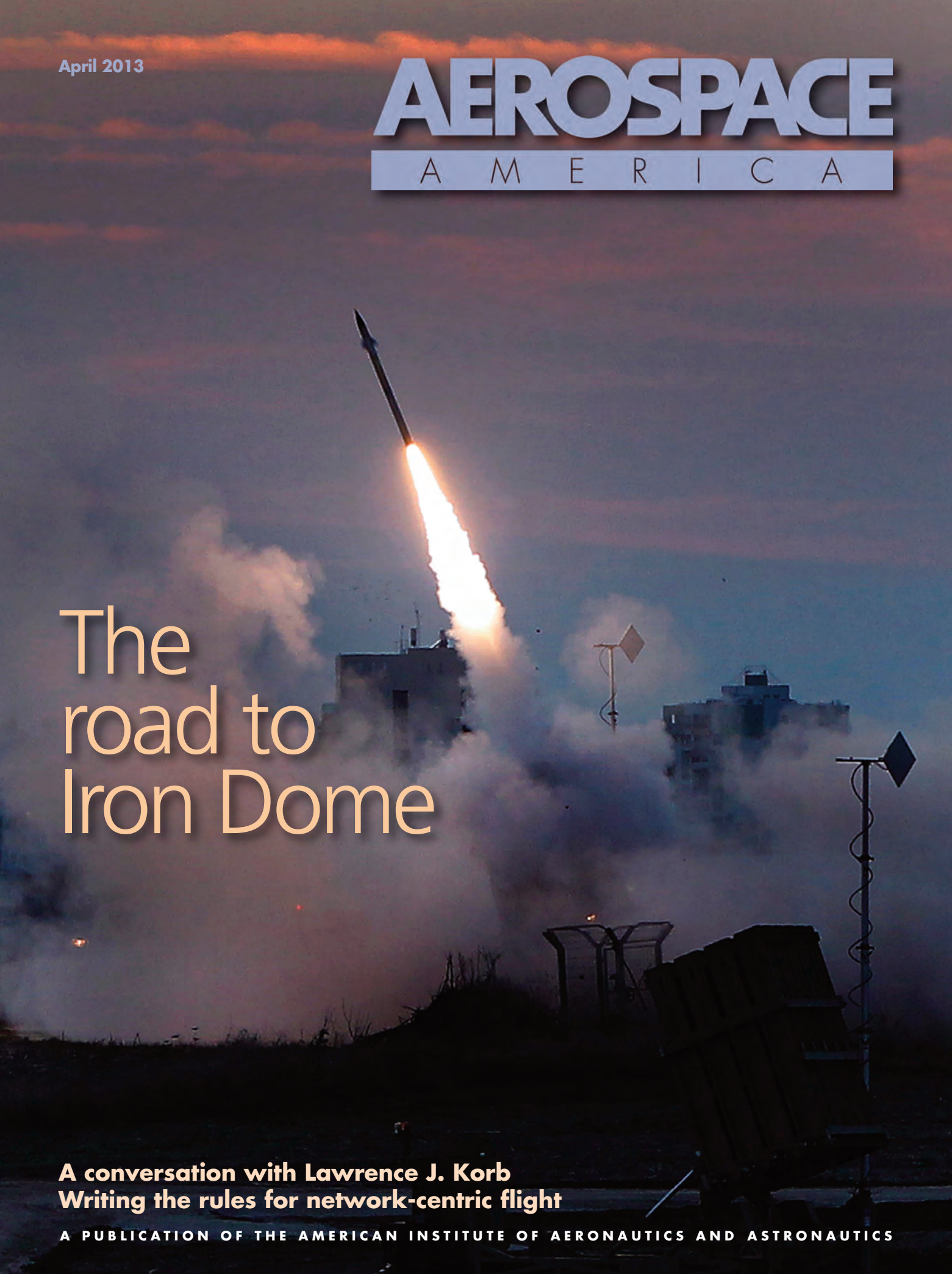
April 2013

AEROSPACE AMERICA



The road to Iron Dome

A conversation with Lawrence J. Korb
Writing the rules for network-centric flight

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

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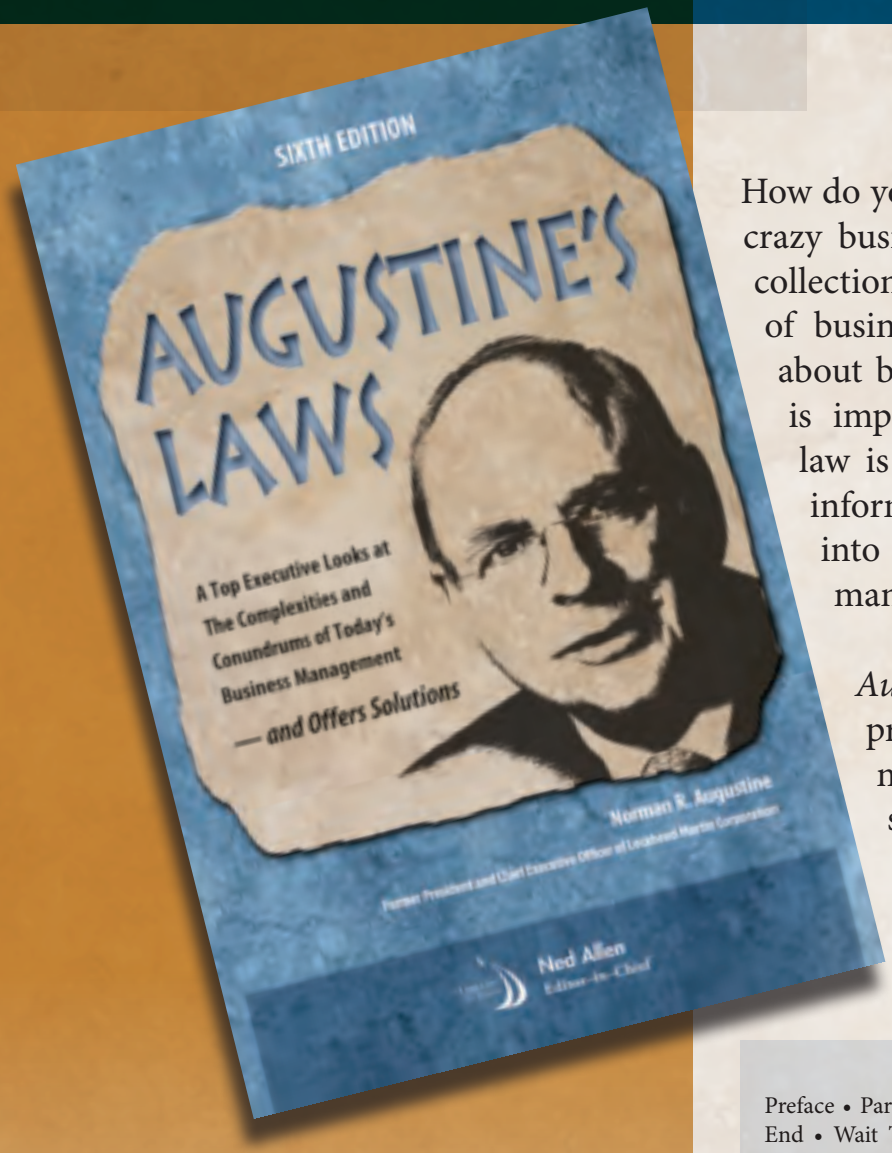

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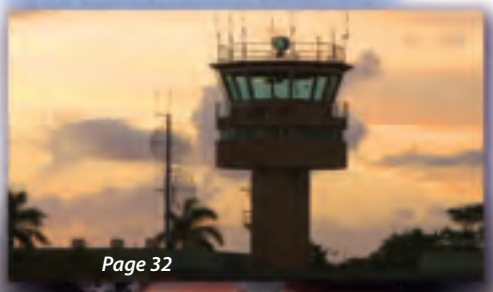
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The Iron Dome defense system fires to intercept incoming missiles from Gaza in the port town of Ashdod. For information on Israel's missile program, turn to page 26 . Photo by Tsafrir Abayov/Flash90/Redux.

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Commentary

Space beyond sequestration

Most of the recent attention given to the U.S. civil space program has focused on the effects of sequestration, which was to have mandated a 5% across-the-board cut in NASA's 2013 budget. One alternative budget allocation cited by the Baker Institute for Public Policy and others is the deletion of major but long-term human space exploration projects, most notably the Space Launch System and the Orion space exploration capsule.

However, House of Representatives bill HR 933, passed on March 4, called for almost exactly the *opposite*, namely an increase in the budget for these two programs (plus more funds for commercial crew projects) at the expense of Space Operations and Cross Agency Support accounts. The Senate bill also supported these programs. Whether or not this action plays out in conference and with the administration, there are events going on indicating continued support for civil space activities that had remained largely in the background because of the 800-lb sequestration gorilla.

Several imaginative non-NASA space exploration concepts, to be privately funded, have begun to draw media interest. The most daring of these is the proposal by the Inspiration Mars Foundation, created by the first space tourist, Dennis Tito, to fly a married couple past Mars in 2018 using existing transportation and spacecraft hardware, modified as necessary. Clearly this proposal, along with several earlier non-NASA space-exploration concepts, is riddled with major fiscal and technical issues, but it does serve as an indicator that NASA may not be the only game in town.

This aspect of civil space activities is strongly buttressed by the burgeoning growth of viable commercial space companies, most notably Richard Branson's Virgin Galactic, Robert Bigelow's Bigelow Aerospace (inflatable space stations), Elon Musk's SpaceX, and two companies planning to mine asteroids (Planetary Resources and Deep Space Industries), along with a plethora of other new entrants into space development. Again, although these 'newspace' companies face major issues, several have received some NASA funding, and they do indicate a potential change in direction for civil space.

