar rover and the Soviet Luna 17 lander that carried it to the lunar surface in 1970 were found by LRO. Note the fork-like ramps on which the rover descended to the surface and the rover tracks surrounding the lander. LRO found Lunokhod 1 about 6.5 mi. from the lander near the center of the Imbrium Basin. Credit NASA Goddard/Arizona State.

a 38-year-old mystery about a major Soviet Moon mission failure.

The Soviet Luna 23 spacecraft was launched in November 1974 from the Baikonur Cosmodrome atop a large Proton booster. The spacecraft was a 6.5-ton, 12-ft-tall vehicle meant to land on the Moon and drill 7 ft into the lunar surface to obtain subsurface samples that it would then fire back to Earth.

Two earlier spacecraft, Luna 16 in September 1970 and Luna 20 in February 1972, had previously done this successfully, after 11 major failures.

Luna 23 maintained radio contact with Earth after touchdown on Mare Crisium, but ground controllers feared from telemetry that it had landed at too high a velocity.

It was to lower its sampling drill immediately, then transfer its precious load of lunar material to a basketball-sized, ablative-covered Earth reentry vehicle mounted atop the bright silver canister of electronics attached to a propulsion stage.

If all had gone as planned, it would have been fired back to Earth within about 24 hr. But after three days of communications and no sampling activities, Luna 23 went dead.

Two years later, in an impressive feat of targeting, the Soviets managed to command an identical Luna 24 sample return spacecraft to land within 1.5 mi. of the long-dead Luna 23 to sample the same area.

That ended the Soviet lunar program, and Luna 23 was forgotten—but not by the Goddard and Arizona State LRO camera team. They began to search high-resolution LRO images of Mare Crisium and found Luna 23—looking like new, but toppled over on its side. Mystery solved.

Its bright upper canister was unmistakable, lying crosswise atop the large mass of the lander and ascent propulsion system. LRO also found the successful Luna 24 descent stage, sitting upright, just 1.5 mi. to the northeast. Its upper stage and reentry vehicle had departed the Moon and delivered 170 g of lunar material to Earth in August 1976.

In another find, one of the biggest in its three years in lunar orbit, LRO solved another Soviet space mystery, and this time the result was important not just to Russian space history but also to continuing lunar and Earth studies: It discovered the USSR's missing Lunokhod-1 Moon rover, which Soviet ground controllers had lost 42 years ago after driving it 6.5 mi. onto the west side of the Imbrium Basin. (Viewed from Earth, the basin makes up the left eye of the 'man in the Moon.')

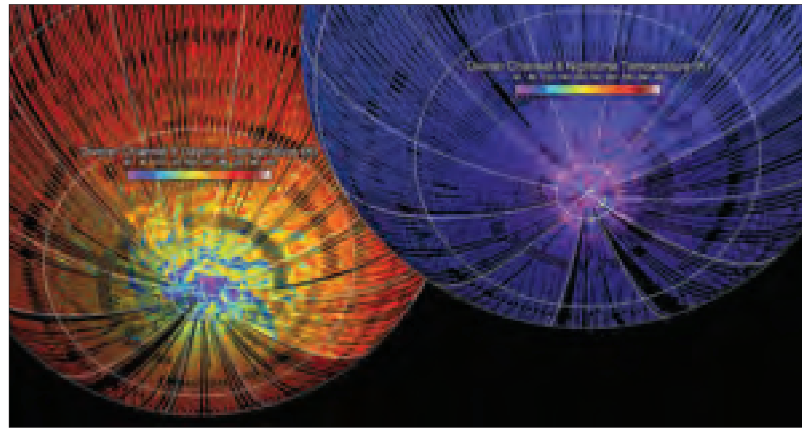
Lunokhod 1 weighs nearly a ton and is shaped like an eight-wheeled bathtub, standing 4.5 ft high and 5.7 ft long. The discovery will finally enable Earth-based lasers to use it as a target for ongoing geodetic and gravity measurement studies, including the validation of theories proposed by Albert Einstein.

The laser system at Apache Point Observatory in New Mexico has begun firing on Lunokhod 1 and receiving laser returns from its French-built retroreflectors.

Because of Lunokhod 1's location away from the Apollo retroreflectors, its discovery is especially important for lunar geophysical studies. Its position near the northwestern limb of the Moon and the ability to receive reflected-back laser light when the Moon is in daylight are special attributes of the big rover.

LRO also found the Luna 17 lander, whose ramps enabled Lunokhod 1 to descend to the surface. The imagery shows numerous wheel tracks around the lander made by the Soviet rover before it departed to explore the surface, where it was lost until its location was precisely pinpointed for the Apache Point geodetic researchers.

The primary objective of the original LRO mission was to enable safe and effective exploration of the Moon. "To do so, we needed to leverage the very best the science community had to offer," says Michael Wargo, NASA's chief lunar scientist. "By doing that, we've fundamentally changed our scientific understanding of the Moon." 𝔸

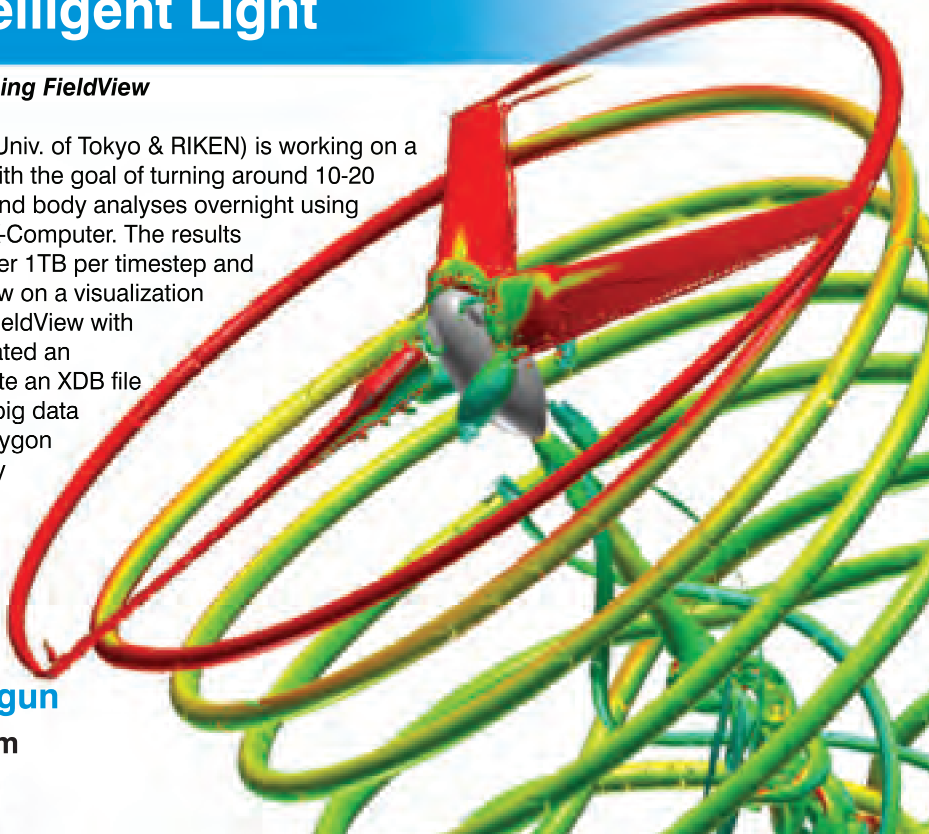


LRO's Diviner radiometer detects south polar temperature differences during the day (left) and at night where some north polar areas are found to be nearly -400F, the coldest place in the solar system. Image courtesy: NASA Goddard/UCLA.

News From Intelligent Light

30 Billion Cells in 120 Seconds Using FieldView

Intelligent Light user Dr. Kenji Ono (Univ. of Tokyo & RIKEN) is working on a project for a Japanese automaker with the goal of turning around 10-20 high-fidelity, unsteady under-hood and body analyses overnight using over 10,000 HPC cores on Riken's K-Computer. The results included over 30 billion cells and over 1TB per timestep and were post-processed using FieldView on a visualization server with 256 processors (x86). FieldView with parallel I/O and extraction read, created an iso-surface (laplacian of P), and wrote an XDB file in 120 seconds quickly making the big data accessible and useful. The 15M polygon isosurface was explored interactively on a laptop.



FieldView Image: Dr. Andrew Wissink
U.S. Army Aeroflightdynamics
Directorate, AMRDEC

FieldView 13

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Intelligent Light

25 Years Ago, January 1988

Jan 30 Setting a record for circumnavigating the world, a Boeing 747SP lands at Boeing Field in Seattle after 36 hr 54 min. The average speed of the flight, which made refueling stops in Athens and Taipei, is 624 mph. Commanding the crew of 18 is Capt. Clay Lucy. One hundred of the 126 passengers have bought high-priced tickets whose proceeds are donated to charity. D. Baker, *Flight and Flying*, p. 472.

50 Years Ago, January 1963

Jan. 3 A Boeing Bomarc B makes its first successful low-altitude intercept of a QB-47 drone target over Eglin AFB, Fla. A new electronic tracking device in the carrier plane aids the strike significantly. *Missiles and Rockets*, Jan. 14, 1963, p. 10.

Jan. 7 The U.K. transmits TV signals across the Atlantic for the first time, from Goonhilly Downs in Cornwall, England, to Nutley, N.J., via NASA's Relay 1 satellite. On Jan. 9, the satellite beams its first TV programs across the Atlantic to British and French viewers, who watch part of the *Today* show and the unveiling of the Mona Lisa exhibit in Washington, D.C. NASA, *Astronautics and Aeronautics, 1963*, p. 5.

Jan. 10 The final test launch of the Skybolt air-launched ballistic missile (ALBM) is declared "completely successful," although the missile was already canceled during the previous month. This is the only known ALBM designed for operational service. The cancellation was due mainly to competition from the Polaris submarine-launched missile. *Missiles and Rockets*, Jan. 14, 1963, p. 9.

Jan. 17 The first satellite radio transmission between the U.S. and Latin America takes place when a 12-min. taped *Voice of America* radio program is broadcast from Nutley, N.J., via the Relay 1 communications satellite to a receiving mobile station at Rio de Janeiro. *Aviation Week*, Jan. 21, 1963, p. 39.

Jan. 17 The prototype of Britain's Short Brothers Skyvan 1 light freight aircraft completes its maiden flight from Sydenham Airfield at Belfast, Northern Ireland. The plane is proposed to carry 15 persons or 3,000 lb of cargo. *Aviation Week*, Jan. 14, 1963, p. 43.

Jan. 21 JPL in Pasadena, Calif., begins sending and receiving radar signals to and from Mars to learn more about that planet's surface. These electronic signals, extending to about 125 million mi. in their round-trip paths, are the longest ever generated in the Western world. They seem to show that Mars has both smooth and rough areas. The signals, which continue until March, also provide more data on the rotation speed of Mars. *Aviation Week*, Feb. 25, 1963, p. 39.

Jan. 28 Swiss balloonist Jean Felix Piccard dies in Minneapolis. Piccard flew his first balloon in 1913 with his twin brother Auguste and became a pioneer in stratospheric and plastic (cellophane) balloons. NASA, *Astronautics and Aeronautics, 1963*, p. 30.

Jan. 30 Australia's first surface-to-air guided missile unit, using Britain's twin-ramjet-powered and rocket-boosted Bloodhound missiles, is formally opened at the Royal Australian Air Force base at Williamtown, NSW, Australia. The 5,000-lb Bloodhound missile has an operation range of about 50 mi. at Mach 2.7. *Flight International*, Feb. 7, 1963, p. 210.

Jan. 30 An Army solid-fuel Pershing surface-to-surface missile meets all test objectives on a 200-mi. test flight from Cape Canaveral, Fla., and is fired from its transporter-erector-launcher. *Missiles and Rockets*, Feb. 4, 1963, p. 11.

And During January 1963

—Lockheed Aircraft Service of Ontario, Calif., converts a Super Constellation into an aerial oceanographic laboratory for the Naval Oceanographic Office. The aircraft is to investigate sea thermal structures, sea surface temperatures, ocean waves, and low-level meteorological phenomena. *Aviation Week*, Jan. 28, 1963, p. 196.

Past

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

75 Years ago, January 1938

Jan. 2 The first air mail and freight service between the U.S. and New Zealand begins when the Pan Am Airways Sikorsky S-42B flying boat Samoa Clipper arrives in Auckland from Honolulu. L. Payne, *Air Dates,* p. 74; *Interavia*, Jan. 11, 1938, p. 8.

Jan. 11 The S-42B Samoa Clipper disappears in the sea near Samoa on its second flight. Capt. Edward C. Musick, a pioneer of oceanic flight and a pilot with more than 10,000 hr and 23 years of flight experience, perishes in the disaster, along with his crew. *Aviation*, February 1938, p. 70.

Jan. 11 During an aviation conference, Maj. Gen. Frank M. Andrews, commander of the Army's General Headquarters Air Force, demands increased and accelerated instruction of flying personnel. He says the U.S. lags behind other countries in manpower. At the same meeting, Maj. James H. Doolittle, famous for his many record-setting military and civilian flights, likewise claims that Europe has surpassed the U.S. in military aviation and urges the creation of a cabinet post, secretary for air. *Interavia*, Jan. 29, 1938, p. 12.

Jan. 16 Spanish rebel aircraft based in Majorca during the Spanish Civil War begin daily bombing of Barcelona. E. Emme, ed., *Aeronautics and Astronautics, 1915-60*, p. 36.


January 16

Jan. 18-19 Eighteen Navy Consolidated patrol bombers flying in formation arrive in Hawaii from San Diego. The 20-hr flight is part of the contemplated buildup of 250 aircraft on the Hawaiian Islands, to be increased to 600 planes in case of "an emergency." Enlargements of the airport installation, including eight double hangars, a mile-long runway, and bomb-proof installations for fuel, will cost $18 million. The plan is to make Pearl Harbor the center of a whole line of U.S. defenses extending more than 5,500 mi. from the Aleutians via Hawaii to the American South Sea and Samoan Islands. *Interavia*, Jan. 22, 1938, pp. 10-11.

Jan. 24 Britain's Armstrong Whitworth Ensign aircraft makes its first trial flights after a delay of about two years. The Ensign is the first in a series of 14 four-engined, high-winged monoplanes with retractable undercarriage, on order by Imperial Airways. *Interavia*, Jan. 25, 1938, p. 5.

Jan. 24 Three Italian air force Savoia-Marchetti S.9 three-engine bombers take off from Guidonia Airport near Rome for a record long-distance flight to Rio de Janeiro. This becomes the fastest intercontinental connection between Europe and South America. The first plane arrives at Rio with a total flying time of 41 hr 32 min. *Interavia*, Feb. 1, 1938, pp. 9-10.

Jan. 30 Gerard F. Vultee, one of the best known U.S. aeronautical engineers and designers, dies in the crash of a single-engined Stinson touring plane in the mountains of Arizona during a blinding snowstorm. At the time of his death, Vultee was head of Airplane Development Corp. He was originally associated with Allan Lockheed and John K. Northrop in developing the Lockheed Vega. Vultee was chief engineer of Lockheed Aircraft and in 1933 established his own firm, developing the Vultee all-metal single-engine transport, the V-1. *Aviation*, March 1938, p. 56.

100 Years Ago, January 1913

Jan. 1 Leonard W. Bonney claims he is the first to deliver baggage by aircraft when he takes a 50-lb trunk in his monoplane from Los Angeles to Dominguez, Calif., a distance of 30 mi. By April, well-known aviator Otto Brodie forms a one-man company to carry baggage, dubbing his plane 'Aerial Parcel Post Carrier No. 1.' However, others also claim the distinction of carrying luggage earlier than either Bonney or Brodie. The Essanay motion picture company films Brodie's aerial deliveries, and the movie is shown internationally. *Aerial Age*, February 1913, p. 15; April 1913, p. 16; and May 1913, p. 8.

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Faculty Position in Ocean Engineering

The Department of Aerospace and Ocean Engineering seeks applications for a tenure-track faculty position in the area of ocean engineering at the level of assistant or associate professor. Applicants with research interests in any field of ocean engineering or naval architecture will be considered. Areas of particular interest include: marine and ship structures, advanced marine materials, fluid-structure interaction, marine hydrodynamics, hydroacoustics, and cavitation erosion.

The successful applicant will have an opportunity to participate in a number of multidisciplinary programs, including the Virginia Center for Autonomous Systems (www.unmanned.vt.edu) and the Virginia Tech Naval Engineering Program, affiliated with the Naval Engineering Education Consortium (www.aoe.vt.edu/multidisciplinary/neec/index-neec.html). New opportunities for research in marine applications may also be developed through the Commonwealth of Virginia's partnership with Rolls Royce. In addition to extensive computational resources (www.arc.vt.edu/resources), the AOE department (www.aoe.vt.edu) is home to world-class experimental facilities and instrumentation including wind/water tunnels and an internationally renowned aeroacoustic flow facility, the Stability Wind Tunnel.

Applicants must hold an earned doctorate in ocean engineering, naval architecture, aerospace engineering, mechanical engineering or a closely related field, and will be expected to develop a significant externally funded research program. Responsibilities will include establishing an internationally recognized research program, directing graduate students, and teaching at both the undergraduate and graduate level in our ocean engineering program. Information on resources for prospective faculty can be found at www.provost.vt.edu.

Review of applications will begin on January 15th, 2013 and will continue until the position is filled. Interested persons should apply on the internet at www.jobs.vt.edu (posting number 0122467) along with a cover letter, current curriculum vita and the names and addresses of three references. All inquiries can be sent to: Prof. William Devenport (devenport@vt.edu), Chair, AOE Ocean Engineering Faculty Search Committee, Aerospace and Ocean Engineering at Virginia Tech, 215 Randolph Hall (0203), Blacksburg, VA 24061.

Faculty Position in Aerospace Propulsion

The Department of Aerospace and Ocean Engineering seeks applications for a faculty position at any rank in the area of aerospace propulsion systems with emphasis on space propulsion. Candidates are sought with expertise and a record of achievement in relevant areas of environmentally responsible space propulsion (chemical, electric, nuclear, or other nontraditional propulsion technologies). Specific areas of interests include thermodynamics, thermal management, materials and structures, control theory, and computational science and diagnostics under the context of designing and optimizing space propulsion systems. Research plans featuring multidisciplinary interactions are encouraged. The successful candidate will have the opportunity to participate in a large, multidisciplinary interaction with Rolls Royce and the Commonwealth Center for Advanced Aerospace Propulsion spanning several departments at Virginia Tech. Exceptional candidates with a high level of sustained accomplishment may be considered for an endowed professorship.

Applicants must hold an earned doctorate in aerospace engineering or a closely related field. Responsibilities will include teaching at both the undergraduate and graduate levels, directing graduate students, and establishing an externally funded research program in the area of space propulsion. AOE faculty members are active in a number of relevant interdisciplinary research centers and groups, including the Center for Space Science and Engineering Research (Space@VT, www.space.vt.edu), AFRL-VT-WS Collaborative Center on Multidisciplinary Sciences (www.aoe.vt.edu/research/groups/afrl/) and the Virginia Center for Autonomous Systems (www.unmanned.vt.edu). Faculty have access to Virginia Tech's extensive computational resources (www.arc.vt.edu/resources) and world-class experimental facilities to support high speed flow measurements, advanced materials characterization, and other infrastructure to support development of aerospace propulsion systems.

Review of applications will begin on February 1, 2013 and will continue until the position is filled. Interested persons should apply on the internet at www.jobs.vt.edu (posting number 0122480) along with a cover lettter, current curriculum vita and the names and addresses of three references. All inquiries can be sent to: Prof. Rakesh K. Kapania (rkapania@vt.edu), Mitchell Professor, Aerospace and Ocean Engineering, 215 Randolph Hall (0203), Blacksburg, VA, 24061.

Virginia Tech, the land-grant University of the Commonwealth, is located in Blacksburg, adjacent to the scenic Blue Ridge Mountains. Blacksburg is consistently ranked among the country's best places to live (www.vt.edu/where_we_are/blacksburg/). It is a scenic and vibrant community nestled in the New River Valley between the Alleghany and Blue Ridge Mountains. The town is near to state parks, trails, and other regional attractions of Southwest Virginia, renowned for their history and natural beauty. The University has a total student enrollment of 31,000, with 8,600 students in the College of Engineering.

Virginia Tech is the recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the participation of women in academic science and engineering careers. Virginia Tech has a strong commitment to the principle of diversity and, in that spirit, seeks a broad spectrum of candidates including women, minorities, and people with disabilities. Individuals with disabilities desiring accommodations in the application process should notify Mrs. Wanda Foushee at (540) 231-9057.

PURDUE

Faculty Openings:
Aeronautics & Astronautics

The School of Aeronautics & Astronautics (AAE) at Purdue University invites outstanding individuals to apply for three open faculty positions at all ranks. AAE faculty members teach and conduct research in the broad disciplines of Aerodynamics, Aerospace Systems, Astrodynamics and Space Applications, Dynamics and Control, Propulsion, and Structures and Materials. Candidates with interests in these areas are encouraged to apply. Of the above, applicants with expertise in one or more of the following areas are especially sought: hypersonics; gas turbines and turbomachinery; aeroacoustics; rocket combustion and propellants; spacecraft design; space environments; satellites; attitude determination and control of spacecraft; multiscale modeling and cross-length scale integration of aerospace vehicles; remote sensing; control of cyber-physical systems, intelligent embedded systems, and human-automation collaborative systems; manufacture of materials and structures for aerospace vehicles, smart structures, aeroelasticity, and computational solid/structural mechanics.

Applicants should have a Ph.D. or equivalent doctoral level degree in aerospace engineering or a closely related field. The successful candidate will have a distinguished academic record with exceptional potential to develop world-class teaching and research programs. Also, the successful candidate will advise and mentor undergraduate and graduate students in research and other academic activities and will teach undergraduate and graduate level courses. To be considered for one of the three tenured/tenure-track positions at the assistant, associate, or full professor ranks, please submit a curriculum vitae, a statement on teaching and research interests, and the names and addresses of at least three references to the College of Engineering Faculty Hiring website, https://engineering.purdue.edu/Engr/AboutUs/Employment/, indicating interest in AAE. Review of applicants begins on 1/30/13 and continues until the positions are filled. A background check will be required for employment in this position.

Details about the School, its current faculty, and research may be found at the Purdue AAE website (https://engineering.purdue.edu/AAE).

Purdue University is an Equal Opportunity/Equal Access/Affirmative Action employer fully committed to achieving a diverse workforce.

Georgia Institute of Technology

Faculty Position in Dynamical Systems and Control

The Daniel Guggenheim School of Aerospace Engineering at Georgia Institute of Technology, Atlanta, Georgia, invites nominations and applications for a tenure-track or tenured faculty positions in the areas of dynamical systems, control theory, and information science, and the interactions between these fields beginning August, 2013. Applicants for Assistant Professor, Associate Professor or Professor will be considered. Salary and rank will be commensurate with qualifications. While all related areas of research in dynamical systems and control will be considered, we are particularly interested in exceptional candidates with nontraditional research fields of interest in emerging topics, such as information and energy systems, nonlinear and stochastic control theory, communications and network systems, computation and control, embedded systems, human-machine/human-robot interaction, or hybrid systems, and their relevance to aerospace science and engineering.

Candidates are required to have a doctorate in Aerospace Engineering or a closely related field. The successful transdisciplinary candidate will have an outstanding research record and will be expected to teach graduate and undergraduate courses, supervise graduate students, and interact with the faculty on the development of a strong, externally funded research program. Applications will be reviewed continuously until the position has been filled.

The School of Aerospace Engineering presently has 36 full-time faculty members and its undergraduate and graduate programs are ranked among the top aerospace engineering programs in the nation. The research interests of the faculty cover a broad spectrum of aerospace engineering including gas dynamics, propulsion, combustion, aerodynamics, structural mechanics, flight dynamics, and control. Information about the School can be found at www.ae.gatech.edu.

Applicants should send (electronically or via mail) a curriculum vitae, a cover letter, a statement of teaching interests and philosophy, a statement of research plans, and the name and contact information of at least four references to: Vivian Robinson O'neal, c/o Professor Wassim M. Haddad, Search Committee Chair, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA, 30332-0150. Phone: (404) 894-3026, e-mail: vivian.robinson@aerospace.gatech.edu

Faculty Position in Air Vehicle Design

The Daniel Guggenheim School of Aerospace Engineering at the Georgia Institute of Technology, Atlanta, Georgia, invites nominations and applications for a tenure-track or tenured faculty positions in the area of air vehicle design. Applicants for Assistant Professor, Associate Professor or Professor will be considered. Salary and rank will be commensurate with qualifications. Candidates with demonstrated research expertise in configuration aerodynamics and aerodynamic shape optimization are of particular interest; however, exceptional candidates with expertise in other aspects of air vehicle design are also encouraged to apply. Example areas of interest include: aircraft conceptual and preliminary design; propulsion system integration; multidisciplinary design optimization; uncertainty quantification and mitigation in design; design, verification, and validation of aircraft cyber-physical and electromechanical subsystems; design for advanced manufacturing; and model-based systems engineering.

Candidates are required to have a doctorate in aerospace engineering or a closely related field. Responsibilities for this position include teaching courses at the undergraduate and graduate levels, supervising graduate students, developing an externally funded research program, and collaborating with faculty in interdisciplinary research areas.

Interested applicants should submit a cover letter, statements of research and teaching interests, a curriculum vitae, and names, addresses, phone numbers and email addresses of four professional references to Dr. Dimitri Mavris at dimitri.mavris@aerospace.gatech.edu or via hard copy to Dr. Dimitri Mavris, Search Committee Chair, Daniel Guggenheim School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0150

Board of Regents policy requires Federal and State background investigations, including a criminal background check. Georgia Tech is an equal opportunity/affirmative action employer.

UNIVERSITY OF WASHINGTON
Department of Aeronautics & Astronautics
Tenure-Track Faculty Position

The Department of Aeronautics & Astronautics at the University of Washington invites applications for a full-time tenure-track faculty position at the level of Assistant, Associate, or Full Professor in the general area of aerospace structures. The successful candidate will complement our existing research strengths, interact with various research groups within the department, and provide a bridge between Aeronautics & Astronautics and other disciplines. University of Washington faculty engage in teaching, research and service.. The successful candidate will be expected to build and lead a vigorous and innovative externally-funded research program and to provide high-quality teaching that integrates research with instruction at both the undergraduate and graduate levels. An earned doctorate degree in an appropriate engineering or related discipline is required.

Applications should include a letter of application, a CV with a list of publications, concise statements of research and teaching interests and goals, the names and contact information of five professional references, and a statement of specific plans for securing extramural funding for at least two research projects, including contacts already made with funding agencies. The research statement should include current and potential interdisciplinary aspects of the applicant's work. All application materials must be submitted via our faculty search website: http://www.engr.washington.edu/facsearch/?dept=AA. The position will be open until filled, but we expect interviews to begin in January 2013. For any administrative issues related to this search, please, contact the A&A Department Search Committee, at search@aa.washington.edu. For information about the department, please visit http://www.aa.washington.edu.

The University of Washington is an affirmative action, equal opportunity employer. The University is building a culturally diverse faculty and staff and strongly encourages applications from women, minorities, individuals with disabilities and covered veterans. The University is the recipient of a 2006 Alfred P. Sloan Award for Faculty Career Flexibility and a 2001 National Science Foundation ADVANCE Institutional Transformation Award to increase the advancement of women faculty in science, engineering, and mathematics (www.engr.washington.edu/advance). Filling this position will be contingent on budgetary approval at the University of Washington.

UtahState University

Assistant Professor

The Department of Mechanical and Aerospace Engineering (MAE) at Utah State University invites applications for tenure-track faculty positions at the assistant professor level. Applicants must have a strong background in engineering fundamentals and must have research background and teaching interests within the broad areas of Mechanical and/or Aerospace Engineering. Preference will be given to candidates with expertise and training in aeronautics, controls, heat transfer, materials, and mechatronics.

See **http://jobs.usu.edu** (Req. ID 053514) for more information and to apply online.

AA/EOE

UtahState University

WRIGHT STATE UNIVERSITY

MECHANICAL ENGINEERING
WRIGHT STATE UNIVERSITY

Wright State University (WSU) invites applications for two tenure-track faculty positions in the Department of Mechanical and Materials Engineering: One in thermofluids, and the other in mechanical design. In addition to general mechanical design, those with research in the area of thermal/fluid design both computationally and experimentally are especially encouraged to apply. The openings are at the assistant professor level, however exceptional candidates at the associate or full professor level will also be considered. Successful candidates will be expected to develop a funded research program and teach courses in Mechanical Engineering at both the undergraduate and graduate levels. Applicants must anticipate an earned Ph.D. in Mechanical Engineering or related discipline before the start date of August 19, 2013. Applicants for assistant professor are expected to show a propensity for scholarship, generating a research program, and teaching. Consideration for higher ranks must also have significant additional experience and a demonstrated proficiency in scholarship, sponsored research, and teaching commensurate with the level sought. Applicants must apply through the Wright State University website http://jobs.wright.edu. Review of applications will begin February 15, 2013. WSU is a public institution of over 19,000 students located in a technologically rich region of southwestern Ohio next to Wright-Patterson Air Force Base. WRIGHT STATE UNIVERSITY is an Affirmative Action/Equal Opportunity employer.

UNIVERSITY OF ALASKA FAIRBANKS

Tenure Track Faculty Position
Electrical and Computer Engineering Department
Geophysical Institute

The Electrical and Computer Engineering (ECE) Department and the Geophysical Institute (GI) at the University of Alaska Fairbanks (UAF) invite applications for a tenure-track faculty position at the assistant or associate level to begin in August 2013. The successful applicant will be expected to have a strong commitment to undergraduate and graduate teaching, and to develop a strong research program with a focus on Unmanned Aerial Systems. The State of Alaska is supporting a major new initiative in Unmanned Aerial Systems. Academic rank will be dependent on the applicant's qualifications.

Applicants must have a B.S. degree in electrical or computer engineering and a Ph.D. in engineering or a closely related field. The duties of this position include teaching at both the undergraduate and graduate level, conducting externally funded research and performing university service. The position consists of a half-time research appointment through GI with an emphasis on developing Unmanned Aerial System capabilities. Specific research duties include contributing to efforts on externally funded research projects, writing proposals to obtain further funding, writing technical reports and publishing results in professional journals.

The University of Alaska Fairbanks (UAF) is a Land, Sea, and Space Grant Institution. The Carnegie Classification of UAF is Research University with high research activity. UAF is the major research campus in the University of Alaska system and hosts several research institutes including the Geophysical Institute, the Institute of Northern Engineering, the International Arctic Research Center, the Arctic Region Supercomputing Center, and the Institute of Arctic Biology. Applicants are invited to visit the UAF E&CE website at http://cem.uaf.edu/ece and the GI web site at http://www.gi.alaska.edu.

Fairbanks is a modern city with approximately 100,000 residents in the area. It is located in interior Alaska between the Alaska and Brooks mountain ranges and hosts a large variety of cultural and outdoor activities.

Applications are only accepted online at www.UAKJobs.com (posting #0065530). All applications must include a cover letter, curriculum vitae, statement of research objectives, philosophy of teaching, and at least three professional references with contact information.

First review of applications will begin on February 11, 2013, but later applications will continue to be reviewed until the position is filled. Questions regarding this vacancy can be directed to Dr. Joseph Hawkins, Search Committee Chair, jghawkins@alaska.edu. UAF is an AA/EO Employer and Educational Institution. Additional information about this position can be found at www.UAKJobs.com.

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USC University of Southern California

As part of a Viterbi School of Engineering hiring initiative involving multiple departments, the Department of Aerospace and Mechanical Engineering at USC is seeking applications and nominations for tenure-track or tenured faculty positions in Autonomous Systems, preferably with a focus in science and technology related to air, space, sea or land vehicles. Within this context, research emphases may include but are not limited to: robotics (vehicle control, collaboration), vehicle dynamics (schooling, platooning), structures and materials (aeroelasticity, extreme environments, adaptive structures), energy systems (storage, conversion, propulsion) and safety (autonomous firefighting, bomb disposal, hazardous material remediation). Applicants with an emphasis in large-scale computational efforts are particularly encouraged to apply. We seek synergies between successful applicants in multiple departments (in particular Civil and Environmental Engineering and Computer Science), thus a demonstrated ability to work across disciplines is essential. We also encourage applications from scholars whose accomplishments are transforming their fields of study.

Applicants must have earned a Ph.D. or the equivalent in a relevant field by the beginning of the appointment and have a strong research and publication record. Applications must include a letter clearly indicating area(s) of specialization, a detailed curriculum vitae, a concise statement of current and future research directions, a teaching statement, and contact information for at least four professional references. This material should be submitted electronically at http://viterbi.usc.edu/facultyapplications/. Candidates are encouraged to visit the website of the Department (http://ame-www.usc.edu) for details on current educational and research programs. Early submission is strongly advised and encouraged as the application review process will commence January 7, 2013.