There is also the renewed interest in near-Earth object (NEO) detection and counteraction, sparked by the large meteoroid impact in February over the Urals in Russia, which caused major damage and injured over 1,000 persons. That event appears to be stimulating significant expansion not only of NASA's now-substantial Near Earth Object Program Office, which has created (and funded) a new Asteroid Terrestrial-Impact Last Alert System (ATLAS), but also the revitalization of the privately funded B612 Foundation, which is trying to raise $450 million to build and deploy a space telescope (Sentinel) that could detect small NEOs that are otherwise not visible. Russia, too, has said it will complete a plan for a program to protect itself against threats from space by the end of this year. The Russian Academy of Sciences will develop a monitoring system; Roscosmos, the Russian space agency, will monitor space debris; and the Foreign Ministry will examine how to counter space threats.

All in all, whatever course is finally decided on to deal with the effects of sequestration, there is plenty of evidence that civil space remains viable and that there are exciting new developments in the offing.

Jerry Grey
Editor-at-Large

Europe spotlights wake turbulence research

In February EADS Innovation Works—the company's research center in Munich, Germany—released an update on the work it has undertaken to develop a LIDAR (light detection and ranging)-based detection system for remotely tracking 3D airflow ahead of an aircraft in flight.

According to the center's Nikolaus Schmitt, "What our LIDAR sees is at most a second ahead. That's long enough for a machine, but not for the human brain. But our measurement of the airflow at that distance in front of the aircraft is extremely accurate, so the aircraft really will be able to automatically react to a vertical or horizontal draft on the basis of our advance information."

LIDAR with no limit

EADS researchers are now working on a LIDAR sensor that radiates ultraviolet light pulses, typically at a rate of 60 per second, which are scattered by the nitrogen and oxygen molecules present even in aerosol-depleted air at high cruise altitudes. By contrast, the more conventional LIDAR only detects the backscatter from aerosols and other matter present mainly at lower altitudes. "We have tested the system up to 39,000 ft, and there appears to be no limit—as long as there is air, we can measure its flow," says Schmitt. "Our system can additionally pick up the backscatter of aerosols if it is there, but does not rely on it."

Four rays measure the motion vector of the air 50-200 m in front of the aircraft's nose. The single system under consideration could be used to detect clear air turbulence at cruise altitudes, along with wake vortex incidents and low-level wind-shear around airports.

LIDAR technology could also be used to measure key data such as speed, temperature, or air pressure and density during flight. Particles in the air, such as volcanic ash, could also be identified and their concentration determined. This could enable safe operation in low ash concentration areas in case of volcanic explosions. The accuracy of the measurement data will allow system designers to link the sensor to the flight control system, which will automatically adjust flight control surfaces to negate any turbulent influences.

EADS researchers are now working on miniaturizing the sensors and enabling them to be integrated in the flight control system, but it is likely to be around 10 years of design and development before the system enters operation. "We have flight proven that the principle works," says Schmitt. "But we have not yet looked at miniaturization, and we have not yet researched the direct connection to the flight control. These are the steps we have to undertake before any industrialization." The researchers are further examining how the light pulses must be aligned to yield a full picture of the position of a wake vortex.

EADS has undertaken this research work in cooperation with its Airbus subsidiary.

Growing urgency

Over the past few years the European Commission (EC) and industry have funded a wide range of research programs to improve the detection of turbulent air conditions in front of aircraft in flight (some of these programs have supported the work at EADS). This is becoming an increasingly important area of research in Europe. As European airspace becomes increasingly congested, designers will need to devise more and more capable aircraft self-protection systems to ensure that small and large aircraft can operate safely alongside each other. While EADS' LIDAR work has so far focused on turbulence detection at high altitudes, the system's potential for detecting turbulent occurrences closer to the ground could have important consequences for improving airport capacity at busy European hubs.

Congested hubs such as London/Heathrow need to examine new ways of separating aircraft on approach and takeoff, based on dynamic wind and traffic conditions rather than on theoretical minima. If controllers and pilots know the exact profile of a vortex from a particular aircraft in any prevailing weather condition, they can safely lower the separation distances between planes on a single runway, increasing airport capacity without having to lay down more concrete.

FAA initiative

Until recently, aircraft separation criteria were based on standards published in the 1970s and expressed in the minimum distances allowed between different classes of aircraft (heavy, medium, and light). But they tended to be very conservative, especially under strong headwind conditions, where the ground speed of the aircraft decreases. Despite Europe's efforts, it is the FAA that has led the way in recategorizing wake turbulence separation standards for different classes of aircraft. The agency's RECAT (recategorization) initiative, introduced in November 2012, increased the number of separation categories from five to six, based primarily on aircraft weight. The main change has been to split the previous 'heavy' category into three classes: A (super), B (upper heavy), and C (lower heavy), cutting down the separation distances required for lower heavy aircraft.

The new FAA standards were deployed on November 1, 2012, in collaboration with cargo carrier FedEx, a major operator of class-C aircraft, at its principal cargo hub in Memphis. Controllers can now separate FedEx MD-

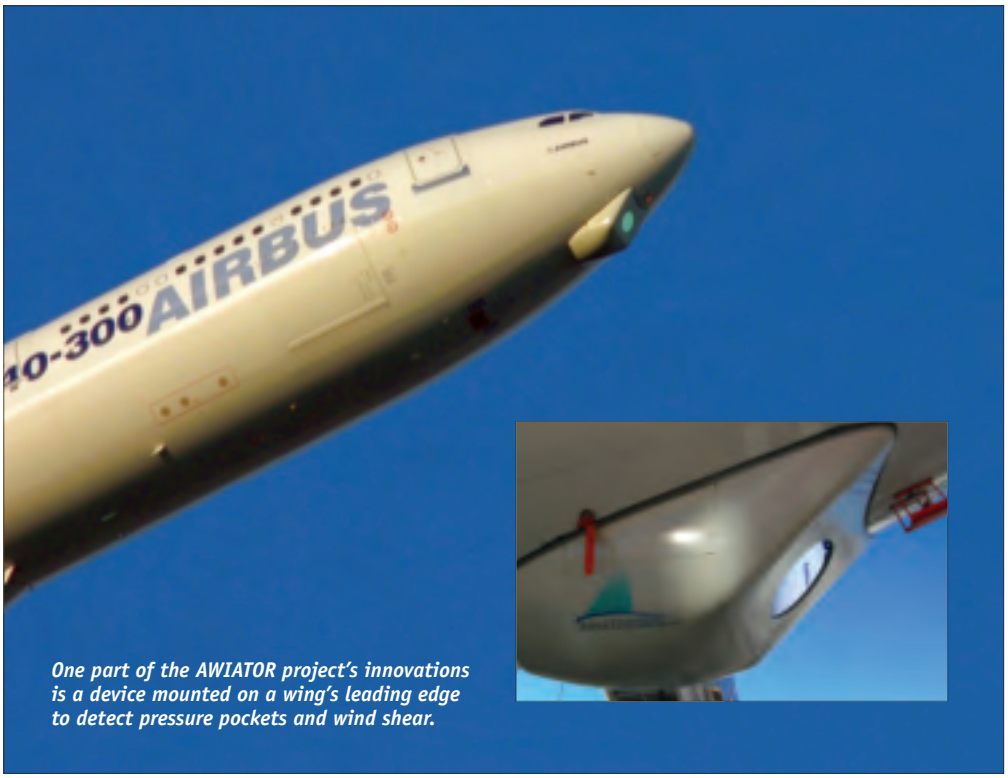
11, Boeing 767, and Airbus A300s by 2.5 n.mi. instead of the previous 4 n.mi., and this has produced a 15% increase in flight-handling capacity at the airport, according to FAA estimates made in early 2013.

The U.S. and Europe have collaborated on a global RECAT program within the International Civil Aviation Organization, to develop a global three-step strategy for replacing the previous rules with more dynamic separation standards. It has taken a decade of collaboration between the FAA, the DOT/Volpe National Transportation System Center, and Europe's EUROCONTROL to develop the plan.

But the U.S. has moved ahead of other countries in implementing the strategy, it has been reported, over concerns that the global initiative has become tied to Europe's push for developing less stringent separation requirements for the Airbus A380. That aircraft currently requires a separation distance of 8 n.mi. between itself and a following light aircraft.

The FAA plans to expand the new standards to other airports this year and in 2014, and it estimates an average capacity increase of 7%. Capacity increases at each airport will depend on the mix of aircraft categories operating there. Phase two of the FAA's program—which is based upon the global initiative—will see the introduction of "an overall pair-wise static wake separation matrix."

In other words, the six categories will be replaced by a standard within which each aircraft pair will have its own separation minima defined. Phase three will include real-time weather/wind information to permit dynamic pair-wise separation.



One part of the AWIATOR project's innovations is a device mounted on a wing's leading edge to detect pressure pockets and wind shear.

The case for reducing A380 separation distances will be made much stronger by the introduction of effective onboard and ground-based wake vortex detection systems.

Potentially fatal challenges

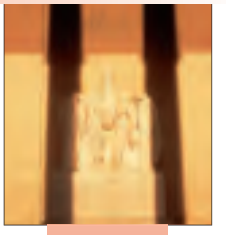
There are other important reasons for the research effort in this area in Europe. Clear-air turbulence is an enduring safety challenge for aircraft in cruise; it represents 40% of turbulence accidents and cannot be detected by any existing airborne equipment, including weather radar. According to the EC, the number of turbulence incidents has been growing annually by a factor of five since 1980, and some occurrences can result in fatalities: Mexican Interior Secretary Juan Camilo Mouriño and eight other passengers and crew were killed in the crash of a Learjet 45 in November 2008 when the plane was hit by vortices from a Boeing 767 above and a heavy helicopter below.

Low-level wind shear remains a hard-to-detect and potentially fatal safety hazard for aircraft on approach into and departure from airports. And even in benign meteorological conditions the vortices of larger aircraft can damage properties that sit just outside the airport's boundaries. But it is the potential to lower separation distances between aircraft on approach—especially the A380—which is particularly important for Europe.

Understanding how vortices are formed, how they behave in different weather conditions, and how they dissipate is a tough challenge.

"All aircraft generate vortices at the wing tips as a consequence of produc-

(Continued on page 19)



Yawning at doomsday

THE NATION PLUNGED OVER THE FISCAL cliff on March 1, and Americans yawned.