The USC Viterbi School of Engineering is among the top tier engineering schools in the world. It counts 174 full-time, tenure-track faculty members, and is home to the Information Sciences Institute (ISI), two National Science Foundation Engineering Research Centers, the Department of Homeland Security's first University Center of Excellence (CREATE), and an Energy Frontiers Research Center (EFRC) supported by the Department of Energy. USC Viterbi faculty conduct research in leading-edge technologies with annual research expenditures typically exceeding $180 million.

USC Viterbi
School of Engineering

USC is an equal-opportunity/affirmative action employer. Women and underrepresented minorities are especially encouraged to apply.

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AIAA

Aerospace and Ocean Engineering at Virginia Tech

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Faculty Position in Ocean Engineering

The Department of Aerospace and Ocean Engineering seeks applications for a tenure-track faculty position in the area of ocean engineering at the level of assistant or associate professor. Applicants with research interests in any field of ocean engineering or naval architecture will be considered. Areas of particular interest include: marine and ship structures, advanced marine materials, fluid-structure interaction, marine hydrodynamics, hydroacoustics, and cavitation erosion.

The successful applicant will have an opportunity to participate in a number of multidisciplinary programs, including the Virginia Center for Autonomous Systems (www.unmanned.vt.edu) and the Virginia Tech Naval Engineering Program, affiliated with the Naval Engineering Education Consortium (www.aoe.vt.edu/multidisciplinary/neec/index-neec.html). New opportunities for research in marine applications may also be developed through the Commonwealth of Virginia's partnership with Rolls Royce. In addition to extensive computational resources (www.arc.vt.edu/resources), the AOE department (www.aoe.vt.edu) is home to world-class experimental facilities and instrumentation including wind/water tunnels and an internationally renowned aeroacoustic flow facility, the Stability Wind Tunnel.

Applicants must hold an earned doctorate in ocean engineering, naval architecture, aerospace engineering, mechanical engineering or a closely related field, and will be expected to develop a significant externally funded research program. Responsibilities will include establishing an internationally recognized research program, directing graduate students, and teaching at both the undergraduate and graduate level in our ocean engineering program. Information on resources for prospective faculty can be found at www.provost.vt.edu.

Review of applications will begin on January 15th, 2013 and will continue until the position is filled. Interested persons should apply on the internet at www.jobs.vt.edu (posting number 0122467) along with a cover letter, current curriculum vita and the names and addresses of three references. All inquiries can be sent to: Prof. William Devenport (devenport@vt.edu), Chair, AOE Ocean Engineering Faculty Search Committee, Aerospace and Ocean Engineering at Virginia Tech, 215 Randolph Hall (0203), Blacksburg, VA 24061.

Faculty Position in Aerospace Propulsion

The Department of Aerospace and Ocean Engineering seeks applications for a faculty position at any rank in the area of aerospace propulsion systems with emphasis on space propulsion. Candidates are sought with expertise and a record of achievement in relevant areas of environmentally responsible space propulsion (chemical, electric, nuclear, or other nontraditional propulsion technologies). Specific areas of interests include thermodynamics, thermal management, materials and structures, control theory, and computational science and diagnostics under the context of designing and optimizing space propulsion systems. Research plans featuring multidisciplinary interactions are encouraged. The successful candidate will have the opportunity to participate in a large, multidisciplinary interaction with Rolls Royce and the Commonwealth Center for Advanced Aerospace Propulsion spanning several departments at Virginia Tech. Exceptional candidates with a high level of sustained accomplishment may be considered for an endowed professorship.

Applicants must hold an earned doctorate in aerospace engineering or a closely related field. Responsibilities will include teaching at both the undergraduate and graduate levels, directing graduate students, and establishing an externally funded research program in the area of space propulsion. AOE faculty members are active in a number of relevant interdisciplinary research centers and groups, including the Center for Space Science and Engineering Research (Space@VT, www.space.vt.edu), AFRL-VT-WS Collaborative Center on Multidisciplinary Sciences (www.aoe.vt.edu/research/groups/afrl/) and the Virginia Center for Autonomous Systems (www.unmanned.vt.edu). Faculty have access to Virginia Tech's extensive computational resources (www.arc.vt.edu/resources) and world-class experimental facilities to support high speed flow measurements, advanced materials characterization, and other infrastructure to support development of aerospace propulsion systems.

Review of applications will begin on February 1, 2013 and will continue until the position is filled. Interested persons should apply on the internet at www.jobs.vt.edu (posting number 0122480) along with a cover lettter, current curriculum vita and the names and addresses of three references. All inquiries can be sent to: Prof. Rakesh K. Kapania (rkapania@vt.edu), Mitchell Professor, Aerospace and Ocean Engineering, 215 Randolph Hall (0203), Blacksburg, VA, 24061.

Virginia Tech, the land-grant University of the Commonwealth, is located in Blacksburg, adjacent to the scenic Blue Ridge Mountains. Blacksburg is consistently ranked among the country's best places to live (www.vt.edu/where_we_are/blacksburg/). It is a scenic and vibrant community nestled in the New River Valley between the Alleghany and Blue Ridge Mountains. The town is near to state parks, trails, and other regional attractions of Southwest Virginia, renowned for their history and natural beauty. The University has a total student enrollment of 31,000, with 8,600 students in the College of Engineering.

Virginia Tech is the recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the participation of women in academic science and engineering careers. Virginia Tech has a strong commitment to the principle of diversity and, in that spirit, seeks a broad spectrum of candidates including women, minorities, and people with disabilities. Individuals with disabilities desiring accommodations in the application process should notify Mrs. Wanda Foushee at (540) 231-9057.

AIAA Bulletin

About 3 million years ago in the nearby galaxy M33, a large cloud of gas spawned dense internal knots that gravitationally collapsed to form stars. NGC 604 was so large, however, it could form enough stars to make a globular cluster. Many young stars from this cloud are visible in this image from the Hubble Space Telescope, along with what is left of the initial gas cloud. Some stars were so massive they have already evolved and exploded in a supernova. The brightest stars that are left emit light so energetic that they create one of the largest clouds of ionized hydrogen gas known, comparable to the Tarantula Nebula in our Milky Way's close neighbor, the Large Magellanic Cloud. (*Image Credit: NASA*)

JANUARY 2013

AIAA Directory

AIAA HEADQUARTERS
1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
www.aiaa.org

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

Other Important Numbers: ***Aerospace America*** / Greg Wilson, ext. **7596*** • ***AIAA Bulletin*** / Christine Williams, ext. **7500*** • **AIAA Foundation** / Suzanne Musgrave, ext. **7518*** • **Book Sales** / **800.682.AIAA** or **703.661.1595**, Dept. 415 • **Corporate Members** / Merrie Scott, ext. **7530*** • **International Affairs** / Megan Scheidt, ext. **3842***; Emily Springer, ext. **7533*** • **Editorial, Books and Journals** / Heather Brennan, ext. **7568*** • **Education** / Lisa Bacon, ext. **7527*** • **Honors and Awards** / Carol Stewart, ext. **7623*** • **Journal Subscriptions, Member** / **800.639.AIAA** • **Exhibits / Journal Subscriptions, Institutional / Online Archive Subscriptions** / Chris Grady, ext. **7509*** • **Professional Development** / Patricia Carr, ext. **7523*** • **Public Policy** / Steve Howell, ext. **7625*** • **Section Activities** / Chris Jessee, ext. **3848*** • **Standards, Domestic** / Amy Barrett, ext. **7546*** • **Standards, International** / Nick Tongson, ext. **7515*** • **Student Programs** / Stephen Brock, ext. **7536*** • **Technical Committees** / Betty Guillie, ext. **7573***

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

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

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

Meeting Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
2013				
7–10 Jan	**51st AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition** (Oct)	Dallas/Ft. Worth, TX	*Jan 12*	**5 Jun 12**
28–31 Jan†	**Annual Reliability and Maintainability Symposium (RAMS)**	Orlando, FL (Contact: P. Dallosta, 703.805.3119, www.rams.org)		
10–14 Feb†	**23rd AAS/AIAA Space Flight Mechanics Meeting**	Kauai, HI	*May 12*	**1 Oct 12**
2–9 Mar†	**2013 IEEE Aerospace Conference**	Big Sky, MT (Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org)		
19–20 Mar	**Congressional Visits Day**	Washington, DC (Contact Duane Hyland, duaneh@aiaa.org)		
25–27 Mar†	**3AF-48th International Symposium of Applied Aerodynamics Aerodynamics of Small Bodies and Details**	Saint-Louis, France (Contact: Anne Venables, secr.exec@aaafasso.fr, www.3af-aerodynamics2013.com)		
25–28 Mar	**22nd AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar** (Dec) **AIAA Balloon Systems Conference** **20th AIAA Lighter-Than-Air Systems Technology Conference**	Daytona Beach, FL	*May 12*	**5 Sep 12**
8–11 Apr	**54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **21st AIAA/ASME/AHS Adaptive Structures Conference** **15th AIAA Non-Deterministic Approaches Conference** **14th AIAA Dynamic Specialist Conference** **14th AIAA Gossamer Systems Forum** **9th AIAA Multidisciplinary Design Optimization Conference**	Boston, MA	*Apr 12*	**5 Sep 12**
10–12 Apr†	**EuroGNC 2013, 2nd CEAS Specialist Conference on Guidance, Navigation and Control**	Delft, The Netherlands (Contact: Daniel Choukroun, d.choukroun@tudelft.nl, www.lr.tudelft.nl/EuroGNC2013)		
15–19 Apr†	**2013 IAA Planetary Defense Conference**	Flagstaff, AZ (Contact: William Ailor, 310.336.1135, william.h.ailor@aero.org, http://www.pdc2013.org)		
23–25 Apr†	**Integrated Communications Navigation and Surveillance 2013**	Herndon, VA (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.i-cns.org)		
17–17 May†	**Seventh Argentine Congress on Space Technology**	Mendoza, Argentina (Contact: Pablo de Leon, 701.777.2369, Deleon@aate.org, www.aate.org)		
27–29 May	**19th AIAA/CEAS Aeroacoustics Conference (34th AIAA Aeroacoustics Conference)**	Berlin, Germany	*Jul/Aug 12*	**31 Oct 12**
27–29 May†	**20th St. Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia (Contact: Prof. V. Peshekhonov, +7 812 238 8210, icins@eprib.ru, www.elektropribor.spb.ru)		
29–31 May†	**Requirements for UTC and Civil Timekeeping on Earth: A Colloquium Addressing a Continuous Time Standard**	Charlottesville, VA (Contact: Rob Seaman, 520.318.8248, info@futureofutc.org, http://futureofutc.org)		
6 Jun	**Aerospace Today ... and Tomorrow: Disruptive Innovation, A Value Proposition**	Williamsburg, VA (Contact: Merrie Scott: merries@aiaa.org)		
12–14 Jun†	**6th International Conference on Recent Advances in Space Technologies (RAST 2013)**	Istanbul, Turkey (Contact: Suleyman Basturk, rast2013@rast.org.tr, www.rast.org.tr)		
17–19 Jun†	**2013 American Control Conference**	Washington, DC (Contact: Santosh Devasia,devasia@u.washington.edu,http://a2c2.org/conferences/acc2013)		
24–27 Jun	**43rd AIAA Fluid Dynamics Conference and Exhibit** **44th AIAA Plasmadynamics and Lasers Conference** **44th AIAA Thermophysics Conference** **31st AIAA Applied Aerodynamics Conference** **21st AIAA Computational Fluid Dynamics Conference** **5th AIAA Atmospheric and Space Environments Conference** **AIAA Ground Testing Conference**	San Diego, CA	*Jun 12*	**20 Nov 12**
14–17 Jul	**49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit** **11th International Energy Conversion Engineering Conference (IECEC)**	San Jose, CA	*Jul/Aug 12*	**21 Nov 12**
14–18 Jul	**43rd International Conference on Environmental Systems (ICES)**	Vail, CO	*Jul/Aug 12*	**1 Nov 12**
11–15 Aug†	**AAS/AIAA Astrodynamics Specialist Conference**	Hilton Head Island, SC (Contact: Kathleen Howell, 765.494.5786, howell@purdue.edu, www.space-flight.org/docs/2013_astro/2013_astro.html)		

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
12–14 Aug	**AIAA Aviation 2013: Charting the Future of Flight Continuing the Legacy of the AIAA Aviation Technology, Integration, and Operations (ATIO) Conference and Featuring the 2013 International Powered Lift Conference (IPLC) and the 2013 Complex Aerospace Systems Exchange (CASE)**	Los Angeles, CA	*Oct 12*	**28 Feb 13**
19–22 Aug	**AIAA Guidance, Navigation, and Control Conference AIAA Atmospheric Flight Mechanics Conference AIAA Modeling and Simulation Technologies Conference AIAA Infotech@Aerospace Conference**	Boston, MA	*Jul/Aug 12*	**31 Jan 13**
10–12 Sep	**AIAA SPACE 2013 Conference & Exposition**	San Diego, CA	*Sep 12*	**31 Jan 13**
6–10 Oct†	**32nd Digital Avionics Systems Conference**	Syracuse, NY (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)		
2014				
13–17 Jan	**AIAA SciTech 2014 (AIAA Science and Technology Forum and Exposition)**	National Harbor, MD		5 Jun 13
16–20 Jun	**AVIATION 2014 (AIAA Aviation and Aeronautics Forum and Exposition)**	Atlanta, GA		Nov 13
28–30 Jul	**Propulsion and Energy 2014 (AIAA Propulsion and Energy Forum and Exposition)**	Cleveland, OH		Nov 13
2–10 Aug†	**40th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events**	Moscow, Russia http://www.cospar-assembly.org		
5–7 Aug	**SPACE 2014 (AIAA Space and Astronautics Forum and Exposition)**	San Diego, CA		Feb 14

For more information about the 2014 Forums and the conferences that they feature, please go to **www.aiaa.org/forums**. For other questions on the meetings listed above, contact AIAA Customer Service, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344; 800.639.AIAA or 703.264.7500 (outside U.S.). Also accessible via Internet at www.aiaa.org/calendar.

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

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AIAA Courses and Training Program

DATE	COURSE	VENUE	LOCATION
2013			
5–6 Jan	**Specialist's Course on Flow Control**	ASM Conference	Grapevine, TX
5–6 Jan	**Six Degrees of Freedom Modeling of Missile and Aircraft Simulations**	ASM Conference	Grapevine, TX
5–6 Jan	**Systems Engineering Verification and Validation**	ASM Conference	Grapevine, TX
30–31 Jan	**Fundamentals of Communicating by Satellite**	Webinar	
1 Feb–30 Jun	**Introduction to Computational Fluid Dynamics**	Home Study	
1 Feb–30 Jun	**Advanced Computational Fluid Dynamics**	Home Study	
1 Feb–30 Jun	**Computational Fluid Turbulence**	Home Study	
1 Feb–30 Jun	**Introduction to Space Flight**	Home Study	
1 Feb–30 Jun	**Fundamentals of Aircraft Performance and Design**	Home Study	
7 Feb	**Introduction to Bio-Inspired Engineering**	Webinar	
13 Feb	**CADAC++ Framework for Aerospace Simulations**	Webinar	
28 Feb–1 Mar	**Mathematical Introduction to Integrated Navigation Systems, with Applications**	The AERO Institute	Palmdale, CA
28 Feb–1 Mar	**Optimal State Estimation**	The AERO Institute	Palmdale, CA
4–5 Mar	**Modeling Flight Dynamics with Tensors**	National Aerospace Institute	Hampton, VA
20 Mar	**Risk Analysis and Management**	Webinar	
3 Apr	**UAV Conceptual Design Using Computer Simulations**	Webinar	
6–7 Apr	**Advanced Composite Structures**	SDM Conferences	Boston, MA
6–7 Apr	**Basics of Structural Dynamics**	SDM Conferences	Boston, MA
15–16 Apr	**A Practical Introduction to Preliminary Design of Air Breathing Engines**	The Ohio Aerospace Institute	Cleveland, OH
15–16 Apr	**Computational Heat Transfer (CHT)**	The Ohio Aerospace Institute	Cleveland, OH
24 Apr	**Space Radiation Environment**	Webinar	
10–11 Jun	**Introduction to Spacecraft Design and Systems Engineering**	The Ohio Aerospace Institute	Cleveland, OH
10–11 Jun	**Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-on Training Using CIFER®**	The Ohio Aerospace Institute	Cleveland, OH
22–23 Jun	**Fundamentals of Hypersonic Aerodynamics**	Fluids Conferences	San Diego, CA
22–23 Jun	**Verification and Validation in Scientific Computing**	Fluids Conferences	San Diego, CA
29–30 Jul	**Introduction to Space Systems**	National Aerospace Institute	Hampton, VA
29–30 Jul	**Phased Array Beamforming for Aeroacoustics**	National Aerospace Institute	Hampton, VA
29–30 Jul	**Turbulence Modeling for CFD**	National Aerospace Institute	Hampton, VA
11 Sep	**Missile Defense: Past, Present, and Future**	Webinar	
23–24 Sep	**Gossamer Systems: Analysis and Design**	The AERO Institute	Palmdale, CA

**Courses subject to change*

To receive information on courses listed above, write or call AIAA Customer Service, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344; 800.639.2422 or 703.264.7500 (outside the U.S.). Also accessible via the internet at www.aiaa.org/courses or www.aiaa.org/SharpenYourSkills.