A poll by the Washington-based Ralston Institute indicated that only 35% of Americans know that the term 'sequester' refers to the $1.2 trillion in automatic long-term federal spending cuts (including $85 billion this year) that are now being inflicted across the board with little attention to policy or priorities.

A *Washington Post*-Pew poll put the figure at 25%, meaning that while sequester talk is dominating the nation's capital, three-fourths of us are not paying attention.

According to a Gallup Poll, 37% of Americans who recognized the term said they would tell their member of Congress to let the deep spending cuts go into effect; nearly one in five had no opinion.

Conceived as a way of forcing government to confront the nation's fiscal troubles, the sequester meant sacrifice and pain for up to 800,000 Americans who might face work furloughs or job layoffs. Some observers, however, said the administration was exaggerating the impact.

President Barack Obama found himself accused by some of displaying the 'Washington Monument syndrome,' or the 'firemen first tactic,' a term coined decades ago by Charles Peters, then editor of the *Washington Monthly*. The tactic entails responding to a funding crisis by idling the most needed and admired government employees, like firefighters, or by shutting down the most visible government service, such as a national park. The National Park Service allegedly has a long-standing practice of claiming that any funding cuts would lead to an immediate closure of the vastly popular Washington Monument.

A variation on this theme—or at least a very real reaction to the sequester—was the decision to keep the aircraft carrier USS Harry S. Truman and her carrier strike group at pierside in Norfolk, Virginia, rather than dispatching it to the Persian Gulf as scheduled. This decision reduced the U.S. carrier presence in waters near Iran and Israel from two to one and prompted some Republicans to say the administration was playing politics with U.S. national security.

This criticism overlooks the plain fact that the Navy's 10 carrier strike groups—the law requires 11, but the replacement for the retiring USS Enterprise is still years away—have been stretched to the limit.

Until recently, most naval experts said one carrier strike group in the region was sufficient. The USS Dwight D. Eisenhower was slated to routinely relieve the USS John C. Stennis on station in Middle East waters during March. Stennis and her battle group will be returning home after seven months at sea. The reduction to one carrier went mostly unnoticed outside Washington and places like Norfolk, where jobs are affected.

But some have a different view of the sequester. Their argument, which may be considered extreme by some but taken seriously by many, contends that the sequester is not draconian, does not signal disaster, and does not go far enough. The U.S. government now borrows about 35 cents of every dollar it spends; the sequester would reduce that by 2 cents. As syndicated columnist Charles Krauthammer noted in a *New York Daily News* article—titled "Bring on the mandatory cuts"—the sequester is just 0.5% of gross domestic product.

"It amounts to 1.4 cents on the dollar of nondefense spending, 2 cents overall," Krauthammer wrote. Arguing that it would have very little impact on the nation's deeper financial woes, he wrote that the entire sequester would have reduced last year's deficit from $1.33 trillion to only $1.24 trillion—"a fraction of a fraction." Even if the sequester remains in effect, the federal government will spend more in 2013 than it did in 2012.

One early reaction to the sequester was to leave the USS Harry S. Truman in Norfolk, Virginia, rather than dispatching it to the Persian Gulf.

Compounding the issue

Whether the sequester signals 'doomsday,' as former Defense Secretary Leon Panetta warned, or merely "a pittance that does not cut enough," as Sen. Rand Paul (R-Ky.) wrote in an opinion piece, it is not the only money problem confronting a divided government that now appears congenitally unable to enact a traditional budget. The continuing resolution (CR) under which government has been operating (in lieu of a traditional budget) was slated to expire on March 27. Legislation to raise the nation's debt ceiling is due on May 19, after being delayed by a temporary measure the president signed in February.

The sequester, the CR, and the debt ceiling are symptoms of persistent divisiveness in the nation's capital, which in turn reflects divisions across the land. Washington leaders on both sides of the aisle agree that government cannot keep "lurching from one financial crisis to the next," as Speaker of the House John Boehner (R-Ohio) put it—but that is exactly what many observers, both Democrat and Republican, expect will continue. Perhaps, in fact, it will persist as long as everyday Americans outside the Washington Beltway shrug it off as 'inside baseball.' Said one, interviewed for this column: "This doesn't affect those of us who don't receive money from the government and are just struggling to get by."

Hagel's new hat

Secretary of Defense Chuck Hagel took office on February 27 after a bruising Senate battle over his confirmation—reflecting again the divisions across the nation. The 58-41 Senate vote was the narrowest win ever for a nominee to become Pentagon boss.

Some of the opposition had little to do with Hagel himself, but reflected the view of some Republicans that the administration must share more information about the September 11, 2011, attack on the U.S. Consulate in Benghazi, Libya. Administration officials counter that they have acknowledged

Secretary of Defense Chuck Hagel

mistakes during the Benghazi event, which killed four Americans, including a U.S. ambassador, and that there is nothing more to reveal.

In his first meeting with reporters, Hagel, 66, avoided dire language about budget issues and said the Pentagon will manage them. "These are adjustments," Hagel said. "We anticipated these kinds of realities, and we will do what we need to do to ensure the capabilities of our forces." If the sequester continues, he said, the Navy will stand down four air wings, and unpaid furloughs for Pentagon civilian workers could begin after April 25. Most observers do not expect actions this drastic to take place, but there is general agreement that some sacrifice will be inflicted on military members and Dept. of Defense civilians.

Brennan and drone strikes

Even before Hagel rose from one hot seat in the Senate, John O. Brennan, the administration's nominee to be CIA director, was sitting down in another one. Brennan (whose appointment was later approved in the Senate by a vote of 63-34) appeared before a committee in the upper house on February 7 to face protesters and tough questions about the so-called 'targeted killing' of extremists by CIA drone aircraft.

Brennan, 57, testified before the Senate Intelligence Committee—the first time a high-ranking official spoke in public about the missile-firing robot aircraft that have been picking off alleged al-Qaeda and Taliban leaders.

The architect of the drone policy, Brennan became the nominee after the administration passed over CIA Acting Director Michael J. Morell. That occurred because Morell—although he did so with permission from the White House—had cooperated with Kathryn Bigelow and Mark Boal, the director-producer duo that created the motion picture *Zero Dark Thirty*. The movie recreates the May 1, 2011, mission by Navy SEALs into Pakistan to capture Osama bin Laden. When Morell worked with the filmmakers he was deputy director under then-CIA chief Leon Panetta. The White House feared Republican critics would put a 'hold' on Morell if his nomination were sent to the Senate.

Ironically, that is what Sen. John McCain (R-Ariz.) and Sen. Lindsey Graham (R-S.C.) said they might do with the Brennan appointment, not because of drone strikes but because of Benghazi.

As for senators' reaction to the CIA's campaign of aerial drone strikes, it was probably never likely to impede Brennan, but it did arouse comment and controversy. Details of a 'kill list,' administered by Brennan and approved by Obama on a weekly basis, remain secret. At least two individuals targeted for killing by drone-fired missiles were U.S. citizens, and some strikes have killed innocent civilians and friendly warlords. Separate drone strikes killed U.S.-born cleric Anwar al-Awlaki and, subsequently, his 16-year-old son in Yemen.

CIA Director John O. Brennan

The Super Tucano won the Air Force competition to provide light air support.

"I think this has gone about as far as it can go as a covert activity," Sen. Dianne Feinstein (D-Calif.) told Brennan of the drone campaign. Feinstein wants greater transparency and believes some kind of classified court arrangement must be established to determine who may lawfully come under attack in a drone strike.

A more critical view of the way the administration uses unmanned aircraft came from Paul, who complained about "having one person in the executive branch get together with some flashcards and decide [whom] they're going to kill around the world, particularly American citizens."

Some U.S. military experts share Feinstein's concern that the targeted killings may have gone too far. So long as drones are used against al-Qaeda and Taliban forces engaged in belligerency against U.S. troops in Afghanistan (even if the insurgents are inside the Pakistan border), the program is justifiable, some say. But now, the targeted strikes are taking place in Yemen, aimed at members of al-Qaeda in the Arabian Peninsula and mounted from covert bases in Saudi Arabia and the Horn of Africa. The CIA is reportedly constructing another covert drone base in the African nation of Niger—it is close to Mali, where French troops with U.S. help are combating a strong jihadist movement.

The USAF handles most drone operations within publicly acknowledged war zones—currently, Afghanistan—but CIA officers and civilian contractors who work for them carry out strikes against targets in Pakistan, Yemen, and Mali. The rise of a CIA paramilitary apparatus using unmanned aircraft operated by civilians is a recent phenomenon. It is not clear how their work fits with the internationally recognized Law of Armed Conflict.

Some argue that the drone strike program should be halted because it does not work: For every jihadist insurgent killed by an exploding Hellfire missile, they say, an innocent dies. Every strike that wipes out a terrorist may also inspire a hundred new recruits. The revelation of close U.S. cooperation with Saudi Arabia is especially damaging: The U.S. presence on the Arabian peninsula was the primary justification given by bin Laden for al Qaeda's September 11, 2001, attacks.

Brennan negotiated with officials in Riyadh for the building of the Saudi base, whose exact location still is not appearing in print: It was built in December 2009 and first used in the strike that killed al-Awlaki.

In contrast to the popular Morell and the more affable Panetta, even supporters view Brennan with little warmth. Nor does he have many fans among journalists, who see him as stilted and even deceptive in his rare public appearances. When he gave the first public description of the raid that killed bin Laden days after the event, almost every detail he provided was inaccurate.

David Brooks, in his February 8 *New York Times* column, made the case for drone kills, writing of Obama (and by extension of Brennan): "He's decided, correctly, that we are in a long war against al Qaeda; that drone strikes do effectively kill terrorists; that, in fact, they inflict fewer civilian deaths than bombing campaigns, boots on the ground or any practical alternative; that, in fact, civilian death rates are dropping sharply as the CIA gets better at this." The bottom line for Brooks: "Acting brutally abroad saves lives at home."

Military matters

Gen. John R. Allen, who was commander of U.S. and NATO forces in Afghanistan until February, will retire rather than remain the administration's nominee to become commander of U.S. and NATO forces in Europe. Allen is a congenial and widely respected Marine Corps leader viewed as less hard-nosed than Gen. James N. Mattis, whose retirement was announced last month. Allen enjoyed good rapport with the White House but was caught up peripherally in a scandal involving former CIA Director David Petraeus. Allen announced his retirement to take care of his seriously ill wife several weeks after an investigation absolved him of any wrongdoing in the Petraeus matter.