From the Corner Office

AIAA SECTION ACTIVITIES

Michael Griffin, AIAA President

My previous forays into this editorial arena have dealt with what I have believed to be matters of national scope, topics such as how AIAA can remain relevant in our profession, or the larger significance of *Curiosity's* landing on Mars. But while the nature of our profession certainly encourages a big-picture view, for many of our members their AIAA experience is not at national meetings or technical conferences, but rather in engagement with their sections and the relationships that are built in their local area.

We have 59 AIAA sections around the world. Add to that our 195 student sections, also spread globally, and in any given week the members of the AIAA are meeting, exchanging experiences, celebrating the aerospace profession, and learning more about various aspects of the industry about which we are all so passionate. We don't hear much about this; my impression is that, all too often, what happens in our sections goes virtually unnoticed by the national level of AIAA—and vice versa. I've seen this situation from both sides. My involvement with national-level AIAA activities and committees goes back to 1978. But I have also served twice as Program Chair of the AIAA National Capitol Section, and am married to the former and so far the only two-term President of that section. In those years, when "AIAA national" seemed to have only minimal involvement even with its hometown section, how much of a connection could be expected with events happening in, say, Colorado? The answer is, not much, and I don't believe things have changed a lot in that regard. I think this is something that could use some work within our Institute.

So, with this column I will take a bit of time and a few column-inches to review some of what is happening in our more active sections. Maybe it will spark some ideas for similar events in less active areas.

Section activities and schedules vary widely based on the location and interests of the members in that section. There are a wide variety of activities occurring around the country at any given time, on a variety of themes. Despite such diversity there are certain themes that run through most of the offerings. For example, nearly every section is involved in Engineer's Week in February, working to engage and educate the public about the engineering profession in general and engineers involved in the aerospace industry in particular.

In addition, many sections participate in some kind of educational outreach effort, whether at the university or the K–12 level. We aerospace professionals clearly love what we do, and we love to share it with others. In Region 1, one of the outreach activities this past year took the form of a Young Professional, Student and Educator Conference. The Cape Canaveral Section participated in the Florida Institute of Technology's Aviation Day to reach out to both university students and the larger public to share the mission of AIAA and the wonderful things going on in aviation and space. The Wisconsin section hosted a workshop for teachers entitled "Rocket Science for Educators," which educated teachers about the aerospace industry and provided materials for them to take back to the classroom. The St. Louis Section hosted STEM movie nights once a month, inviting families to view aerospace-related movies ranging from educational documentaries to feature films. The Phoenix Section even built a tabletop wind tunnel to take to various outreach events to demonstrate basic principals of aeronautics. Outside the United States, the Sydney Section worked with students on a rocket avionics project that culminated in the launch of their microprocessor payload from Karaoonda, Australia.

Recent section activities have also involved sharing of technical information and discussions of technology in the industry. The Savannah Young Professional Council took a tour of the R&D labs at Gulfstream Aerospace to obtain a better understanding of where Gulfstream was heading in the future, and of the parameters of industrial R&D. In Ohio, the Dayton/Cincinnati Section hosted an Aerospace Sciences Symposium that drew over 250 attendees and 180 technical presentations—all in one day. The Houston Section also hosted a technical symposium covering many timely topics in space systems design. And for the first time, the Rocky Mountain Section held a technical symposium, "Game Changing Technologies and Strategies—Collaboration to Explore Burgeoning Technology Horizons" (see full article on page **B9**).

Section activities this past year have also provided a means for our members to keep abreast of the latest issues in the aerospace industry by inviting and hosting speakers at meetings and other events. Here is a short list of some of the distinguished lectures that took place in the past year:

Michigan Section: Robert Horton, "Flight Test of the X-45 UCAV"

North Texas Section: Paul Bevilaqua, "Inventing the Joint Strike Fighter"

Long Island Section: Mike Machat, "Republic—The Company and Its Airplane"

Wichita Section: Todd Barber, "Curiosity: Exploring the Red Planet with the Mars Science Laboratory"

Savannah Section: Carl Newman, Hurricane Hunter Pilot Experiences

St. Louis Section: Greg Meholic, "Advanced Space Propulsion Concepts for Interstellar Travel"

Houston Section: Mark Geyer, Program Manager, Orion spacecraft

This is by no means an exhaustive list of the activities that have taken place around the country and internationally this year, but I hope it gives you a flavor of what our members are doing, not only in the technical activities that form the backbone of the organization, but also in topical issues, policy, and outreach.

CIVIL SPACE 2013

The AIAA Greater Huntsville Section is sponsoring a technical symposium titled "Civil Space 2013" to discuss current challenges, opportunities, and emerging technologies relevant to space access and orbital solutions within the civil space market. Civil Space 2013 is scheduled for 12–13 February. Dynetics, Inc. has graciously agreed to host the symposium at their Solutions Complex located at 1004 Explorer Blvd in Huntsville, AL. This conference provides a unique focus on civil (inclusive of commercial) space access and orbital solutions, challenges, mission assurance, safety, policy, global competition, and vision. The emphasis is on supporting Earth orbital systems, operations, and solutions. It is a working-level conference designed to highlight for discussion some of the biggest challenges facing the market today, including technology gaps, market stability, obsolescence, and integration and safety standards.

Dr. Michael Griffin, former NASA administrator and AIAA president, will be providing a keynote address regarding the world stage and global competition for civil space. Mr. Steve Cook, former manager of Ares I and V programs at NASA MSFC and current Director of Space Technologies at Dynetics, will be chairing the panel session on Commercial Crew Transportation Systems – Qualified Hardware, Requirement, Standards and Certification. Representatives across industry will be participating in the panel sessions. The cost to attend is $75 for AIAA members and $150 for nonmembers. The complete agenda can be found at **http://tinyurl.com/CivilSpace2013**.

AIAA ANNOUNCES 2013 ASSOCIATE FELLOWS

AIAA is pleased to announce the selection of the AIAA Associate Fellows class of 2013. The 2013 Associate Fellows will be honored at the AIAA Associate Fellows Dinner on Monday, 7 January 2013, at the Gaylord™ Texan Hotel and Convention Center, Grapevine, TX, in conjunction with the 51st AIAA Aerospace Sciences Meeting and Exhibit.

To be selected for the grade of Associate Fellow an individual must be an AIAA Senior Member with at least twelve years professional experience, and be recommended by a minimum of three current Associate Fellows. By AIAA Region and Section, the 179 AIAA members selected for Associate Fellows are:

REGION I

Connecticut
Gavin J. Hendricks, Pratt & Whitney
John W. Watkins, Pioneer Aerospace Corporation

Delaware
Timothy Dominick, Alliant Techsystems, Inc.

Hampton Roads
Daniel G. Baize, NASA Langley Research Center
Steven C. Dunn, Jacobs Technology, Inc.
Francis A. Greene, NASA Langley Research Center
Lin Ma, Virginia Polytechnic Institute and State University
Jill M. Marlowe, NASA Langley Research Center
Duncan E. McIver, Technology Commercialization Center
Daniel G. Murri, NASA Langley Research Center
Gary D. Seidel, Virginia Polytechnic Institute and State University
Alan E. Stockwell, Lockheed Martin Corporation
Jeffery A. White, NASA Langley Research Center

Mid-Atlantic
Ryan C. Frederic, Applied Defense Solutions, Inc.
Dan E. Marren, United States Air Force
Justin R. Thomas, Johns Hopkins University Applied Physics Laboratory

National Capital
Harlan Bittner. The Aerospace Corporation
Kenneth J. Bocam, Orbital Sciences Corporation
Fred C. Briggs, Wyle
Steve Isakowitz, Virgin Galactic, LLC
John D. Kelley, NASA Headquarters
Malcolm B. Milam, NASA Goddard Space Flight Center
Chandru Mirchandani, Lockheed Martin Corporation
Henry A. Obering, III, Booz Allen Hamilton
Ronald R. Springer, Johns Hopkins University Applied Physics Laboratory

New England
Neil J. Adams, The Charles Stark Draper Laboratory, Inc.
Hamsa Balakrishnan, Massachusetts Institute of Technology
John J. Blandino, Worcester Polytechnic Institute
Deborah G. Douglas, Massachusetts Institute of Technology
Linda R. Fuhrman, The Charles Stark Draper Laboratory, Inc.
Jeffrey A. Hoffman, Massachusetts Institute of Technology
Vlad J. Hruby, Busek Co. Inc.
Lauren J. Kessler, The Charles Stark Draper Laboratory, Inc.
Leena Singh, The Charles Stark Draper Laboratory, Inc.
James J. Szabo, Busek Co. Inc.
Paul B. Voss, Smith College

Northeastern New York
Jeongmin Ahn, Syracuse University
Pier Marzocca, Clarkson University
Liling Ren, General Electric Company

Northern New Jersey
Sam Adhikari, Sysoft

Southern New Jersey
Scott Doucett, Federal Aviation Administration
Michael A. Konyak, Engility Corporation

REGION II

Atlanta
Mark H. Morton, Lockheed Martin Corporation
Massimo Ruzzene, Georgia Institute of Technology

Cape Canaveral
Peter C. Warren, Northrop Grumman Corporation

Carolina
Hong Luo, North Carolina State University
Robert A. Rivers, Contractor

Central Florida
Seetha Raghavan, University of Central Florida
Yunjun Xu, University of Central Florida

Greater Huntsville
Gil L. Crouse, Jr., Auburn University
Charles F. Kopicz, ERC Inc.
Emmett J. McDonald, Jacobs
Kenneth D. Philippart, Missile and Space Intelligence Center
Kurt A. Polzin, NASA Marshall Space Flight Center
Shuangzhang Tu, Jackson State University
Ming Xin, Mississippi State University
Sijun Zhang, ESI CFD, Inc.

Northwest Florida
Michael W. Kelton, Department of the Air Force
Kirit V. Patel, Jacobs Technology, Inc.

Palm Beach
Manhar R. Dhanak, Florida Atlantic University

Tennessee
James M. Burns, Arnold Engineering Development Center

REGION III

Dayton/Cincinnati
James W. Brinkley, Brinkley Research & Design Group
Douglas D. Decker, Science Applications International Corporation
Douglas J. Dolvin, Air Force Research Laboratory
Andrew T. Hsu, Wright State University
Paul F. McManamon, Exciting Technology LLC
Michael Winter, University of Kentucky

Illinois
Kevin W. Cassel, Illinois Institute of Technology

Indiana
Steven H. Frankel, Purdue University
Stanislav Gordeyev, University of Notre Dame
Inseok Hwang, Purdue University
Meng Wang, University of Notre Dame

Michigan
Joaquim Martins, University of Michigan
Ahmed M. Naguib, Michigan State University

Northern Ohio
Brett A. Bednarcyk, NASA Glenn Research Center
James H. Gilland, Ohio Aerospace Institute
Richard E. Kreeger, NASA Glenn Research Center
Rickey J. Shyne, NASA Glenn Research Center

Wisconsin
Todd H. Treichel, Orbital Technologies Corporation

REGION IV

Albuquerque
Matthew F. Barone, Sandia National Laboratories
Dale C. Ferguson, Air Force Research Laboratory
Demos T. Kyrazis, R-Cubed, Inc.
Alfred C. Watts, Sandia National Laboratories
Wayne N. White, Jr., SpaceBooster LLC

Houston
Nancy J. Currie, NASA Johnson Space Center

North Texas
Bryan E. Cepak, Lockheed Martin Corporation
Neal D. Domel, Lockheed Martin Corporation
Thomas L. Frey, Jr., Lockheed Martin Corporation
Glenn J. Miller, Lockheed Martin Corporation
Yung-Kang Sun, Engineering Design and Development Group
Greg S. Tallant, Lockheed Martin Corporation
Jeffrey B. Vermette, Lockheed Martin Corporation

Southwest Texas
David B. Goldstein, University of Texas

White Sands Space Harbor
Ahsan R. Choudhuri, University of Texas at El Paso
Evgeny Shafirovich, University of Texas at El Paso

REGION V

Rocky Mountain
Robert L. Berry, Lockheed Martin Corporation
Francis K. Chun, United States Air Force Academy
James H. Crocker, Lockheed Martin Corporation
Jeanette L. Domber, Ball Aerospace & Technologies Corp.
John C. Grace, Lockheed Martin Corporation
Paul H. Graf, Aerospace Solutions, LLC
Lisa R. Hardaway, Ball Aerospace & Technologies Corp.
Lakshmi H. Kantha, University of Colorado
Roger P. McNamara, Lockheed Martin Corporation
Martiqua Post, United States Air Force Academy
Mark N. Sirangelo, Sierra Nevada Corporation

St. Louis
Asghar Esmaeeli, Southern Illinois University
John D. Kelley, The Boeing Company

Wichita
Jim Hoppins, Cessna Aircraft Company

REGION VI

Antelope Valley
Daniel W. Banks, NASA Dryden Flight Research Center
Ming Chang, Lockheed Martin Corporation
Brian T. Holm-Hansen, Lockheed Martin Corporation
Ivett A. Leyva, Air Force Research Laboratory
Alton D. Romig, Jr., Lockheed Martin Corporation
Alan M. Sutton, Air Force Research Laboratory

Los Angeles
Jeff Beranek, Lockheed Martin Corporation
Glenn C. Buchan, RAND Corporation
John M. Carson, III, Jet Propulsion Laboratory
Robert P. Frueholz, The Aerospace Corporation
Charles A. Gaharan, Lockheed Martin Corporation

Malina M. Hills, The Aerospace Corporation
Ray F. Johnson, The Aerospace Corporation
Randy L. Kendall, The Aerospace Corporation
Tomoya T. Ochinero, Structural Mechanics Corporation
Arthur C. Or, The Aerospace Corporation
Neil D. Pignatano, Raytheon Space & Airborne Systems
Brad Reed, USAF Space and Missile Systems Center

Orange County
Richard D. Baily, The Boeing Company
James B. Chang, The Aerospace Corporation
Stewart B. Lumb, The Boeing Company
Alex Velicki, The Boeing Company

Pacific Northwest
Steve M. Atkins, The Boeing Company
Bruce Dickinson, The Boeing Company
John A. Hamilton, The Boeing Company
Daniel P. Mooney, The Boeing Company
Perry N. Rea, The Boeing Company
Larry A. Schneider, The Boeing Company
Lynne Thompson, The Boeing Company

Phoenix
Mark D. Sensmeier, Embry-Riddle Aeronautical University
Gary E. Yale, Embry-Riddle Aeronautical University

San Diego
Gustaaf B. Jacobs, San Diego State University

San Fernando Pacific
Azam H. Arastu, The Boeing Company

San Francisco
Juan J. Alonso, Stanford University
Jay H. Ambrose, Lockheed Martin Corporation
Thomas J. Davis, NASA Ames Research Center
Eric R. Mueller, NASA Ames Research Center
Robert W. Parks, Zee.Aero
Ashok N. Srivastava, NASA Ames Research Center
Hyeonsoo Yeo, NASA Ames Research Center

San Gabriel Valley
Thomas A. Cwik, Jet Propulsion Laboratory
Jeffery L. Hall, Jet Propulsion Laboratory
Michel D. Ingham, Jet Propulsion Laboratory
John Y. Liu, The Boeing Company
George T. Whitesides, Virgin Galactic, LLC

Tucson
Hermann F. Fasel, University of Arizona

Utah
Marc Bodson, University of Utah

REGION VII

Belgium
Guillermo Paniagua, The Von Karman Institute For Fluid Dynamic

Brazil
Marco A. Minucci, Institute for Advanced Studies

Canada
Marcus Dejmek, Canadian Space Agency
Willie R. Quinn, St. Francis Xavier University

China (PRC)
Ya-Ling He, Xi'an Jiaotong University

France
Christophe Bogey, École Centrale de Lyon

Germany
Thomas M. Berens, Cassidian
Cord C. Rossow, DLR The German Aerospace Center

India
Gundra S. Reddy, Defence Research and Development Organisation
N. Sitaram, Indian Institute of Technology Madras
M. Suresh, Ministry of Defence

Italy
Giuliano Coppotelli, University of Rome
Alessandro A. Quarta, University of Pisa

Pakistan
Abid A. Khan, National University of Sciences and Technology

Singapore
Poh Eng Kee, DSO National Laboratories

South Africa
Franz-Josef Kahlen, University of Cape Town

Spain
Martin Lara, Real Observatorio de la Armada

Sydney
Kee-Choon Wong, The University of Sydney

Taiwan (ROC)
Kuo-Long Pan, National Taiwan University

The Netherlands
Richard Curran, Delft University of Technology
Erwin Mooij, Delft Technical University of Technology

United Kingdom
Sondipon Adhikari, Swansea University
Epaminondas Mastorakos, University of Cambridge

AIAA BOARD OF DIRECTORS, YOUNG PROFESSIONAL LIAISON

Application Deadline: 1 February 2013
Position Duration: May 2013–May 2015

The Young Professional Liaison position on the AIAA Board of Directors helps give AIAA a more direct link to the Institute's young professional members, and provides insights and feedback to help AIAA create comprehensive programs to attract and retain young professionals and members in general.

The Young Professional Liaison is a non-voting Board of Directors position lasting two years. The liaison will be required to attend AIAA Board of Directors meetings in January, May, and July or August each year. In addition, the Young Professional Liaison will be asked to participate in various other meetings and activities that are collocated with the Board of Directors meeting (receptions, special events, etc.). The Young Professional Liaison will work with the AIAA Young Professional Committee (YPC) and perform various responsibilities including attending the committee's meetings and supporting the committee's various activities. AIAA will reimburse the liaison for necessary expenses incurred to attend the Board of Directors meetings.

ELIGIBILITY

Applicants for the position of Young Professional Liaison to the AIAA Board of Directors shall meet the following eligibility requirements:

1) Applicant must be an AIAA professional member in good standing for at least one year prior to selection.
2) Applicants must be a young professional member (35 years of age or under) for the entire duration of the appointment.

SELECTION CRITERIA

The Young Professional Liaison to the AIAA Board of Directors will be selected on the basis of the following criteria, which are listed in order of importance:

1) *Candidate Statement*
The candidate should state his/her goals and desires for the position and the benefits for the young professional membership if chosen.

2) *Resume/Biography*
The candidate should submit a short resume or biography listing AIAA participation and current position.

3) *Letter of Management Endorsement*
The candidate and his/her managers should discuss the shared commitment associated with selection as the Young Professional Liaison to the AIAA Board of Directors. The applicant must include a letter of recommendation from his/her immediate supervisor in support of candidacy.

4) *Phone Interview*
A phone interview may be requested by the Young Professional Committee after the applications have been submitted and before the final selection.

All application materials must be received at AIAA Headquarters by 1 February 2013. All documents should be typewritten, in English.

ADMINISTRATION OF THE PROGRAM

1) *General*
A selection committee made up of the voting members of the institute's AIAA Young Professional Committee will select the liaison. Final approval of the appointment is made by the AIAA president. AIAA headquarters shall serve as the custodian and disbursing agency for the travel funds and will be responsible for handling the administrative details of the program.

2) *Publicity*
The Young Professional Liaison to the AIAA Board of Directors will be publicized in *Aerospace America* and in various AIAA newsletters or the *AIAA Bulletin*. The program will also be publicized in other appropriate AIAA publications.

3) *Young Professional Committee*
It is expected that upon selection as the Young Professional Liaison to the AIAA Board of Directors, the candidate will become an active voting member of the AIAA Young Professional Committee. The candidate will report directly to the Chair of the YPC. Information about the Young Professional Committee can be found at **https://info.aiaa.org/SC/YPC/default.aspx**.

4) *Submittal of Applications*
The completed application must be received by **1 February 2013**, for consideration for the May 2013–May 2015 position. The application and related materials should be addressed to:

AIAA Young Professional Liaison Application
c/o Christopher Horton
Membership Programs Manager
1801 Alexander Bell Drive
Suite 500
Reston, VA 20191-4344

It is the responsibility of the applicant to ensure receipt of all required materials by the submission date.

5) *Selection of the Young Professional Liaison to the AIAA Board of Directors*
The decision of the selection committee is considered to be final and all candidates will be advised of the outcome by **15 March 2013**.

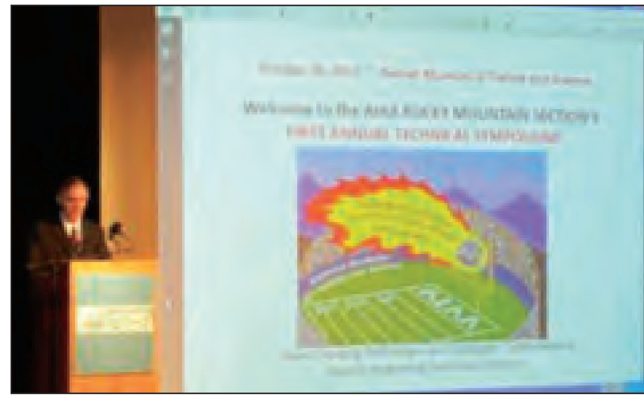
6) *Disbursement of the Travel Reimbursement*
AIAA will incur the cost of travel for the Young Professional Liaison to the AIAA Board of Directors to travel to the three AIAA Board of Directors meetings each year. The AIAA Board of Directors Meetings are usually held each January, May, and July or August. Travel support will include the cost of airfare, hotel, and meals during the program dates.

7) *Questions*
All questions can be directed to Christopher Horton, phone 703.264.7561, or email chrish@aiaa.org.

ROCKY MOUNTAIN SECTION HOLDS ITS FIRST ANNUAL TECHNICAL SYMPOSIUM

On 26 October, the Rocky Mountain Section (RMS) held its first Annual Technical Symposium (ATS) at the Denver Museum of Nature and Science. The RMS ATS had corporate sponsorship from Lockheed Martin Space Systems, Ball Aerospace, Stellar Solutions, United Launch Alliance, Surrey Satellite Technologies, and Red Canyon Engineering and Technologies; and received support from the Space Foundation and the Colorado Space Business Roundtable. AIAA Region V provided CATIII funds to support logistics for this event.

The theme for this symposium was "Game Changing Technologies and Strategies—Collaboration to Explore Burgeoning Technology Horizons," with the goal of communicating locally across technologies and disciplines. The diverseness of the day's topics was rare for AIAA events, as most conferences/symposiums are focused on a single area of interest rather than being geographically based. With an ambitious number of presentations, an outstanding facility, and an eagerness for networking, the symposium was an immense success.


Roger McNamara, RMS Chair-Elect and ATS Chair, welcoming attendees to the opening session.

Nearly 100 area professionals, young professionals, and students participated, enjoying 20 technical presentations and 3 keynote speakers. Keynote topics were Orion Stepping Stones, Large Aperture Telescopes, and Space Port Colorado. Technical presentations, including topics such as The Self-Refueling Mars Airplane, Natural Gas Heating via Pulsed Optical Lattices, New and Advanced Techniques in Aircraft Reconstruction, Putting LiDAR Technology to Work: Mapping our World in 3-Dimensions, Nanosatellite Launch Vehicles: A Global Perspective and Business Case Analysis, The Hyperion 2.1 Green Airplane Project, and Utilizing Leadership to Capitalize on Cutting-Edge Technologies, demonstrated that the ATS goal to provide visibility across technologies is a concept that works.

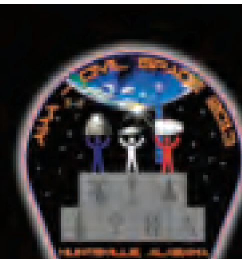
Area educational institutions, including the United States Air Force Academy, University of Colorado, and University of Colorado at Colorado Springs, accounted for almost half of the technical presentations. Ms. Janet Stevens of the Space Foundation presented each school with a copy of the Foundation's publication, "The Space Report: The Authoritative Guide to Global Space Activity." A post-event networking social was held at Red Canyon Engineering and Software and featured Red Rocket—the official beer of Space Port Colorado, donated by Bristol Brewery of Colorado Springs.

The RMS has a dedicated location on the website that has information about the 2012 ATS including the agenda, presentations materials, and photos from the event (**www.aiaa-rm.org/ATS**). Planning has begun for the 2013 ATS to be held in Colorado Springs.

CIVIL SPACE 2013

February 12-13 at Dynetics, Inc. Huntsville, AL

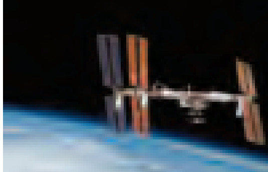
"Accelerating Tomorrow's Commercial Space Marketplace"



The Greater Huntsville Section of the American Institute of Aeronautics and Astronautics (AIAA) is sponsoring this technical symposium to discuss current challenges, opportunities, and emerging technologies relative to space access and orbital solutions within the civil space market.

- Meet with government and industry leaders to discuss the risks and challenges of civil space, focused on access and Earth orbital concerns.
- Hear expert analyses on global competition.
- Panel sessions on reliability vs. safety, system integration and standards, hardware qualification and certification, operations and risk mitigation, and a vision for the next 50 years

For more Information and to Register, Please Visit HTTP://tinyurl.com/civilspace2013



$75 for AIAA Members
$150 for Non Members

AIAA GREATER HUNTSVILLE SECTION

OBITUARIES

AIAA Senior Member Sinkiewicz Died In September

John Stanley Sinkiewicz, 69, died on 24 September 2012.

Mr. Sinkiewicz attended Wentworth Institute, Boston and graduated with an Associates Degree in Electrical Engineering. He subsequently attended Northeastern University, Boston and received a Bachelor of Science in Electrical Engineering in 1972. He spent many years within the aerospace industry, both at Draper Laboratory, Massachusetts Institute of Technology, Cambridge and Avco Systems Division (now Textron Systems) in Wilmington. Mr. Sinkiewicz later became a small business owner and entrepreneur, owning and operating an auto repair business, restaurant, and consulting in the international aerospace/inertial guidance field.

AIAA Associate Fellow McLane Died in November

Pioneering space program engineer and World War II fighter pilot **James Calvin McLane Jr.** died on 7 November 2012. Mr. McLane moved frequently as a child because of his father's road construction job. Constant new environments helped him cultivate a sociable personality, grow intellectually curious and develop excellent mechanical aptitude. During one interesting period, Mr. McLane lived at the city jail in Abbeville, SC, where his grandfather, Foster McLane, was sheriff. As a teenager Mr. McLane was only the second person in the state of South Carolina to fly a gasoline-powered model airplane. He finished high school in Newberry and enrolled as a cadet in Clemson College.

In 1943 McLane left college to join the Army Air Corp. He served as an instructor pilot in P-40 aircraft. In 1945 he flew P-51's Mustangs with the famed 357th Fighter Group in combat missions over Germany. His personal aircraft carried the words "Dainty Dotty" on its nose in honor of his wife. Later he piloted C-119 and C-130 transport planes with the Air Force Reserve, retiring as a major.

After World War II, McLane returned to Clemson and obtained a Bachelor of Civil Engineering degree. Beginning in 1947 he worked for the National Advisory Committee for Aeronautics in Langley, VA. In 1951 he moved to Tullahoma, TN, to design wind tunnels for the Army Corps of Engineers and later the Air Force. He obtained licenses to practice Professional Engineering in Tennessee and Texas.

In 1963 McLane went to Houston, TX, to take a job with NASA. He spearheaded design of the Lunar Receiving Laboratory that handled the precious rocks brought back from the moon. In February 1967 *Science* magazine featured his article about this facility. During NASA's Apollo program, the joint Apollo-Soyuz project with the Russians, Skylab, and Space Shuttle development he headed the Space Environmental Simulation Lab at NASA's Johnson Space Center. His work allowed him to personally meet many significant historical figures.

Mr. McLane was active in AIAA, where he was an Associate Fellow and held various offices. After retiring from NASA in the Senior Executive Service he consulted with industry on space environment simulation. He and his wife visited China five times—on one trip sponsored by the United Nations, McLane presented a course to Chinese technical specialists on ground-based space simulation.

AIAA Fellow and World-Class Researcher Ballal Died in November

Dilip Ballal, an internationally renowned University of Dayton fuels researcher who directed the Hans von Ohain Fuels and Combustion Center at the University of Dayton, died on 23 November 2012.

Ballal also served as division head for energy and environmental engineering at the University of Dayton Research Institute and the Hans von Ohain Distinguished Professor in Mechanical and Aerospace Engineering. His distinguished 40-year career included experience in fuels, gas-turbine combustion, emissions, and related research in academia and industry.

Ballal joined the University of Dayton in April 1983 as group leader for Fuels and Combustion at the Research Institute and, in 1999, was named the University's first Hans von Ohain Distinguished Professor. During his nearly 30-year career at the Research Insitute, Ballal helped garner more than $130 million in Air Force funding for research and development in synthetic, alternative, and blended fuels as well as technologies to improve combustion and thermal management and reduce emissions.

Under his leadership, research activities in fuels and combustion grew extensively, enabling the creation of the energy and environmental engineering division at the Research Institute in 2003. That same year, Ballal was named director of the University's new Hans von Ohain Fuels and Combustion Center, named after propulsion pioneer Hans von Ohain, co-inventor of the jet engine. The continued growth in fuels research also necessitated the opening of the Fuels and Combustion Laboratory at the Research Institute's Shroyer Park Center, dedicated to fuels and combustion, environmental engineering, and bio-environmental research.

Tony Saliba, dean of the School of Engineering, described Ballal as "a brilliant man, researcher and faculty member. In talking or working with him, you would not know of the international reputation he had for excellence in his field. He was a true role model with a humble spirit, a love for the UD family, and a remarkable ability to build bridges across units within the University and beyond the walls of our campus. No words can ever describe the wonderful person Dilip was and the life-changing influence he had on so many of his students and colleagues."

Ballal enjoyed international renown as a leading fuels researcher. In 2011 he received the American Society of Mechanical Engineers (ASME) R. Tom Sawyer Award, the organization's highest international award in gas-turbine technology. In 2010 he was named the first Pratt & Whitney Distinguished Chair (Visiting) Professor in Gas Turbine Engineering at the Indian Institute of Science in Bangalore. AIAA recognized Ballal in 1993 with the National Energy Systems Award for outstanding research in gas turbine combustion and again in 2000 with the Propellants and Combustion Award for outstanding contributions to combustion science and jet fuel technology.

Ballal was elected an ASME Fellow in 1992 and an AIAA Fellow in 1993. He was a senior vice president for the ASME Institutes Sector Board, a member of the board of directors of the ASME-International Gas Turbine Institute, the International Combustion Institute (Central States Section), and NASA combustion research and development committee. He also served as editor-chief of ASME's *Journal of Engineering for Gas Turbines and Power*.

Ballal graduated with a bachelor's degree in mechanical engineering in 1967 from the College of Engineering in Bhopal, India. He earned a master's degree in 1968 and a doctorate in mechanical engineering in 1972 from the Cranfield Institute of Technology in Cranfield, England, which also awarded him a doctor of science degree in 1983 for his "original and outstanding research contributions." Prior to coming to Dayton, Ballal held positions at the General Motors Research Laboratories, Purdue University and the Cranfield Institute of Technology.

CALL FOR NOMINATIONS

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 nominations on a daily basis and applies them to the appropriate year.

Any AIAA member in good standing may serve as a nominator and strongly are urged to read award guidelines carefully 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.

Beginning in 2013, all nominations, whether submitted online or in hard copy, must comply with the limit of 7 pages for the nomination package. The nomination package includes the nomination form, a one-page basis for award, one-page resume, one-page public contributions, and a minimum of 3 one-page signed letters of endorsement from AIAA members. Up to 5 signed letters of endorsement (include the 3 required from AIAA members) may be submitted and increase the limit to 9 pages. Nominators are reminded that the quality of information is most important.