Controversy is rife within the military over the new Distinguished Warfare Medal for drone operators and cyber practitioners. The new award, announced February 13, has prompted a backlash from troops because of where it was placed in the hierarchy of military decoration—higher than the Bronze Star with 'V' device (for valor) and the Purple Heart, both of which are given troops for being in combat.

One of several petitions being gathered by veterans expressed the complaint this way: "Under no circumstance should a medal that is designed to honor a pilot [who] is controlling a drone via remote control, thousands of miles away from the theater of operation, rank above a medal that involves a soldier being in the line of fire on the ground. This is an injustice to those who have…risked their lives."

Control booths for military drones are located in Arizona, California, and Nevada. Each military drone typically has a crew of two, a pilot, and a sensor operator. Civilians, including the CIA personnel who conducted targeted killings with drones, are not eligible for the new award.

The F-35 Lightning II Joint Strike Fighter ran into its latest problem on February 19 when a routine engine in-

Gen. John R. Allen

spection revealed a half-inch crack on a low-pressure turbine blade of the plane's F135 turbofan engine. The Pentagon immediately grounded the 51 JSFs currently in inventory. This is the latest glitch in the Pentagon's plan to spend $400 billion to buy 2,456 JSFs by the late 2030s.

The powerplant problem may revive debate on Capitol Hill over whether the JSF should be offered to purchasers with the choice of an alternate engine: Having two types of engines available worked well with the F-16 Fighting Falcon program of the 1970s. Some in Washington say that the debate over an alternate engine is dead and that the JSF is simply too important to lawmakers' home districts to be allowed to fail. Sen. McCain, one of the plane's staunchest critics, took off his skeptic hat long enough to greet the first F-35 to arrive at a base in his home state weeks before the grounding. The fleet resumed flying under some restrictions on March 2.

The Air Force announced on February 27 that the A-29B Super Tucano turboprop aircraft won its light air support competition to provide 20 light attack warplanes to the Afghan air force. Prime contractor for the A-29B is Sierra Nevada, which is partnered with the aircraft's creator, Brazil's Embraer. Award of the $427-million contract is a setback for Beechcraft (formerly Hawker Beechcraft), which hoped the nod would go to its AT-6 Texan II.

Deliveries of A-29Bs from an assembly plant in Jacksonville, Florida, to Shindand and Kandahar air bases in Afghanistan are anticipated to begin next summer at a rate of two per month. The Afghans will use the A-29s in roles including advanced flight training, surveillance, close air support, and air interdiction. Other efforts to build an Afghan air capability have been stymied by local issues ranging from illiteracy to corruption, and some in Washington wonder whether the U.S. needs to build the Afghan air force at all.

Robert F. Dorr
robert.f.dorr@cox.net

Lawrence J. Korb

You've been part of or close to the national security scene for a long time. How do you see it now? What is the most pressing issue now?

The most critical thing we need to do is get our deficit under control and our economy growing again. If we don't do that, we can't have a strong national defense. We got into the situation we're in now by allowing the base defense budget to go up much more rapidly than it needed to go up after 9/11.

Why did that happen?

After 9/11, the country—the Congress, the media, a lot of think tanks—no one wanted to be seen as anti-defense. So we had what [former Defense Secretary] Bob Gates referred to as a gusher of defense spending. The defense establishment—the DOD, the armed services—no longer had to make tough decisions about what it wanted because it got everything it wanted. And the wars in Iraq and Afghanistan were funded separately, not as part of the defense budget.

We had separate, supplementary budgets for the Korean and Vietnam wars at their beginning, but once they were under way, we folded their costs into the regular defense budget, and we had to make tough decisions—make difficult tradeoffs—about paying the costs of the wars or the costs of other things, like dealing with the nuclear threat. After 9/11, we didn't have to make those tough tradeoffs.

So what happened?

The base defense budget went up and so did the separate war funding. In real terms, the defense budget doubled to levels, even accounting for inflation, that had not been seen since WW II, to levels higher than those during the Korean and Vietnam wars. As a result, when economic catastrophe hit our country in 2008, it was next to impossible for the government to put as much stimulus into the economy as was needed, because we had run up so much deficit and had no money to spare.

Much of that dilemma—not all of it—was due to what had happened with defense spending. At the beginning of the George W. Bush administration, we had a big budget surplus and we were talking about eliminating the entire federal debt in 10 years. But President Bush said we had to give the American people their money back, so he cut taxes, and then 9/11 happened, and he cut taxes again.

In that historical context, where do we stand now?

So now we're in a situation where we simply must deal with the federal deficit, and cutting the defense budget can help us do that, even if we don't cut the whole amount—$50 billion in FY13—that would have been involved in the across-the-board cuts of sequestration, which would get the level of defense spending back down to where it was, in real terms, in 2006-2007. That level would still be higher than it was on average during the Cold War, and we don't have the existential threat now that we did then.

We have threats, sure, but they're not existential threats like the Soviet Union posed for us. So we have to get the federal deficit under control, and

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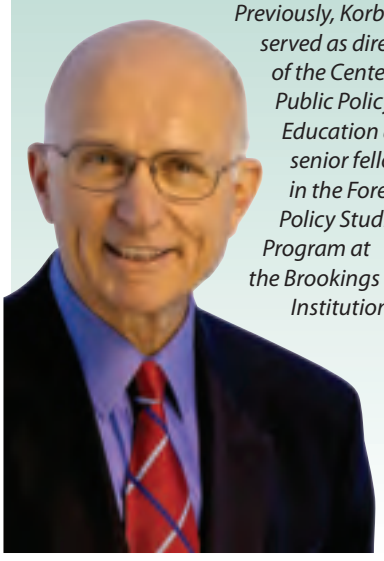

Previously, Korb served as director of the Center for Public Policy Education and senior fellow in the Foreign Policy Studies Program at the Brookings Institution; dean of the Graduate School of Public and International Affairs at the University of Pittsburgh; vice president of corporate operations at Raytheon; and director of defense studies at the American Enterprise Institute.

He served as assistant secretary of defense for manpower, reserve affairs, installations, and logistics from 1981 through 1985, administering about 70% of the defense budget. He was awarded the Department of Defense medal for Distinguished Public Service. He had served for four years on active duty as a naval flight officer, and retired from the Naval Reserve with the rank of captain.

Korb received his Ph.D. in political science from the State University of New York at Albany, and has held full-time teaching positions at the University of Dayton, the Coast Guard Academy, and the Naval War College. He has authored, coauthored, edited, or contributed to more than 20 books and has written more than 100 newspaper and magazine articles on national security. Over the past decade, he has made more than 2,000 appearances as a commentator on numerous television shows.

Interview by James W. Canan

cutting the defense budget has to be a big part of that; and if we do it smartly, long-term national security will improve. If we cut $50 billion, we'd be spending roughly $500 billion a year in the years ahead, and with no existential threat. We can't run the Pentagon, the armed forces, on $500 billion a year? Come on. The annual average of the defense budget for the whole Cold War was something like $450 billion.

What do you mean by cutting the budget smartly?

The first thing we should do is cut the number of nuclear weapons. We are at an inflection point right now. We have 5,000 nuclear weapons. The Air War College did a study that concluded we need 311 nuclear weapons all told. Others say we need 300 to 400. Cutting the number would give us substantial savings.

The trend is just the opposite, isn't it?

The Pentagon wants to modernize all three legs of the nuclear triad by producing new Ohio-class ballistic missile submarines to replace the Tridents, building a new strategic bomber, and upgrading land-based ballistic missiles. This is going to be very expensive.

"So we have to get the federal deficit under control, and cutting the defense budget has to be a big part of that; and if we do it smartly, long-term national security will improve."

The Navy plans to buy 12 new Ohio-class submarines at a cost of $7 billion to $8 billion each. Let's say the cost would actually be more like $10 billion. Instead of buying 12, let's buy eight. That's $40 billion of savings right there. And it would cost a lot less to operate eight submarines than it would to operate 12. Will the Air Force really need all the new strategic bombers that it wants? Do we need anywhere near the number of nuclear weapons that we have? Do we need as many carriers as the Navy would like? All of those areas should be examined for savings.

What else could the DOD do to save?

We should reduce the number of our ground forces. Under current plans, the Pentagon will downsize regular ground forces to 2005 levels. I think we can cut them even more, down to where they were in 2001 or even lower, because we have learned in Iraq and Afghanistan that our National Guard and Reserve forces are pretty darn good. They did very well in those wars.

Next on your list for cutting?

The next thing I would take a look at is something nobody wants to touch: military pay and benefits. When Tricare [military health care] was set up, the Pentagon would pay 75% of its costs and the troops would pay 25%. Right now, working-age military retirees are staying with Tricare and are paying only something like 8%. And a lot of working-age military retirees are staying with Tricare and not taking health care plans where they work in the civilian sector. Why would they?

Health care is an area that badly needs fixing. As [former Joint Chiefs of Staff Chair] Adm. [Mike] Mullen said, health care costs are eating us alive. [Current JCS Chair] Gen. [Martin] Dempsey has said he would be willing to pay more for his Tricare. Military personnel can get Tricare for life; that didn't happen until 2001. And the government pays all the costs—no copays and deductibles. Another point in connection with this: We had 2.3 million men and women in uniform during Iraq and Afghanistan. Only 300,000 of them are still in the service.

Could military health care reform ever get through Congress?

I think it can. And that's one of the reasons I was hoping Chuck Hagel would be confirmed as secretary of defense. I think he could get it through Congress. He's a down-to-earth, sensible guy. He has been in combat as an enlisted soldier, a sergeant. He has credibility.

You mentioned military pay, too, as needing reform.

I would like to reform the whole military pay system, but that isn't going to happen. But I do think we can bring the costs down gradually and deal with some of the working-age retirement benefits. People may say, oh my goodness, you want to cut payments to our wounded veterans. No I don't; those payments are covered by the Dept. of Veterans Affairs.