Aerospace Guidance, Navigation, and Control Award is presented to recognize important contributions in the field of guidance, navigation, and control. (Presented even years)

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

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

Daniel Guggenheim Medal honors persons who make notable achievements in the advancement of aeronautics. AIAA, ASME, SAE, and AHS sponsor the award.

de Florez Award for Flight Simulation is presented for an outstanding individual achievement in the application of flight simulation to aerospace training, research, and development.

Energy Systems Award recognizes 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.

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

George M. Low Space Transportation Award, honors the space transportation achievements of Dr. Low, and is presented for a timely outstanding contribution to the field of space transportation. (Presented even years)

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

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

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

J. Leland Atwood Award recognizes an aerospace engineering educator for outstanding contributions to the profession. AIAA and ASEE sponsor the award. ***Note: Nominations due to AIAA by 1 January.***

Mechanics and Control of Flight Award is presented for an outstanding recent technical or scientific contribution by an individual in the mechanics, guidance, or control of flight in space or the atmosphere.

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

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

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

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

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

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

Space Systems Award is presented to recognize outstanding achievements in the architecture, analysis, design, and implementation of space systems.

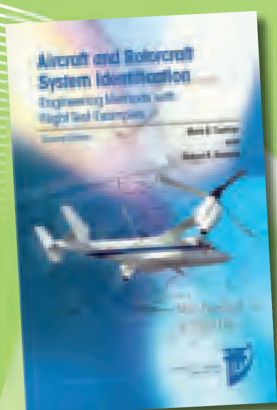
von Braun Award for Excellence in Space Program Management honors outstanding contributions in the management of a significant space or space-related program or project.

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.

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

The American Institute of Aeronautics and Astronautics Presents

New Releases and Featured Titles in Vertical Flight



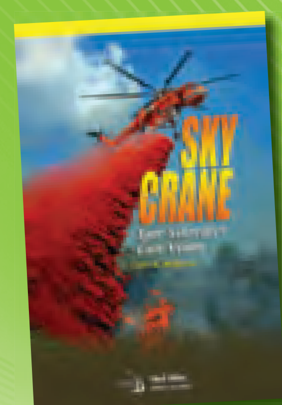
Aircraft and Rotorcraft System Identification, Second Edition

Mark Tischler
Robert Remple

2012, Hardback,
ISBN: 978-1-60086-820-7

$119.95

Addresses the entire process of aircraft and rotorcraft system identification from instrumentation and flight testing to model determination, validation, and application of the results. Includes software for additional learning.



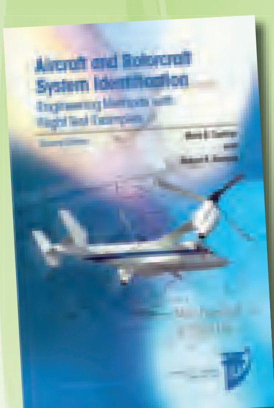
Skycrane: Igor Sikorsky's Last Vision

John McKenna

2010, Paperback,
ISBN: 978-1-60086-756-9

$39.95

A detailed account of the last creation of aircraft design pioneer Igor Sikorsky.



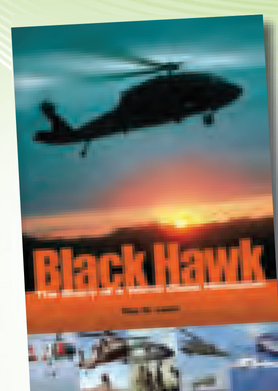
Basic Helicopter Aerodynamics, Third Edition

John Seddon
Simon Newman

2011, Hardback,
ISBN: 978-1-60086-861-0

$74.95

The perfect introduction to the first principles of the aerodynamics of helicopter flight.



Black Hawk: The Story of a World Class Helicopter

Ray Leoni

1997, Paperback,
ISBN: 978-1-56347-918-2

$39.95

The story of how Sikorsky Aircraft created one of the most successful helicopters in the world.

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54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference
21st AIAA/ASME/AHS Adaptive Structures Conference
15th AIAA Non-Deterministic Approaches Conference
14th AIAA Dynamic Specialist Conference
14th AIAA Gossamer Systems Forum
9th AIAA Multidisciplinary Design Optimization Conference

28–11 April 2013
Boston Park Plaza Hotel & Towers
Boston, Massachusetts

54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference

The 54th Structures, Structural Dynamics, and Materials Conference (SDM) is sponsored by AIAA, ASME, ASCE, AHS, and ASC. This established annual conference is a widely acknowledged event that provides a unique forum dedicated to the latest developments in the collective disciplines of structures, structural dynamics, materials, design engineering, and survivability. This year's presentations will address integration of fundamentals of materials development to structural design to enable accelerated materials technology transition to efficient and innovative flight-worthy aircraft and spacecraft structures.

21st AIAA/ASME/AHS Adaptive Structures Conference

The Adaptive Structures Conference is the premier conference focused on the advancement of adaptive structures technology and its application to aerospace systems. This conference brings together basic and applied researchers from diverse disciplines in academia, government, and industry; as such, the range of relevant topics is quite broad.

15th AIAA Non-Deterministic Approaches Conference

The need for Non-Deterministic Approaches (NDA) to manage uncertainty is well recognized within the aerospace industry. These approaches, which include both probabilistic and nonprobabilistic methods, provide treatment of high consequence of failure events associated with the development and operation of aerospace systems. The NDA Conference is dedicated to the development and dissemination of nondeterministic perspectives, methods, and applications.

14th AIAA Dynamics Specialists Conference

The conference theme is emerging structural dynamics technologies that will enable development of the next generation of aerospace vehicle systems including Micro Air Vehicles (including flapping wing approaches), Unmanned Air Vehicles, Rotorcraft and Tilt-Rotors, Composite Business Jets and Transports, Military Aircraft, Quiet Supersonic Aircraft, Hypersonic Vehicles, Commercial Launch Vehicles, Space Exploration Vehicles, Ultralight (thin-membrane or sandwich) Structures, Turbomachinery, and Next Generation Large-Scale Off-Shore Wind Turbines.

14th AIAA Gossamer Systems Forum

An emerging class of large-scale, lightweight structures is enabling a paradigm shift in design, launch, and operation of spaceflight systems. Spacecraft with structural characteristics optimized for operation in space and for the ability to collapse into small packages for launch yield order-of-magnitude reductions in mass, launch volume, and lifecycle cost, as compared to large spaceflight systems. The objective of the Gossamer Systems Forum is to provide an opportunity to discuss recent research findings and newly proposed concepts emerging from this technology.

9th AIAA Multidisciplinary Design Optimization Specialist Conference

Multidisciplinary design optimization (MDO) focuses on optimizing the performance and reducing the costs of complex systems that involve multiple interacting disciplines, such as those found in aircraft, spacecraft, automobiles, industrial manufacturing equipment, and various consumer products, and also on the development of related methodologies. MDO is a broad area that encompasses design synthesis, sensitivity analysis, approximation concepts, optimization methods and strategies, artificial intelligence, and rule-based design—all in the context of integrated design dealing with multiple disciplines and interacting subsystems or systems of systems.

54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference

General Chair
Anthony M. Waas
University of Michigan

Technical Program Chair
Ajit K. Roy
Air Force Research Laboratory

Student Papers Technical Chair
John D. Whitcomb
Texas A&M University

21st AIAA/ASME/AHS Adaptive Structures Conference

General Chair
David F. Voracek
NASA Dryden Flight Research Center

Technical Program Chair
Ratneshwar (Ratan) Jha
Clarkson University

15th AIAA Non-Deterministic Approaches Conference

General Chair
Gianluca Iaccarino
Mechanical Engineering & Institute for Computational and Mathematical Engineering
Stanford University

Technical Program Chair
Ben Thacker
Southwest Research Institute

14th AIAA Dynamics Specialists Conference

General Chair
John B. Kosmatka
University of California, San Diego

Technical Program Chair
Joseph C. Slater
Wright State University

14th AIAA Gossamer Systems Forum

General Chair
James D. Moore
ManTech Nexolve

Technical Program Chair
Jeremy A. Banik
Air Force Research Laboratory
Kirtland AFB

9th AIAA Multidisciplinary Design Optimization Conference

General Chair
Maxwell Blair
Air Force Research Laboratory

Technical Program Chair
Andy Ko
AVID LLC

Program-at-a-Glance

Saturday, 6 April 2013

0815–1700 hrs
Continuing Education Courses

Sunday, 7 April 2013

0815–1700 hrs
Continuing Education Courses

Monday, 8 April 2013

0800–0900 hrs
SDM Keynote
John Tracy, The Boeing Company

1330–1430 hrs
SDM Lecture
Daniel J. Inman, University of Michigan

1800–1930 hrs
Welcome Reception

Tuesday, 9 April 2013

0800–0900 hrs
NDA Keynote

1300–1400 hrs
ASC Keynote

Wednesday, 25 April 2012

0800–0900 hrs
ASME Keynote

1200 hrs
Awards Luncheon (Speaker: Rollie Dulton, AFRL)

1800–1900 hrs
GSF Keynote
John Mankins, CEO of Artemis Innovations

Thursday, 26 April 2012

0800–0900 hrs
MDO Keynote
Christina Bloebaum, Iowa State University

AIAA **Programs**

	Registration Type	By 26-March AIAA Member	By 26-March Nonmember	Conference Sessions	Online Proceedings	Monday Reception	Wednesday Awards Luncheon
Option 1	**Full Conference**	**$815**	**$975**	●	●	●	●
Option 2	**Full -Time Undergraduate Student**	**$25**	**$60**	●			
Option 3	**Full -Time Undergraduate Student with Networking**	**$153**	**$188**	●		●	●
Option 4	**Full-Time Graduate or PH.D. Student**	**$75**	**$105**	●			
Option 5	**Full-Time Graduate or PH.D. Student with Networking**	**$203**	**$233**	●		●	●
Option 6	**AIAA Retired Member Only**	**$60**	**n/a**	●		●	●
Option 7	**Discounted Group Rate***	**$734**	**n/a**	●	●	●	●
Option 8	**Continuing Education (CE) Course and Full Conference With Online Proceedings**	**$1,305**	**$1,415**	●	●	●	●
	Extra Tickets				$200	$75	$53

Pricing subject to change.

*10% discount off AIAA member rate for 10 or more persons from the same organization who register and pay at the same time

Registration Information

All participants are urged to register online via the AIAA website at **www.aiaa.org/sdm2013**. Registering in advance saves conference attendees time and up to $200. A PDF registration form is also available on the AIAA website. Print, complete, and mail or fax with payment to AIAA. Payment must be received in order to process registration. Early-bird registration forms must be received by **26 March 2013**. If you require more information, please call 703.264.7503 or email Lynned@aiaa.org.

Hotel Information

AIAA has arranged for a block of rooms to be held at:

Boston Park Plaza Hotel & Towers
50 Park Plaza at Arlington St.
Boston, MA 02116

Rates are $199 plus applicable taxes for single or double occupancy. Rooms will be held until **8 March 2013** or until the block is full. Please make your reservations early to avoid missing the discounted rate. In addition, please mention AIAA when you make your reservations to be included in this block. Reservations can be made by calling 617.426.2000.

Attention Federal Government Employees: A limited number of rooms have been blocked at the current federal per diem rate at the hotel. Please ask for the AIAA Government Rate when making your reservations, as there may not be rooms available at that rate outside the AIAA block.

AIAA Bookstore

Stop by the AIAA Bookstore in the registration area to browse and purchase specially selected titles for the SDM conference. Also featured will be the entire 2013 AIAA Book of Month collection at their special month prices. All books offered at SDM will be 30% off list price. Lastly, the title *Structures Technology: Historical Perspective and Evolution*, by Ahmed Noor, has been selected as the conference book of SDM and is on sale for $34.95.

Conference Sponsorship Opportunities

When your brand is on the line, AIAA sponsorship can raise the profile of your company and put you where you need to be. Available packages offer elevated visibility, effective marketing and branding options, and direct access to prominent decision makers from the aerospace community. Contact Merrie Scott at merries@aiaa.org or 703.264.7530 for more details.

Awards Luncheon

Join fellow attendees at the Wednesday, 10 April 2013, AIAA Awards Luncheon. The prestigious AIAA-ASC James H. Starnes, Jr. Award, along with other AIAA awards, will be presented. The luncheon is included in the registration fee where indicated. Additional tickets may be purchased for $54 via the registration form found at **www.aiaa.org/sdm2013** or on site at the AIAA registration desk, based on availability.

Student Paper Awards

A limited number of students will receive recognition for their papers at the Wednesday awards luncheon, at which the Jefferson Goblet Award, The Harry H. and Lois G. Hilton Award, The Lockheed Martin Award, and The American Society of Composites Award will be presented.

	Sunday April 7, 2013	Monday April 8, 2013	Tuesday April 09, 2013	Wednesday April 10, 201	Thursday April 11, 2013
7:00 - 7:30 AM		Networking Breakfast	Networking Breakfast	Networking Breakfast	Networking Breakfast
7:30 - 8:00 AM		Speakers Briefing in Session Rooms	Speakers Briefing in Session Rooms	Speakers Briefing in Session Rooms	Speakers Briefing in Session Rooms
8:00 - 8:30 AM		SDM Keynote John Tracy, Boeing	NDA Keynote	ASME Keynote	MDO Keynote Christina Bloebaum, Iowa State University
8:30 - 9:00 AM					
9:00 - 9:30 AM		Coffee Break	Coffee Break	Coffee Break	Coffee Break
9:30 - 10:00 AM		Technical Paper Sessions (5 Papers 150 min)	Technical Paper Sessions (5 Papers 150 min)	Technical Paper Sessions (5 Papers 150 min)	Technical Paper Sessions (5 Papers 150 min)
10:00 - 10:30 AM					
10:30 - 11:00 AM					
11:00 - 11:30 AM					
11:30 - 12:00 PM					
12:00 - 12:30 PM		Lunch On Own	Lunch On Own	Awards Luncheon Rollie Dulton, AFRL	Lunch On Own
12:30 - 1:00 PM					
1:00 - 1:30 PM		SDM Lecture Dan Inman, University of Michigan	ASC Keynote		Coffee Break / Speakers Briefing in session room
1:30 - 2:00 PM					Technical Sessions (6 Papers, 180 min)
2:00 - 2:30 PM		Coffee Break / Speakers Briefing in session room	Coffee Break / Speakers Briefing in session room	Coffee Break / Speakers Briefing in session room	
2:30-3:00 PM		Technical Paper sessions (7 Papers, 210min)	Technical Paper sessions (7 Papers, 210 min)	Technical Paper sessions (7 Papers, 210 min)	
3:00 - 3:30 PM					
3:30 - 4:00 PM					
4:00 - 4:30 PM	Registration Open				
4:30 - 5:00 PM					
5:00 - 5:30 PM					
5:30 - 6:00 PM					
6:00 - 6:30 PM		Opening Reception		GSF Ketynote John Mankins, CEO of Artemis Innovations	
6:30 - 7:00 PM					
7:00 - 7:30 PM	Committee Meetings		Committee Meetings	Committee Meetings	
7:30 - 8:00 PM		Committee Meetings			
8:00 - 8:30 PM					
8:30 - 9:00 PM					
9:00 - 9:30 PM					
9:30 - 10:00 PM					

Continuing Education Courses

Let AIAA Continuing Education courses pave the way to your continuing and future success! As the premier association representing professionals in aeronautics and astronautics, AIAA has been a source for continuing the aerospace professional's education for more than seventy years. AIAA is committed to keeping aerospace professionals at their technical best. AIAA offers the best instructors and courses to meet the professional's career needs.

On 6–7 April at the Boston Park Plaza Hotel & Towers, AIAA will be offering the following Continuing Education courses in conjunction with the AIAA Structures Conferences:

- *Advanced Composite Structures* (Instructor: Carl Zweben, Independent Consultant, AIAA Associate Fellow, Devon, PA)
- *Basics of Structural Dynamics* (Instructor: Dr. Andrew Brown, NASA Marshall Space Flight Center, Huntsville, AL)

Register for one of these courses and attend the SDM Conference for FREE! (Registration fee includes full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.)

Please check the SDM Conference website at **www.aiaa.org/sdm2013** for more information and full descriptions regarding the courses.

"No Paper, No Podium" Policy

If a written paper is not submitted by the final manuscript deadline, authors will not be permitted to present the paper at the conference. This policy is intended to eliminate no-shows and to improve the quality of the conference for attendees.

On-Site Check-in

Partnering with Expo Logic, we've streamlined the on-site registration check-in process!