But we can trim other costs. Regular military compensation—housing allowances, food, all of it—averages $120,000 a year per person. People in general have no idea that the compensation is that high. They have the impression that all the troops' families are on food stamps. Not so. Now that we're basically out of Iraq and getting out of Afghanistan and cutting forces, and because we are now turning to drones and special forces and all that, I think we have an opportunity to address the need to cut military pay and allowances. Will it be easy? No, but I think Hagel can lead the way and get it done.

And by the way, we should consider deeper cuts of our forces in Europe. The Europeans have never had to worry about air and ground threats, because we've always been there in big numbers since WW II. That is changing, but maybe it should change

even more. We've been cutting back forces in Europe but we'll still have about 70,000 there. I'd cut it to 40,000.

Where else besides strategic forces—bombers and ballistic missile submarines—does procurement figure in your suggestions for cutting defense spending?

Lots of other things can be done in procurement. Take the Joint Strike Fighter—the F-35—for example. The Navy does not want it, it's too expensive. The Navy wants to stick with the F-18 Superhornet and let the Air Force and the Marines have the F-35 if they can work it out. So why not let the Navy do that.

The Pentagon is shifting its strategic emphasis to the Pacific region. How does that play into all this? Does it conflict with your outlook?

No. I think the strategy implies that the marginal dollars will go to the sea and air forces. But the fact is we have always had a big military presence in the Pacific region—Japan, Guam, and so on. The Navy is smart in homeporting its littoral combat ships [LCS] in Singapore. It could do some of that in the region with its carriers, too. It doesn't have to keep so many of its carriers forward-deployed. It already has a carrier in Japan.

President Obama wanted to keep the carrier force at 11 ships, The Joint Chiefs were saying 10. We can probably go to nine carriers and homeport some of them overseas and surge them wherever they're needed. It takes a long time to transit the Pacific from the continental U.S. If we have carriers always going there and coming back from there, each one would have only four months on station. But if we homeport some of them in that part of the world, they could be on station much more quickly and longer, ready to do battle.

What about spending money to meet other threats, like cyberwarfare?

Yes, cyber is a threat, but it will not cost us a lot of money to deal with.

Missile defense?

We should take a look at it. We'd soon find out how high missile defense rates among our priorities if we eliminated the Missile Defense Agency and gave its money to the services to spend as they see fit. I suspect they would downgrade its importance.

Every administration talks about saving big money by reforming and streamlining the defense acquisition process. Will it ever work?

I always get frustrated when the Pentagon says it will be more efficient in acquisition. There are some successes, but never really big savings.

Are we up against a big cultural roadblock here? Sequestration aside, would the American public and its representatives sit still for big long-term cuts in defense spending?

I think they are ready to listen to reason and act accordingly. Opinion polls indicate as much. Sequestration was a bad idea, a management monstrosity, a horrible process, indiscriminate cutting. But we can make selective cuts of about $500 billion over the next decade and come out at the same levels.

By the way, everybody says we've already cut $487 billion. No we haven't; we've cut $487 billion from our projected increases over that time. It's an important difference. When I say to you that you're making $50,000 and I was going to raise you to $100,000 but things are tough so I can only raise you to $80,000, is that a cut? The sequestration cut was pegged at 7% in real terms from where the budget is now. Do you know how much the defense budget was cut in real terms through the four years of President Reagan's second term? Ten percent.

"I always get frustrated when the Pentagon says it will be more efficient in acquisition. There are some successes, but never really big savings."

You said in the beginning that the country is at an inflection point. Talk a bit more about that.

We're evolving. We're adopting a different perspective, moving toward a new strategy. President Bush's strategy was preemptive war and nation-building to fight terrorism everywhere. But we're not at war with terrorism at large, we are at war with terrorist groups with a global reach—Al Qaeda and its associates—and with specific rogue nations. That's a big distinction.

We're not going to 'nation-build' any more to try to get rid of terrorism, using large ground forces. Special forces and drones will be our weapons of choice whenever and wherever they may be needed. In the Pacific, we'll build up a bit to send a signal to China. And by the way, I dislike the term "Air-Sea Battle" that we use to describe our military doctrine for the Pacific. The Chinese I've talked to see that as very provocative. We should take the "battle" out of it and call it "Air-Sea Operations" or something. This viewpoint is not original with me; a lot of people have it.

Back to the budget and procurement and all that. How can we learn from the past?

The best place to look when we're trying to figure out what to do is the Nixon era Pentagon under [Defense Secretary Melvin] Laird and [Deputy Defense Secretary David] Packard. I would argue that the Pentagon has not been run as well since they ran it. They came in with the intention of cutting the defense budget, and they went to what was called the 'high-low mix' of high-end and low-end weapon systems, like fighter aircraft, the F-15 and the F-16. The services resisted, saying they couldn't buy low-end weapons because they would expose our forces to danger. The F-16 was considered a 'low' weapon by the Air Force, and look at it now. In those

years, near the end of the Vietnam war and right after it, the Nixon doctrine came into play. It said no more land wars in Asia; the U.S. will not be the world's policeman.

Didn't it work pretty well for awhile?

Yes, and nuclear arms control cooperation with the Soviet Union was a big part of it.

Speaking of which, what about arms control in space? Is it coming?

We need to sign a treaty—the Chinese have been bugging us to sign it—that forbids the military use of space. It would outlaw offensive weapons in space. That's the way to go for us in order to protect our advantage in communications and everything else related to our space systems. Space systems are vital to our economy and to all global economies, which are interconnected. Under the treaty, no nation could put anything in space that could shoot. Why not agree to that?

"Under the treaty, no nation could put anything in space that could shoot. Why not agree to that?"

How do you see all this coming out in the end? Are you optimistic? Are we working our way out of problems, maybe even growing up a bit about things?

I think we are, because we're over 9/11, we're past the Patriot Act. I think we overreacted to 9/11. We saw it as a reason to change regimes and rebuild nations and solve all the world's problems.

I think by the end of 2013 our country, our political leaders, will be working out a long-term budget deal that will involve more cuts in defense. I don't think we'll see $500 billion in cuts over the next decade, more like $100 billion. We'll probably see means testing for Medicare benefits and chained Consumer Price Index payments into Social Security. And we'll take some of the savings and start fixing up our roads, our infrastructure.

Over in Europe, I was asked not long ago what's the biggest danger to the United States, and I said: "our bridges." I think we can get ourselves back on a sustainable track of defense spending that will keep us safe in the world and help us at home. And I hope that the people who are running our country are up to the challenge.

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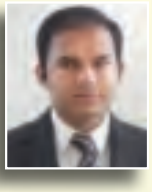

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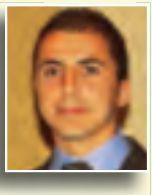

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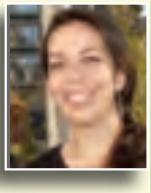
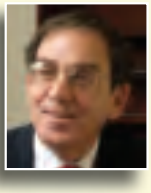


Rachel Ellman
Massachusetts Institute of Technology
Cambridge, Massachusetts



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Thank You Nominators!

AIAA extends a sincere thank you to the individuals who devoted their time and effort to preparing and submitting the nomination packages.

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High-end trainers: Growth through T-X?

JANUARY SAW TWO NOTABLE STEPS IN the T-X program, an Air Force effort aimed at replacing the service's aging fleet of Northrop T-38 advanced jet trainers. First, the service held an industry day at Wright Patterson AFB in Ohio, signifying its intent to begin studying aircraft options. Then, Italy's Alenia Aermacchi announced that it would team with General Dynamics C4 Systems to offer its M-346 jet (designated T-100 for T-X). This removed the remaining uncertainty about industrial teaming arrangements for the T-X competition.


M-346

T-X is a key program, not just because it is the only undecided U.S. military fixed-wing aircraft competition currently planned. It is also the only thing that could rejuvenate and grow the world jet trainer market, which has been stagnant for decades.

Slow market, many players

Historically, high-end jet trainers have been one of the smallest jet markets. Deliveries over the past 20 years have averaged just $1 billion a year (in 2013 money). There also are no signs at all of any growth. If anything, there are traces of shrinkage, with the early 1990s seeing market peaks of $2.2 billion in deliveries, although numbers are at times inflated by large procurement batches for individual countries and services.

However, the T-X program calls for 350-500 such aircraft, which would boost this market considerably. In fact, in the past 10 years (2003-2012), just 403 high-end jet trainers were delivered worldwide. Assuming T-X procurement lasts over 10 years, the program should lead to a doubling of the market for that period.

The entire world fleet of high-end trainers comes to 2,467 aircraft. This implies that, even allowing for a certain degree of shrinkage, and assuming an average lifetime of 35 years, annual deliveries should be closer to 60 aircraft rather than the recent 40.

The number of players in this market is surprisingly high. No fewer than 10 aircraft have had some kind of market share in the past 10 years. In the past 40 years only three models—BAE Systems' Hawk, Alenia's MB.326, and Dassault/Dornier's Alphajet—have seen more than 250 sales over their lifespans. However, BAE's Hawk has dominated the market for the past few decades (it enjoyed a 35% market share by value in 2003-2012 deliveries, with another 19% going to Boeing's T-45, a carrier adaptation of the Hawk).

The recent Alenia/General Dynamics agreement was particularly important, because the M-346 is the latest successful new entrant in the high-end trainer market. Not only Italy but also two very prestigious export customers, Singapore and Israel, have purchased the aircraft. There is also the promise of a sale to the UAE, since it selected the type several years ago without placing a firm contract.

The General Dynamics agreement was also important because Northrop Grumman, which had been proposed as a likely partner for Alenia, had instead helped create the first T-X team. In September 2011, BAE Systems and Northrop Grumman announced a partnership to offer BAE's Hawk (with L-3 Link Simulation & Training to provide the ground-based training system). Meanwhile, negotiations between Alenia and Boeing on a teaming arrangement went nowhere. In short, Alenia was in danger of being caught without


T-38

a U.S. prime as a partner—historically a risky strategy for non-U.S. defense companies bidding for U.S. contracts.