All advance registrants will receive an email with a registration barcode. In order to pick up your badge and conference materials, make sure to print the email that includes your ExpressPass Barcode, and bring it with you to the conference. Simply scan the ExpressPass barcode at one of the ExpressPass stations in the registration area to print your badge and receive your meeting materials.

Notice on Visas

If you plan to attend an AIAA technical conference or course held in the United States and you require a visa for

AIAA Programs

travel, it is incumbent upon you to apply for a visa with the U.S. Embassy (consular division) or consulate with ample time for processing. To avoid bureaucratic problems, AIAA strongly suggests that you submit your formal application to U.S. authorities a minimum of 120 days in advance of the date of anticipated travel.

To request a letter of invitation, please fill out and submit the online Invitation Letter Request Form. You can also request a letter of invitation by contacting:

ATTN: Lynne David
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
703.264.7500 • 703.264.7657 FAX
Email: lynned@aiaa.org

AIAA cannot directly intervene with the U.S. Department of State, consular offices, or embassies on behalf of individuals applying for visas.

For more detailed program information, visit the website at **www.aiaa.org/sdm2013**.

Courses Open to Everyone at Every Level

STAND-ALONE COURSES

AIAA is proud to partner with the following organizations as they host our short courses at their facilities:

AERO Institute

National Institute of Aerospace

OAI Ohio Aerospace Institute

Upcoming Courses:

28 February–1 March 2013
Mathematical Introduction to Integrated Navigation Systems, with Applications
Instructor: Robert Rogers
Early Bird Registration Deadline is **18 January 2013**
The AERO Institute • Palmdale, California

28 February–1 March 2013
Optimal State Estimation
Instructor: Dan Simon
Early Bird Registration Deadline is **18 January 2013**
The AERO Institute • Palmdale, California

4–5 March 2013
Modeling Flight Dynamics with Tensors
Instructor: Peter Zipfel
Early Bird Registration Deadline is **1 February 2013**
National Institute of Aerospace • Hampton, Virginia

15–16 April 2013
A Practical Introduction to Preliminary Design of Air Breathing Engines
Instructor: Ian Halliwell
Early Bird Registration Deadline is **14 March 2013**
Ohio Aerospace Institute • Cleveland, Ohio

15–16 April 2013
Computational Heat Transfer (CHT)
Instructor: Dean Schrage
Early Bird Registration Deadline is **14 March 2013**
Ohio Aerospace Institute • Cleveland, Ohio

Save over $100 by signing up TODAY!

View all courses at **www.aiaa.org/StandAloneAA**

AIAA

13-0003update

Calls for Papers

AIAA SciTech 2014 (AIAA Science and Technology Forum and Exposition)

13–17 January 2014
National Harbor, Maryland (near Washington, D.C.)
Website: www.aiaa.org/SciTech2014
Twitter: #AIAAscitech

Abstract Deadline: 5 June 2013

The best minds in the aerospace industry will be coming together at AIAA SciTech 2014. In technical sessions participants will share the newest research, seek answers to challenging questions, and move new technologies forward. Engineers and educators, researchers and designers, scientists and students will all join together to play a part in advancing the state of aerospace science and technologies.

From presentations that will help to unravel engineering challenges, to networking events where the exchange of experiences can lead to effective solutions, this forum can enrich your current work and help enhance your future career path.

At the same time, you will be able to hear from market analysts, corporate decision makers, journalists, and government and military leaders as they address the difficult questions facing the industry:

- How will Congress and the White House impact future funding for research and development in the civil sector?
- Will corporations have to go it alone in developing tomorrow's cutting-edge technologies?
- Will today's students see a bright future in aerospace, or will they look elsewhere, and how will we keep the best foreign students from returning home?

And most important, what will *you* miss if you're not there?

Who Should Attend?

- If you influence, affect, advance, study, or work in aerospace research and development, you should attend.
- If you are looking for innovative and effective solutions to complex problems, you should attend.
- If you are looking for career-long connections, you should attend.

Abstract Submission

AIAA SciTech 2014 features the following conferences:

- 22nd AIAA/ASME/AHS Adaptive Structures Conference
- 52nd AIAA Aerospace Sciences Meeting
- 15th AIAA Gossamer Systems Forum
- AIAA Guidance, Navigation, and Control Conference
- Infotech@Aerospace Conference
- AIAA Modeling and Simulation Technologies Conference
- 10th Multidisciplinary Design Optimization Specialist Conference
- 16th AIAA Non-Deterministic Approaches Conference
- 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference
- 32nd ASME Wind Energy Symposium

You'll want to make sure that you participate in this exciting new event. A detailed call for papers will be available at **www.aiaa.org/scitech2014**.

Important Dates
Abstract Submission Opens: February 2013
Abstract Deadline: 5 June 2013
Program Live on Website: September 2013
Registration Opens: 3 September 2013

SciTech Exposition

Raise your company's profile when you reach more than 2,000 attendees—become an exhibitor or sponsor!

Exposition Contact
Chris Grady
AIAA Exhibits Business Manager
Office: 703.264.7509 • Email: chrisg@aiaa.org

Sponsorship Contact
Merrie Scott
Industry Partnerships Manager
Office: 703.264.7530 • Email: merries@aiaa.org

National Harbor

National Harbor is just 15 minutes from the heart of Washington, DC and Old Town Alexandria, VA. A town within a town, you'll find more than 30 restaurants and 40 retailers for every kind of shopper. And best of all? It's all perched right on the sparkling Potomac River. You'll find the riverside views—particularly the spectacular sunsets—relaxing after your busy day.

Follow the latest developments on Twitter @aiaa_news
www.aiaa.org/SciTech2014

Upcoming AIAA Professional Development Courses

5–6 January 2013

The following Continuing Education courses are being held at the 51st AIAA Aerospace Sciences Meeting in Grapevine, TX. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for one of the ASM 2013 courses, go to **www.aiaa.org/asm2013.**

	Early Bird by 10 Dec	Standard (11 Dec–4 Jan)	On-site (5 Jan)
AIAA Member	$1295	$1395	$1495
Nonmember	$1400	$1500	$1600

Specialist's Course on Flow Control (Instructor: David Williams, Professor of Mechanical, Materials & Aerospace Engineering Department, Director of Fluid Dynamics Research Center, Illinois Institute of Technology, Chicago, IL; Daniel Miller, Technical Lead and PI for Propulsion Integration R&D, Lockheed Martin Skunk Works, Bainbridge Island, WA; Dr. Kunihiko Taira, Assistant Professor, Department of Mechanical Engineering, Florida A&M/Florida State University, Tallahassee, FL)

The techniques of active flow control are becoming more sophisticated as fluid dynamics, control and dynamical systems theory merge to design control architectures capable of solving challenging flow control applications. The two-day course will examine advanced topics in active flow control, placing particular emphasis on "how to do flow control." This new course will complement the more fundamental AIAA Short Course on "Modern Flow Control." Modern dynamical systems and control theory related to closed-loop flow control and performance limitations will be discussed. State-of-the-art actuator and sensor design techniques will be covered. Two case studies will be presented that describe recent success stories about the implementation of active flow control on advanced aircraft. The six course lecturers have extensive backgrounds in flow control, coming from industry and academia.

Six Degrees of Freedom Modeling of Missile and Aircraft Simulations (Instructor: Peter Zipfel, Adjunct Associated Professor, University of Florida, Shalimar, FL)

As modeling and simulation (M&S) is penetrating the aerospace sciences at all levels, this two-day course will introduce you to the difficult subject of modeling aerospace vehicles in six degrees of freedom (6 DoF). Starting with the modern approach of tensors, the equations of motion are derived and, after introducing coordinate systems, they are expressed in matrices for compact computer programming. Aircraft and missile prototypes will exemplify 6 DoF aerodynamic modeling, rocket and turbojet propulsion, actuating systems, autopilots, guidance, and seekers. These subsystems will be integrated step by step into full-up simulations. For demonstrations, typical fly-out trajectories will be run and projected on the screen. The provided source code and plotting programs lets you duplicate the trajectories on your PC (requires FORTRAN or C++ compiler). With the provided prototype simulations you can build your own 6 DoF aerospace simulations.

Systems Engineering Verification and Validation (Instructor: John C Hsu, CA State University, The University of CA at Irvine, Queens University and The Boeing Company, Cypress, CA)

This course will focus on the verification and validation aspect that is the beginning, from the validation point-of-view, and the final part of the systems engineering task for a program/project. It will clarify the confusing use of verification and validation. Familiarize yourself with validating requirements and generating verification requirements. Start with the verification and validation plans. Then learn how to choose the best verification method and approach. Test and Evaluation Master Plan leads to test planning and analysis. Conducting test involves activities, facilities, equipments, and personnel. Evaluation is the process of analyzing and interpreting data. Acceptance test assures that the products meet what intended to purchase. There are functional and physical audits. Simulation and Modeling provides virtual duplication of products and processes in operational valid environments. Verification management organizes verification task and provides total traceability from customer requirements to verification report elements.

1 February–30 June 2013
2013 Home Study Courses

Introduction to Computational Fluid Dynamics (Instructor: Klaus Hoffmann)

This introductory course is the first of the three-part series of courses which will prepare you for a career in the rapidly expanding field of computational fluid dynamics.

Advanced Computational Fluid Dynamics (Instructor: Klaus Hoffmann)

This advanced course is the second of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics.

Computational Fluid Turbulence (Instructor: Klaus Hoffmann)

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

Introduction to Computational Fluid Dynamics

	Early Bird by 1 Jan	Standard (2 Jan–1 Feb)
AIAA Member	$1165	$1275
Nonmember	$1285	$1395

Advanced Computational Fluid Dynamics

	Early Bird by 1 Jan	Standard (2 Jan–1 Feb)
AIAA Member	$1210	$1320
Nonmember	$1330	$1440

Computational Fluid Turbulence

	Early Bird by 1 Jan	Standard (2 Jan–1 Feb)
AIAA Member	$1270	$1380
Nonmember	$1390	$1500

Introduction to Space Flight (Instructor: Francis J. Hale)
By the time you finish this course, you will be able to plan a geocentric or interplanetary mission to include the determination of suitable trajectories, the approximate velocity budget (the energy required), the approximate weight (mass) and number of stages of the booster, and the problems and options associated with the terminal phase(s) of the mission.

Fundamentals of Aircraft Performance and Design
(Instructor: Francis J. Hale)
This course will give you an introduction to the major performance and design characteristics of conventional, primarily subsonic, aircraft. At the end of the course, you will be able to use the physical characteristics of an existing aircraft to determine both its performance for specified flight conditions and the flight conditions for best performance.

Home Study Courses, continued

Introduction to Space Flight

	Early Bird by 1 Jan	*Standard (2 Jan–1 Feb)*
AIAA Member	$1075	$1185
Nonmember	$1195	$1305

Fundamentals of Aircraft Performance and Design

	Early Bird by 1 Jan	*Standard (2 Jan–1 Feb)*
AIAA Member	$1075	$1185
Nonmember	$1195	$1305

28 February–1 March 2013
The following standalone course is being held at The AERO Institute in Palmdale, California.

Mathematical Introduction to Integrated Navigation Systems, with Applications (Instructor: Robert M. Rogers)
Integrated Navigation Systems is the combination of an on-board navigation system solution for position, velocity, and attitude as derived from accelerometer and/or gyro inertial sensors, and navigation aids providing independent/redundant data to update or correct this on-board navigation solution. In this course, and described in the accompanying textbook, this combination is accomplished with the use of the Kalman filter algorithm.

This course is segmented into two parts. In the first part, elements of the basic mathematics, kinematics, equations describing navigation systems and their error models, aids to navigation, and Kalman filtering are reviewed. Detailed derivations are provided. The accompanying textbook provides exercises to expand the application of the materials presented.

Applications of the course material, presented in the first part, are presented in the second part for actual Integrated Navigation Systems. Examples of these systems are implemented in the MATLAB/Simulink™ commercial product, and are provided for a hands-on experience in the use of the mathematical techniques developed

The AIAA textbook, *Applied Mathematics in Integrated Navigation Systems, Third Edition*, is included in the registration fee.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 18 Jan	*Standard (19 Jan–17 Feb)*	*On-site (18–28 Feb)*
AIAA Member	$995	$1125	$1220
Nonmember*	$1115	$1245	$1340

*Includes a one-year AIAA membership

28 February–1 March 2013
The following standalone course is being held at The AERO Institute in Palmdale, California.

Optimal State Estimation (Instructor: Dan Simon)
The instructor presents state estimation theory clearly and rigorously, providing the right balance of fundamentals, advanced material, and recent research results. After taking this course, the student will be able to confidently apply state estimation techniques in a variety of fields. The features of this course include:

- A straightforward, bottom-up approach that begins with basic concepts, and then builds step by step to more advanced topics.
- Simple examples and problems that require paper and pencil to solve—leading to an understanding of how theory works in practice.
- MATLAB®-based state estimation source code for realistic engineering problems—enabling students to recreate state estimation results and experiment with other simulation setups and parameters.

Students then are presented with a careful treatment of advanced topics, including H-infinity filtering, unscented filtering, high-order nonlinear filtering, particle filtering, constrained state estimation, reduced order filtering, robust Kalman filtering, and mixed Kalman/H-infinity filtering. The textbook *Optimal State Estimation: Kalman, H Infinity, and Nonlinear Approaches* is included in the registration fee.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 18 Jan	*Standard (19 Jan–17 Feb)*	*On-site (18–28 Feb)*
AIAA Member	$995	$1125	$1220
Nonmember*	$1115	$1245	$1340

*Includes a one-year AIAA membership

4–5 March 2013
The following standalone course is being held at the National Aerospace Institute in Hampton, Virginia.

Modeling Flight Dynamics with Tensors (Instructor: Peter Zipfel)
Establishing a new trend in flight dynamics, this two-day course introduces you to the modeling of flight dynamics with tensors. Instead of using the classical "vector mechanics" technique, the kinematics and dynamics of aerospace vehicles are formulated by Cartesian tensors that are invariant under time-dependent coordinate transformations.

This course builds on your general understanding of flight mechanics, but requires no prior knowledge of tensors. It introduces Cartesian tensors, reviews coordinate systems, formulates tensorial kinematics, and applies Newton's and Euler's laws to build the gen-

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 1 Feb	*Standard (2–25 Feb)*	*On-site (26 Feb–4 Mar)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

eral six degrees of freedom equations of motion. For stability and control applications, the perturbation equations are derived with their linear and nonlinear aerodynamic derivatives. After taking the course you will have an appreciation of the powerful new "tensor flight dynamics," and you should be able to model the dynamics of your own aerospace vehicle.

6–7 April 2013

The following Continuing Education courses are being held at the 54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference in Boston, MA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for one of the SDM 2013 courses, go to **www.aiaa.org/sdm2013.**

	Early Bird by 11 Mar	*Standard (12 Mar–5 Apr)*	*On-site (6 Apr)*
AIAA Member	$1305	$1405	$1505
Nonmember	$1415	$1515	$1615

Advanced Composite Structures **(Instructor: Carl Zweben, Independent Consultant, AIAA Associate Fellow, Devon, PA)**
Advanced composites are critical, and in many instances enabling, materials for a large and increasing number of aerospace applications. Historically considered primarily structural and thermal protection materials, they also have great potential in virtually all subsystems, including propulsion, mechanisms, electronics, power, and thermal management. Physical properties are increasingly important. For example, composites with low densities, low CTEs, and thermal conductivities higher than copper are now in production. Materials of interest include not only polymer matrix composites (PMCs), currently the most widely used class of structural materials, and carbon-carbon composites (CCCs), which are well established for thermal protection, but also ceramic matrix composites (CMCs), metal matrix composites (MMCs) and other types of carbon matrix composites (CAMCs). In this short course we consider key aspects of the four key classes of composites, including properties, manufacturing methods, design, analysis, lessons learned, and applications. We also consider future directions, including nanocomposites.

Basics of Structural Dynamics **(Instructor: Dr. Andrew Brown, NASA Marshall Space Flight Center, Huntsville, AL)**
This course is intended to be an introductory course in Vibrations and Structural Dynamics. The goals of the course will be to provide students with the ability to characterize the dynamic characteristics of structures, and enable the prediction of response of structures to dynamic environments. Subjects examined in the course will be free and forced vibration of single degree-of-freedom systems, forced response of multi-DOF systems, modal testing, and component loads analysis. The course will concentrate on the essential concepts within these topics to enable widely-applicable understanding, but we'll include examples of applications focused on rocket engines and launch vehicles as well. We'll also use a variety of software tools and in-class assignments to keep the class active and interesting.