The third team, which is already formed, includes Lockheed Martin and Korea Aerospace Industries (KAI) and covers the T-50, the only supersonic model on offer. The two companies have been collaborating on this design for almost 20 years. While South Korea has ordered the T-50 as well as light attack and fighter derivatives of the basic model, the only firm export customer is Indonesia. The T-50 is probably the most expensive T-X option, in terms of both acquisition and operating costs. But if the USAF decides to replace the T-38 with another supersonic model, the T-50 would be the natural choice.


Hawk

Of these three entrants, the Hawk would appear to have only an outside chance. While the latest version has an updated cockpit with state-of-the-art avionics, the airframe is considerably older than the T-50 and M-346, and many of the systems, particularly the engine, are also from an older generation. On the other hand, if the Air Force wants a subsonic design and if the M-346 price tag is too high, the Hawk might benefit. Also, Boeing's T-45, a navalized Hawk, has been in Navy service for decades, which is an endorsement. If T-X ultimately is extended to provide a navalized version as a T-45 replacement, selecting the Hawk would make this an easy proposition.

Finally, one mystery is Boeing's decision to offer a new, clean-sheet


Alpha Jet

design for T-X. While the company could unquestionably design a plane that is well optimized for T-X requirements, it is not clear where the money would come from to create this design. The Air Force has made it clear that it will not pay for a solution that is not off-the-shelf. While Boeing itself could fund the aircraft's development, spending $500 million-$800 million to get a shot at a four-way competition would seem to be a bigger risk than most airframe companies are willing to take these days.

Facing tough realities

The problem with T-X, of course, is that the U.S. defense budget is trending downward right now, and may enter a sustained down cycle. This kind of budget environment has historically been bad news on new program starts, resulting in lengthy delays and sometimes outright death.

Air Force leadership has conspicuously prioritized just three aircraft programs in the coming years, singling out Lockheed Martin's F-35A JSF, a next-generation bomber, and Boeing's KC-46A aerial refueling tanker for protection against funding cuts. That puts the T-X in the second tier, along with other less pressing priorities such as a new combat rescue helicopter or ongoing C-130J transport procurement.

There are also short-term budget pressures. The T-X program was not funded in the FY12 budget. Since the entire U.S. government is now funded by a continuing resolution that maintains 2012 levels, the T-X will stay unfunded for as long as this resolution remains in place. In any event, funding does not ramp up in a meaningful way until FY15.

Yet it is also quite clear that the Air Force cannot function much beyond 2025 without a T-38 replacement. The T-38 cockpit, systems, engines, and wings have seen significant upgrade or replacement programs, but the average age of the T-38 fleet is now over 45 years, and there have been several fatal crashes in recent years. Even with today's limited funding, the service is still planning on 2020 as T-X IOC (initial operational capability).

While the service is mTaking better use of simulators, neither of its two new premier fighters, the F-22 and F-35, is available in a two-seat model for training purposes. This means that modern advanced jet trainers are essential for the two-seat fighter part of the current trainer syllabus.

Even where two-seat fighters are available, there has been some downward movement of trainer hours from these fighters to more capable and lower cost trainers. South Korea says it can shift about 50% of F-16D syllabus hours to the T-50, and is planning to do so. Britain's RAF is shifting two-seat Eurofighter training hours down to the Hawk 128. As for the USAF, it currently does data-link management training, night vision imaging system training, and high-*g* dogfight training

in two-seat fighters; all of these could be moved to T-X.

Combat version….Really?

In addition to a possible naval derivative of T-X, there has also been discussion of a combat version, for light attack and/or fighter missions. There is a noteworthy precedent here. The T-38 engendered the creation of one of the world's most successful light fighters, the F-5. While not operated as a combat plane by U.S. forces, the F-5 was sold to many allies internationally.

Today, however, the marketplace has changed. Fighters and trainers are different markets, and for the most part require different products. Very few countries use the same platform for these two different roles. The USAF and Navy have not done so in decades.

Meanwhile, economic growth and changing strategic imperatives mean that most of the light fighter market has moved upward. For example, major F-5 customers include Taiwan, Turkey, Greece, Netherlands, Saudi Arabia, South Vietnam, Spain, South Korea, Canada, Switzerland, and Brazil. Of these, only South Korea is replacing its F-5s with an equivalent light fighter (combat versions of the T-50, including the A-50 and FA-50). All the others have moved upward in the market, to medium fighters in the F-16 class and above.

As a result, light fighter sales have dwindled to a negligible part of the world fighter market over the past 20 years. Any combat versions of the T-X would be sold to the last few remaining light fighter markets, such as the Philippines, which recently selected KAI's T-50 for acquisition.

Meanwhile, combat capability is not a key performance parameter in the T-X program, and the Air Force has shown no interest in this role for the plane. Nor has any other part of the Defense Dept., or any other U.S. agency, shown interest in creating a light fighter for foreign sales. The light combat market is not big enough to be on the industrial base agenda, and the idea of coordinating service trainer needs with foreign military sales for marginal markets is a stretch.

Assuming a combat version of T-X does not materialize, then the high-end trainer market in 10 years will look very much the way it has for the past few decades, only with about 36-48 T-X deliveries bolted on top. That means a market value of approximately $1 billion a year on average for non-USAF markets, plus T-X.

This limited market basically implies that a shakeout is coming. The three T-X contenders are likely to find that the market is actually sized for two (assuming Boeing's clean-sheet proposal does not win, and excluding converted jet fighters, and Russian and Chinese jet trainers). That means the future belongs to whoever wins T-X, with one runner-up hanging on, and the third player exiting the market.

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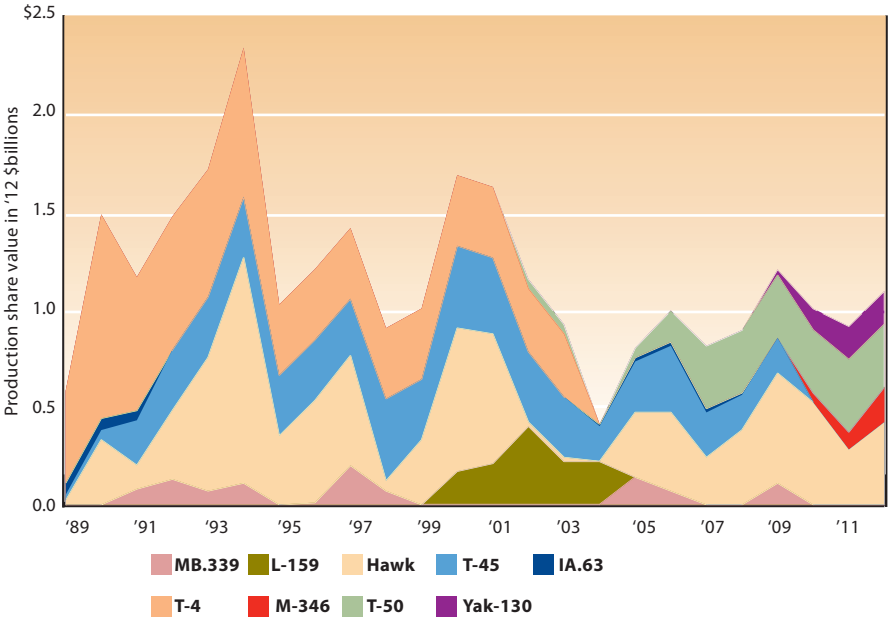
HIGH-END TRAINER PRODUCTION SHARES



T-50

(Continued from page 5)

Research initiatives

Most of Europe's wake vortex research work is captured and shared in the WakeNet3-Europe research area, which brings together all the EC-funded wake vortex programs under a single umbrella. LIDAR is a key enabling technology for many of these. Recent significant research projects include:

AWIATOR

The research program has aimed to integrate advanced technologies into novel fixed-wing configurations, to create lighter but stronger wings and to reduce wake vortex hazards as much as possible . The first part of the research was to better predict what a vortex will do in a given situation, by manipulating it to remove or weaken its punch. The work entailed forcing the vortex to decay more rapidly or diffusing its energy over a bigger radius. This could allow aircraft to fly in closer proximity.

The program's other main goal is to reduce the weight of an aircraft's wings by making them respond more organically to surrounding wind conditions. This requires combining innovative software with some sophisticated new wing-mounted technologies. One of the project's innovations is a 'gust sensor,' a device mounted on a wing's leading edge to detect pressure pockets and wind shear. The gust sensor transmits information instantly to the wings' conventional flaps and several new trailing-edge control devices, just a few centimeters wide, that act like 'miniflaps' to change the aerodynamics of the trailing edge and counter the effects of gusts.

GreenWake

The objective of GreenWake is to develop and validate innovative technologies that will detect hazards promptly to improve passenger safety and comfort, and improve the operating efficiency of airports by providing a safe means of decreasing separation times between trailing aircraft. GreenWake will develop and test an Imaging Doppler LIDAR system that can detect and measure wake vortexes and wind-shear phenomena 50-100 m in front of an aircraft, allowing action to be taken to reduce or avoid the hazard. The project seeks to develop a system suitable for integration into a commercial aircraft, but also to look at how data are to be presented to the aircrew.

DANIELA

The DANIELA (demonstration of anemometry Instrument based on laser) project was designed to prepare the operational use of a flush-mounted air data system around a three-axis Doppler LIDAR function as a primary air data channel on civil aircraft. It also aims to assess optical concepts for the measurement of temperature and density to complete the air data system.

DELICAT

The demonstration of lidar-based clear air turbulence, or DELICAT, research project seeks to validate the concept of LIDAR-based medium- and long-range turbulence detection—but not measurement—to give flight crews time to warn passengers of upcoming turbulence.

ing lift," according to a 'safety sense' communication published by the U.K.'s Civil Aviation Authority in January. "The heavier the aircraft and the slower it is flying, the stronger the vortex. Among other factors, the size of the vortex is proportional to the span of the aircraft which generates it, for instance a Boeing 747, with a span of 65 meters, trails a vortex from both wingtips each with a diameter of around 65 meters. At low altitudes, vortices generally persist for as long as 80 seconds, but in very light or calm wind conditions they can last for up to two and a half minutes. Once formed, vortices continue to descend until they decay (or reach the ground). Decay is usually sudden and occurs more quickly in windy conditions. Crosswinds can carry a vortex away from the flight path of the aircraft. For each nautical mile behind an aircraft, the vortex the aircraft generates will typically have descended between 100 and 200 ft."

But sometimes a vortex can move up rather than down, and no one is exactly sure why.

Aircraft design can also play a major part in the generation of peculiar vortex incidents; the Boeing 757 creates particularly strong vortices.

One important new research program taking place within the SESAR (Single European Sky ATM Research) domain to identify and manage vortices at the airports is the Wake Vortex Decision Support System Architecture program. In mid-May 2011, X-band radar sensors and a ground-based LIDAR system were installed at Paris/Charles de Gaulle to track vortex occurrences and ultimately give controllers advice on minimum separation distances between individual aircraft on approach. These devices take into account the real-time weather conditions as well as the aircraft sensitivity to wake vortex events.

The European airports that stand to gain most from this research are the congested hubs with a relatively high percentage of heavy aircraft movements. At London/Heathrow, for example, heavy or wide-body aircraft account for over 30% of the traffic mix. When the wind is in the 'wrong' direction, these aircraft can also rip tiles off roofs above houses lying next to the airport. A study on the potential damage caused by aircraft vortices at London City airport, in the heart of the city, showed that damage rates throughout the U.K. as a result of aircraft vortices ranged from 2.30 strikes/1,000 arrivals at Heathrow to 0.04 to Belfast City, with the size of the aircraft a major factor.

If the work under way in Europe matures as planned, turbulence detection and measurement systems will be integrated into new aircraft within the next 10 years.

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The 2013 Aerospace Spotlight Awards

Please join AIAA in recognizing the following honorees whose outstanding contributions merit the highest accolades! The awards will be presented on 8 May 2013 during the AIAA Aerospace Spotlight Awards Gala.

AIAA Goddard Astronautics Award

William F. Ballhaus Jr.
President and CEO (Retired)
The Aerospace Corporation
El Segundo, California

"For significant leadership in the advancement of the nation's launch and space programs."

AIAA Reed Aeronautics Award

Paul G. Kaminski
Chairman and Chief Executive Officer, Technovation, Inc.
Former Under Secretary of Defense (Acquisition and Technology)

"For outstanding vision and leadership in the development of advanced aeronautical systems to enhance our national security."

AIAA International Cooperation Award

Scott Pace
Director, Space Policy Institute
Elliott School of International Affairs
The George Washington University
Washington, D.C.

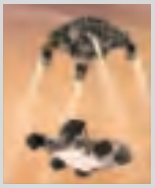
"For outstanding and sustained analysis and assessments to civil, commercial, and national space security policy, and space projects and programs entailing international space cooperation and competition."

AIAA Distinguished Service Award

Aubry T. (Tom) Smith
President
ATS Solutions, Inc.
Locust Grove, Virginia

"For over three decades of exemplary service and leadership to AIAA including fourteen years on the Board of Directors as Director of two Directorates and as Vice President for Finance."

AIAA Foundation Award for Excellence



NASA Mars Science Laboratory/Curiosity Team
NASA Jet Propulsion Laboratory
Pasadena, California

"For significant accomplishment in space exploration, inspiring global fascination with space."

AIAA Public Service Award

Neil deGrasse Tyson
Astrophysicist and Frederick P. Rose Director, Hayden Planetarium
Rose Center for Earth and Space
American Museum of Natural History
New York, New York

"For exceptional contributions promoting the public consciousness of aerospace's societal benefits and dynamic advocacy for aerospace education and research, space exploration, and U.S. aerospace preeminence."

National Capital Section Barry Goldwater Educator Award

John Grunsfeld
Administrator for the Science Mission Directorate
NASA Headquarters
Washington, D.C.

"For outstanding leadership, teaching and communicating space science topics to students and the public through interviews, lectures, teaching, and numerous television appearances with innovative approaches."

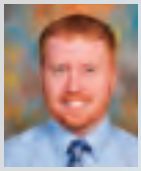
AIAA Foundation Educator Achievement Awards

Lanena Berry
Houston Independent School District, Houston, Texas

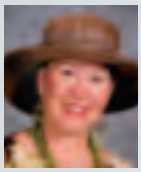
Elizabeth Dabrowski
Magnificat High School, Cleveland, Ohio

Lisa Damian-Marvin
Camden Hills Regional High School, Rockport, Maine

Joan Labay-Marquez
Curington Elementary School, Boerne, Texas



Sean McCullough
Anderson Districts I & II Career and Technology Center, Anderson, S.C.



Deborah Swan
Windsor Hills Math, Science, Aerospace Magnet School, Los Angeles, Calif.

James Weber
Timberland High School, Wentzville, Mo.

2013 AIAA Fellows and Honorary Fellows

Recognition of the newly elected Fellows and Honorary Fellows of AIAA will also take place at the AIAA Aerospace Spotlight Awards Gala.

Honorary Fellow, the highest distinction conferred by AIAA, is granted to preeminent individuals who have had long and highly contributory careers in aerospace, and who embody the highest possible standards in aeronautics and astronautics. The 2013 AIAA Honorary Fellows are:

Allen E. Fuhs
Naval Postgraduate School

William H. Gerstenmaier
NASA Headquarters

David Ian Poll
Cranfield University

David W. Thompson
Orbital Sciences Corporation

The honor of Fellow is conferred by AIAA upon those members of the Institute who have made notable and valuable contributions to the arts, sciences or technology of aeronautics and astronautics. The 2013 AIAA Fellows are:

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Lockheed Martin Aeronautics Company

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Emergent Space Technologies

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Iowa State University

Hsiao-Hua K. Burke
MIT Lincoln Laboratory

Wesley G. Bush
Northrop Grumman Corporation

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Pratt & Whitney Rocketdyne

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Victoria L. Coverstone
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Raisbeck Engineering, Inc.

Rami R. Razouk
The Aerospace Corporation

Gwynne E. Shotwell
SpaceX

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Frank L. Van Rensselaer
VanRSpace

Aspi R. Wadia
GE Aviation

Steven H. Walker
Defense Advanced Research Projects Agency

Kevin A. Wise
Boeing Defense, Space & Security

For more information on the Aerospace Spotlight Award recipients, Honorary Fellows, or Fellows, please contact Carol Stewart at 703.264.7623 or carols@aiaa.org.

To purchase tables or individual seats at the AIAA Aerospace Spotlight Awards Gala, please contact Merrie Scott at 703.264.7530 or merries@aiaa.org.

AIAA
The World's Forum for Aerospace Leadership

Fighter radars finally going AESA

JUST AS THIS COLUMN WENT TO PRESS sequestration kicked in, which means some major programs will see reduced funding. However, delays in F-35 JSF 'production' over the past several years have probably already helped more than hindered active electronically scanned array (AESA) radar development for fighter aircraft. In the past year, the USAF was finally forced to fund major upgrades to existing F-15 and F-16 aircraft, which will remain the backbone of the Air Force for decades, with or without JSF.

AESA antennas comprise a matrix of individual active transmit/receive modules—mini-radars—that can be configured electronically to scan multiple targets and switch between them almost instantaneously. By contrast, mechanically scanned array antennas must physically rotate to change field of regard, and can typically track targets with only a single beam. AESAs also are expected to have reduced failure rates and maintenance requirements compared to complex mechanical antennas, and to provide 'graceful degradation' in the event of damage or partial system failure.

The AN/APG-81 AESA will provide near-simultaneous air-to-ground and air-to-air radar modes for the Joint Strike Fighter.

The U.S. fighter radar market will grow substantially with increasing JSF production in the second half of our forecast, but for the next few years the Air Force F-15 and Navy F/A-18E/F will be worth equal or larger shares of the market. The F-22 Raptor radar—the first major production fighter AESA—will soldier on for decades. But low-cost AESA antenna upgrades for hundreds or even thousands of U.S. and international F-16s are likely to be worth a relatively small sliver of the overall market, as technological maturity and competition between Northrop Grumman and Raytheon keep total values down.

JSF delays and legacy upgrades

Designed from the start for air-to-ground missions, and given its lesser power, the JSF will carry an integrated AESA radar and sensor system. These will have shorter range but greater capabilities than Northrop Grumman/Raytheon's F-22 AN/APG-77 (though the first Increment 3.1 F-22 was deployed in early 2012, adding an air-to-ground synthetic aperture radar, or SAR, mode).

Northrop Grumman's MIRFS (multifunction integrated RF system) is the integrated avionics system in development for JSF since 1996, with the company's AN/APG-81 AESA multifunction nose array the most important and expensive sensor. It will provide near-simultaneous air-to-ground and air-to-air radar modes, as well as high-gain electronic support measures and electronic attack jamming functions. The X-band APG-81 will also interact with other frequency band antennas in apertures around the stealthy JSF.

In January 2009, Lockheed Martin completed the first JSF with a complete mission system. In June 2009, Northrop Grumman began APG-81 test flights aboard its CATBird test aircraft. In mid-2011, the APG-81 and Northrop's AN/AAQ-37 electrooptical distributed aperture system (EODAS) aboard CATBird participated in Northern Edge 2011 exercises. In early 2012, the APG-81 and EODAS detected, tracked, and targeted multiple rocket launches during NASA's ATREX (anomalous transport rocket experiment) event at Wallops Island, Virginia. Reportedly, the APG-81 continuously tracked missiles most of the time, with EODAS repeatedly losing and reacquiring the simulated ballistic missiles. The APG-81 has still not been effectively tested aboard a JSF aircraft.