15–16 April 2013

The following standalone course is being held at The Ohio Aerospace Institute in Cleveland, Ohio.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 14 Mar	*Standard (15 Mar–8 Apr)*	*On-site (9–15 Apr)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

A Practical Introduction to Preliminary Design of Air Breathing Engines **(Instructor: Ian Halliwell)**
The objective of the course is to present an overview of the preliminary design of air-breathing engine systems that is determined primarily by the aircraft mission, which defines the engine cycle—and different types of cycle are investigated. Preliminary design activities are defined and discussed in the context of the overall engine development process and placed in perspective. Some basic knowledge of aerodynamics and thermodynamics is assumed so the mathematical material that appears in many good textbooks is minimized and the question "What do you actually do as an engine designer?" is addressed. The practical means and processes by which thermodynamic concepts are turned into hardware are covered and some design techniques are demonstrated. Finally, the fact that an air breathing engine is much more than the flowpath component is discussed and the future of engine design methods is raised. Class participation is encouraged throughout. This is your course; please try to get from it whatever you want!

15–16 April 2013

The following standalone course is being held at The Ohio Aerospace Institute in Cleveland, Ohio.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 14 Mar	*Standard (15 Mar–8 Apr)*	*On-site (9–15 Apr)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

Computational Heat Transfer (CHT) **(Instructor: Dean Schrage)**
This CHT (Computational Heat Transfer) course provides a singular focus on the thermal modeling and analysis process, providing a unique perspective by developing all concepts with practical examples. It is a computational course dedicated to heat transfer. In the treatment of the general purpose advection-diffusion (AD) equation, the course material provides a strong introductory basis in CFD. The present course attempts to couple both the computational theory and practice by introducing a multistep modeling paradigm from which to base thermal analysis. The first six lectures form a close parallel with the modeling paradigm to further ingrain the concepts. The seventh lecture is dedicated to special topics and brings in practical elements ranging from hypersonic CHT to solidification modeling. The CHT course is also designed around an array of practical examples and employs real-time InterLab sessions. The overall goal of the CHT course is to form a unison of theory and practice, emphasizing a definitive structure to the analysis process. The course has a strong value added feature with the delivery of a general purpose CHT-CFD analysis code (Hyperion-TFS) and a volume Hex Meshing tool (Hyperion-Mesh3D).

10–11 June 2013
The following standalone course is being held at The Ohio Aerospace Institute in Cleveland, Ohio.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**			
	Early Bird by 10 May	*Standard (11 May–3 Jun)*	*On-site (4–10 Jun)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

Introduction to Spacecraft Design and Systems Engineering (Instructor: Don Edberg)

This course presents an overview of factors that affect spacecraft design and operation. It begins with an historical review of unmanned and manned spacecraft, including current designs and future concepts. All the design drivers, including launch and on-orbit environments and their affect on the spacecraft design, are covered. Orbital mechanics is presented in a manner that provides an easy understanding of underlying principles as well as applications, such as maneuvering, transfers, rendezvous, atmospheric entry, and interplanetary transfers. Considerable time is spent defining the systems engineering aspects of spacecraft design, including the spacecraft bus components and the relationship to ground control. Design considerations, such as structures and mechanisms, attitude sensing and control, thermal effects and life support, propulsion systems, power generation, telecommunications, and command and data handling are detailed. Practical aspects, such as fabrication, cost estimation, and testing, are discussed. The course concludes with lessons learned from spacecraft failures.

10–11 June 2013
The following standalone course is being held at The Ohio Aerospace Institute in Cleveland, Ohio.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**			
	Early Bird by 10 May	*Standard (11 May–3 Jun)*	*On-site (4–10 Jun)*
AIAA Member	$995	$1125	$1220
Nonmember*	$1115	$1245	$1340

*Includes a one-year AIAA membership

Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-on Training Using CIFER® (Instructor: Dr. Mark B. Tischler)

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

29–30 July 2013
The following standalone course is being held at the National Aerospace Institute in Hampton, Virginia.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**			
	Early Bird by 1 Jul	*Standard (2–22 Jul)*	*On-site (23–29 Jul)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

Introduction to Space Systems (Instructor: Mike Gruntman)

This two-day course provides an introduction to the concepts and technologies of modern space systems. Space systems combine engineering, science, and external phenomena. We concentrate on scientific and engineering foundations of spacecraft systems and interactions among various subsystems. These fundamentals of subsystem technologies provide an indispensable basis for system engineering. The basic nomenclature, vocabulary, and concepts will make it possible to converse with understanding with subsystem specialists. This introductory course is designed for engineers and managers—of diverse background and varying levels of experience—who are involved in planning, designing, building, launching, and operating space systems and spacecraft subsystems and components. The course will facilitate integration of engineers and managers new to the space field into space-related projects.

29–30 July 2013
The following standalone course is being held at the National Aerospace Institute in Hampton, Virginia.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**			
	Early Bird by 1 Jul	*Standard (2–22 Jul)*	*On-site (23–29 Jul)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

Phased Array Beamforming for Aeroacoustics (Instructor: Robert Dougherty)

This course presents physical, mathematical, and some practical aspects of acoustic testing with the present generation of arrays and processing methods. The students will understand the capabilities and limitations of the technique, along with practical details. They will learn to design and calibrate arrays and run beamforming software, including several algorithms and flow corrections. Advanced techniques in frequency-domain and time-domain beamforming will be presented. The important topics of electronics hardware and software for data acquisition and storage are outside the scope of the course, apart from a general discussion of requirements.

29–30 July 2013
The following standalone course is being held at the National Aerospace Institute in Hampton, Virginia.

Turbulence Modeling for CFD **(Instructor: David Wilcox)**
This course on turbulence modeling begins with a careful discussion of turbulence physics in the context of modeling. The exact equations governing the Reynolds stresses, and the ways in which these equations can be closed, is outlined. The course starts with the simplest turbulence models and charts a course leading to some of the most complex models that have been applied to a nontrivial turbulent flow problem. It stresses the need to achieve a balance amongst the physics of turbulence, mathematical tools required to solve turbulence-model equations, and common numerical problems attending use of such equations.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 1 Jul	*Standard (2–22 Jul)*	*On-site (23–29 Jul)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

23–24 September 2013
The following standalone course is being held at The AERO Institute in Palmdale, California.

Gossamer Systems: Analysis and Design
(Instructor: Chris Jenkins)
An evolving trend in spacecraft is to exploit very small (micro- and nano-sats) or very large (solar sails, antenna, etc.) configurations. In either case, success will depend greatly on ultra-lightweight technology, i.e., "gossamer systems technology." Areal densities of less than 1 kg/m2 (perhaps even down to 1 g/m2!) will need to be achieved.

This course will provide the engineer, project manager, and mission planner with the basic knowledge necessary to understand and successfully utilize this emerging technology. Definitions, terminology, basic mechanics and materials issues, testing, design guidelines, and mission applications will be discussed. A textbook and course notes will be provided.

To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

	Early Bird by 23 Aug	*Standard (24 Aug–15 Sep)*	*On-site (16–23 Sep)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

AIAA Associate Fellows Dinner

179 Institute members have recently been elected to the grade of Associate Fellow. These new Associate Fellows will be inducted during the Associate Fellows Dinner, which will be held at 1930 hrs, Monday, 7 January 2013, at the **Gaylord Texan Hotel and Convention Center,** Grapevine, Texas. Each year, the Institute recognizes exemplary professionals for their accomplishments in engineering or scientific work, outstanding merit and contributions to the art, science, or technology of aeronautics or astronautics.

Please support your colleagues, and join us for the induction of the 2013 Associate Fellows. Tickets to this celebrated event are available on a first-come, first-served basis and can be purchased for $97 via the 51st AIAA Aerospace Sciences Meeting registration form or on site based on availability. Business attire is requested.

AIAA
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Standard Information for all AIAA Conferences

This is general conference information, except as noted in the individual Event Preview information.

On-Site Check-In

Partnering with Expo Logic, we've streamlined the on-site registration check-in process! All advance registrants will receive an email with a registration barcode. To pick up your badge and conference materials, make sure to print the email that includes your ExpressPass Barcode, and bring it with you to the conference. Simply scan the ExpressPass barcode at one of the ExpressPass stations in the registration area to print your badge and receive your meeting materials.

Photo ID Needed at Registration

All registrants must provide a valid photo ID (driver's license or passport) when they check in. For student registration, valid student ID is also required.

Certificate of Attendance

Certificates of Attendance are available for attendees who request documentation at the conference itself. Please request your copy at the on-site registration desk. AIAA offers this service to better serve the needs of the professional community. Claims of hours or applicability toward professional education requirements are the responsibility of the participant.

Conference Proceedings

Proceedings for AIAA conferences will be available in online proceedings format. The cost is included in the registration fee where indicated. Attendees who register in advance for the online proceedings will be provided with access instructions. Those registering on site will be provided with instructions at that time.

Young Professional Guide for Gaining Management Support

Young professionals have the unique opportunity to meet and learn from some of the most important people in the business by attending conferences and participating in AIAA activities. A detailed online guide, published by the AIAA Young Professional Committee, is available to help you gain support and financial backing from your company. The guide explains the benefits of participation, offers recommendations and provides an example letter for seeking management support and funding, and shows you how to get the most out of your participation. The online guide can be found on the AIAA website, **http://www.aiaa.org/YPGuide**.

Journal Publication

Authors of appropriate papers are encouraged to submit them for possible publication in one of the Institute's archival journals: *AIAA Journal*; *Journal of Aircraft*; *Journal of Guidance, Control, and Dynamics*; *Journal of Propulsion and Power*; *Journal of Spacecraft and Rockets*; *Journal of Thermophysics and Heat Transfer*; or *Journal of Aerospace Computing, Information, and Communication*. You may now submit your paper online at **http://mc.manuscriptcentral.com/aiaa**.

Timing of Presentations

Each paper will be allotted 30 minutes (including introduction and question-and-answer period) except where noted.

Committee Meetings

Committee meeting schedule will be included in the final program and posted on the message board in the conference registration area.

Audiovisual

Each session room will be preset with the following: one LCD projector, one screen, and one microphone (if needed). A 1/2" VHS VCR and monitor, an overhead projector, and/or a 35-mm slide projector will only be provided if requested by presenters on their abstract submittal forms. AIAA does not provide computers or technicians to connect LCD projectors to the laptops. Should presenters wish to use the LCD projectors, it is their responsibility to bring or arrange for a computer on their own. Please note that AIAA does not provide security in the session rooms and recommends that items of value, including computers, not be left unattended. Any additional audiovisual requirements, or equipment not requested by the date provided in the Event Preview information, will be at cost to the presenter.

Employment Opportunities

AIAA is assisting members who are searching for employment by providing a bulletin board at the technical meetings. This bulletin board is solely for "open position" and "available for employment" postings. Employers are encouraged to have personnel who are attending an AIAA technical conference bring "open position" job postings. Individual unemployed members may post "available for employment" notices. AIAA reserves the right to remove inappropriate notices, and cannot assume responsibility for notices forwarded to AIAA Headquarters. AIAA members can post and browse resumes and job listings, and access other online employment resources, by visiting the AIAA Career Center at **http://careercenter.aiaa.org**.

Messages and Information

Messages will be recorded and posted on a bulletin board in the registration area. It is not possible to page attendees.

Membership

Nonmembers who pay the full nonmember registration fee will receive their first year's AIAA membership at no additional cost.

Nondiscriminatory Practices

The AIAA accepts registrations irrespective of race, creed, sex, color, physical handicap, and national or ethnic origin.

Restrictions

Videotaping or audio recording of sessions or exhibits as well as the unauthorized sale of AIAA-copyrighted material is prohibited.

International Traffic in Arms Regulations (ITAR)

AIAA speakers and attendees are reminded that some topics discussed in the conference could be controlled by the International Traffic in Arms Regulations (ITAR). U.S. Nationals (U.S. Citizens and Permanent Residents) are responsible for ensuring that technical data they present in open sessions to non-U.S. Nationals in attendance or in conference proceedings are not export restricted by the ITAR. U.S. Nationals are likewise responsible for ensuring that they do not discuss ITAR export-restricted information with non-U.S. Nationals in attendance.


VISIT US: 51st AIAA Aerospace Sciences Meeting, Dallas, TX, 07-10 January 2013, booth 204 www.aiaa.org
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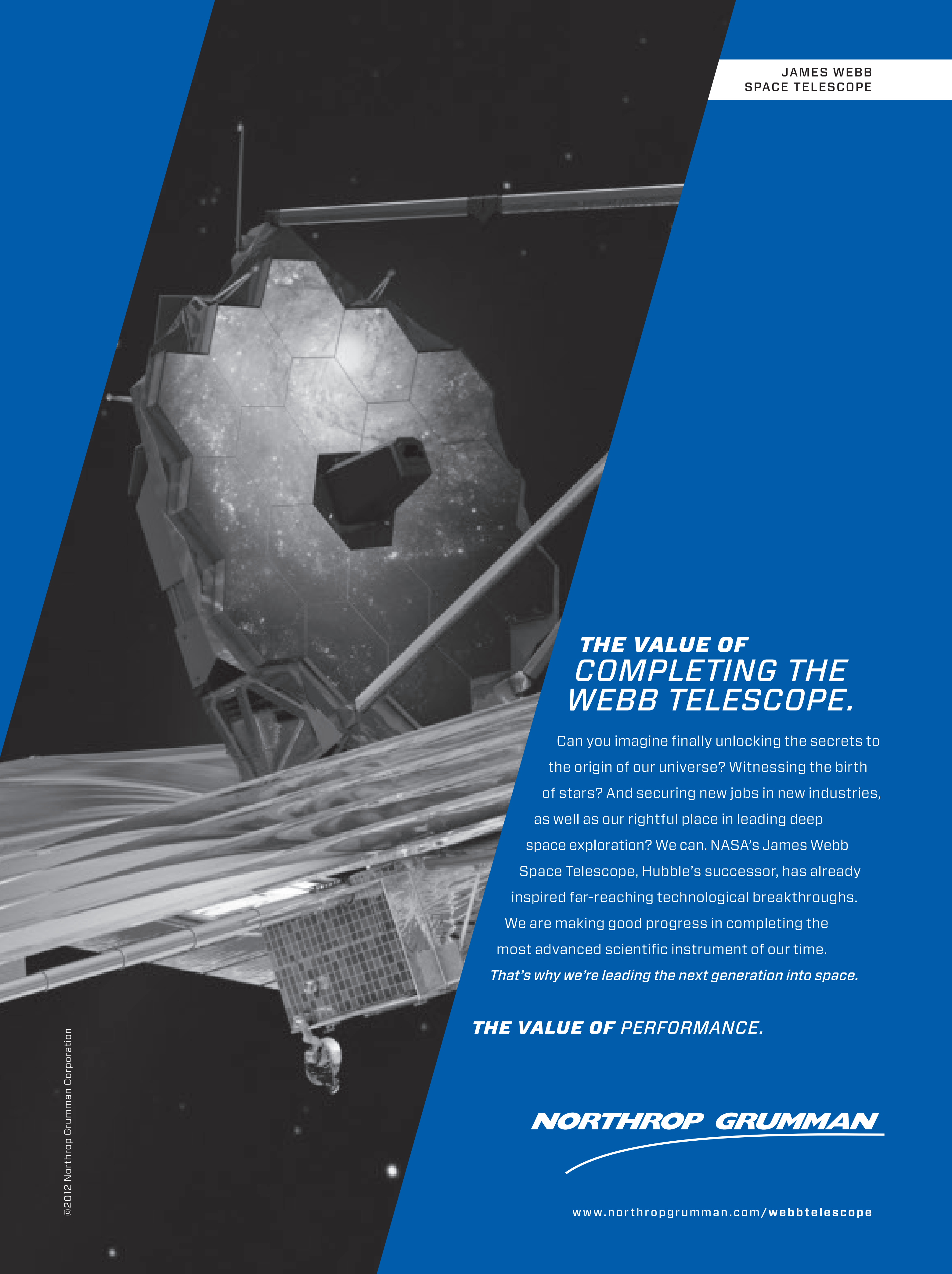
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Can you imagine finally unlocking the secrets to the origin of our universe? Witnessing the birth of stars? And securing new jobs in new industries, as well as our rightful place in leading deep space exploration? We can. NASA's James Webb Space Telescope, Hubble's successor, has already inspired far-reaching technological breakthroughs. We are making good progress in completing the most advanced scientific instrument of our time.
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