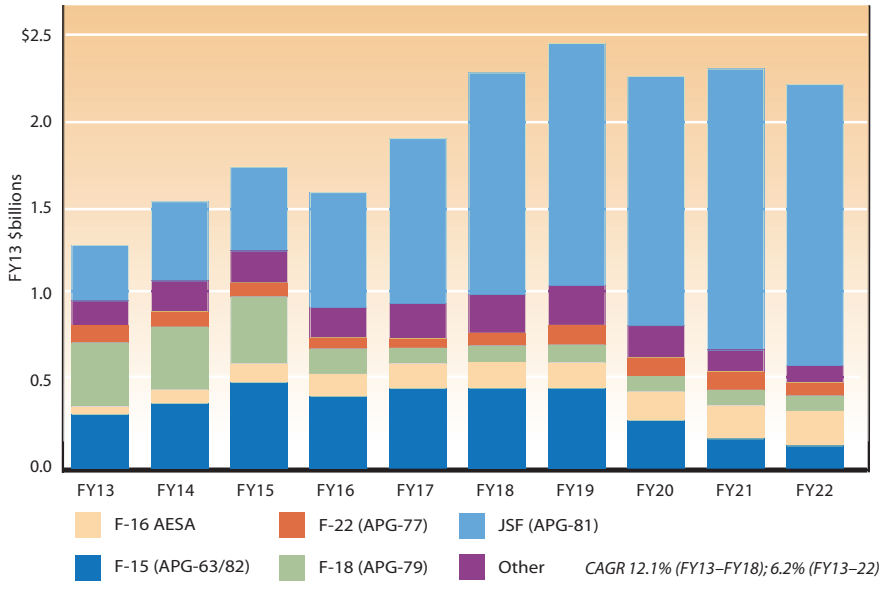
F-35

A major reason for JSF delays—especially in integrating diverse systems aboard the actual aircraft—is the massive amount of new software code needed for the plane's truly integrated avionics/sensors/electronics systems. In April 2012, Mark Maybury, chief scientist of the Air Force, claimed that 90% of JSF functionality will be cyber-based, compared with 70% for the F-22, 60% for the B-2, and 20% for the F-15.

Even getting sensor data off board raises new complexities. Harris's low-observable MADL (multifunction advanced data link) was designed specifically for the JSF, and will limit data transference to other JSFs within a formation or designated MADL-equipped command and control elements. This will create a new form of 'stovepiping' just as international militaries are seeking fully networked C4ISR.

FIGHTER RADAR MARKET FORECAST

RDT&E+Procurement available to the U.S.



JSF's stealthy role could backfire in operational terms, if it proves inefficient for 'non-near-peer' conflicts. So far, only Israel has been approved to install its own radio, data link, and electronic warfare systems. Radars and most systems for most users will remain unique JSF systems with little international variability. Once production is under way, expect Northrop Grumman to profit mightily from the APG-81.

But JSF travails continued this year, with the possibility of major program delays or reductions. Software development continues to fall behind even restructured schedules; less than 10% of limited combat capability software (Block 2B) was available for integration and testing by late 2012, according to a report by the DOD's director of operational test and evaluation (DOT&E). Block 2B is the first software with any weapons capability. Block 3F (full combat capability) is to enter 33 months of flight testing in early 2014, but has made "virtually no progress," according to the DOT&E.

With these delays, the Air Force might have no significant JSF combat capability until next decade. Until then, JSF could remain a very expensive 700-kt scout plane (with little ability to get sensor data off-board, although Link-16 was tested in 2012), and the Air Force is finally funding billions of dollars of AESA radar upgrades for its functional fighters.

In September 2012, USAF planners discussed how many existing aircraft the Air Force expects to keep in service through 2030, as JSF procurement rates remained uncertain. Up to 249 F-15C/Ds could be retained, with at least 175 to be kept until 2035, and possibly all 249. The 220-aircraft F-15E fleet will fly through 2030. And all will likely now get new AESA radars.

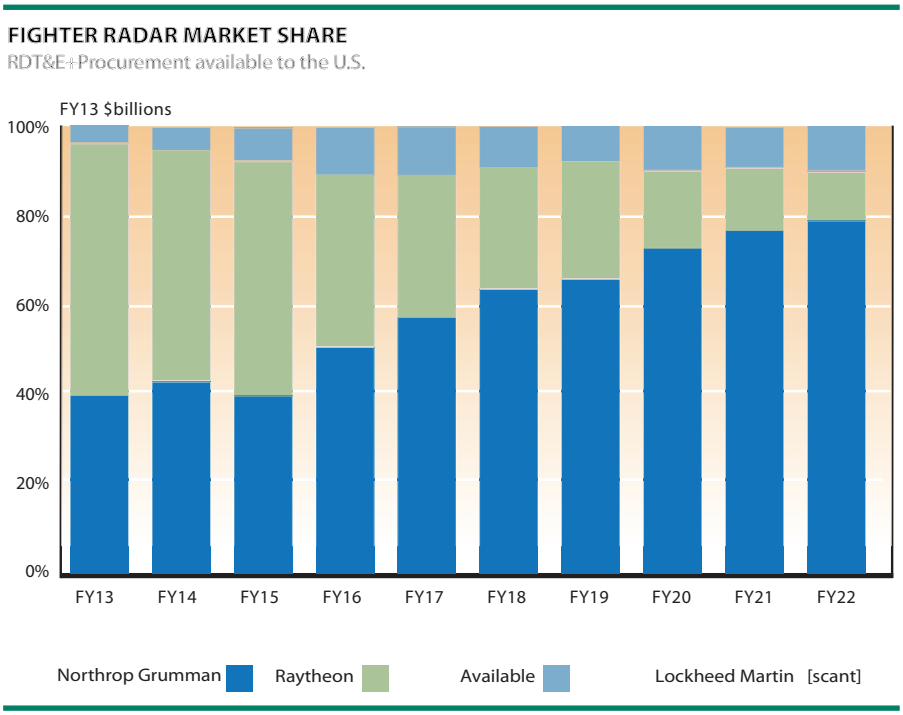
In September 2011, the Air Force granted the F-15E Radar Modernization Program approval to begin low-rate initial production (LRIP) of Raytheon's AESA AN/APG-82(V)1 radar system. As of late 2012, APG-82 operational testing was set to begin in March, with the first production installations slated for early FY14. F-15C/Ds are already getting Raytheon AESA AN/APG-63(V)3 upgrades.

The international F-15 AESA market has also become remarkably robust, following Singapore's pioneering purchase of the APG-63(V)3 for its F-15SGs. In March 2012, the Air Force awarded $11.4 billion to Boeing for 84 new F-15SA fighter aircraft, systems, and munitions for Saudi Arabia. An additional $18 billion will go to upgrading 70 older Saudi F-15S aircraft, as well as support services.

All these various APG-63/82 upgrades should be worth more than $4 billion in our forecast period, making F-15 radars one of the world's largest radar programs over the next 10 years.

The service waited longer before contracting F-16 AESA upgrades. This is perhaps because Northrop Grumman's AN/APG-68 is a newer system than F-15 radars, with the latest (V)9

Northrop Grumman is offering the SABR (top) for the F-16 upgrade, while Raytheon is proposing the RACR.



versions still in production for foreign military sales (including an $88-million contract in June 2012 for 43 radars for Thailand, Oman, and Iraq), and a total of more than 2,500 APG-68s delivered worldwide. But in June the Air Force finally approved an acquisition strategy to "mitigate [JSF] fielding delays" with their F-16 CAPES (combat avionics programmed extension suite) program, the heart of which will be a new AESA radar.

Plans call for a five-year, $330-million CAPES development program; $1.64 billion will be allotted for an initial USAF procurement of 300 F-16s, with installations from 2018 through 2022. The service does not yet plan to upgrade their 700 other in-service F-16s, but we suspect a large portion will get CAPES, and foreign military sales are also highly likely. In an effort to speed development, the Air Force has named Lockheed Martin the sole qualified source for this upgrade, but the radar has not yet been chosen.

Immediately following the USAF's CAPES decision, in July 2012, South Korea and Taiwan both agreed to major F-16 upgrade deals of their own. These will be managed by the Air Force, with the U.S. allowed to choose their AESA radar. Korea plans to upgrade about 134 KF-16C/Ds. Taiwan will upgrade about 146 Block 20 F-16A/Bs, with its first upgraded aircraft to be delivered in 2021. In August 2012, Seoul surprisingly chose BAE Systems to conduct its upgrade (for an initial $1.1 billion) instead of Lockheed Martin (with an initial $1.85 billion from Taiwan). That opened the possibility of a split F-16 AESA market and of reinjecting some much-needed competition for future international programs.

SABR and RACR

A winner for this first (and probably biggest) round of USAF/South Korea/Taiwan F-16 AESA buys will reportedly be chosen this year or in 2014. It will be either Northrop Grumman's SABR (scalable agile beam radar) or Raytheon's RACR (Raytheon advanced combat radar).

RACR is derived from the APG-79 AESA antenna on the Super Hornet. SABR is based on Northrop Grumman's AN/APG-80 on UAE Block 60 F-16s (in early 2012, the company claimed its APG-80 as the first production AESA in combat, operationally deployed aboard UAE F-16s in the Libya campaign). Although Northrop's mechanically scanned APG-68 radar is still in production for new F-16s, Raytheon so far seems at only a small disadvantage in offering its own antenna, as it is currently producing many more AESA systems than Northrop, with APG-63/79/82 production ongoing.

The F-16 AESA upgrade market could be huge, with production possibly in the thousands. But it is too early to forecast with confidence—will there be continuing competitions, or will Northrop or Raytheon dominate? Will an initial USAF/South Korea/Taiwan buy knock one or the other out of future competitions? AESA upgrades for USAF F-15s have so far been extremely expensive, with $8 million or more funded for each upgrade—considerably more than a complete new-build radar a few years ago. If SABR and RACR genuinely provide 'drop-in' flight-line retrofit antennas, and if Selex, Elta, and others also offer viable alternatives, can these upgrades cost more than the $2 million we have estimated (when the Selex Vixen 500E AESA radar costs only $3 million for the entire system)?

If not, then the total funding for APG-68 AESA upgrades will really not be great, certainly not as much as a major program like the APG-77 or APG-81, and profit margins will be low. Guaranteed noncompetitive radar programs such as the F-35 JSF will continue to earn much more money.

For the first round of USAF/South Korea/Taiwan F-16 AESA buys, some reports indicate Northrop Grumman's SABR may be the Air Force's preferred choice, apparently because of lower expected costs compared to RACR. We provide a speculative forecast, without picking a winner.

Super Hornet and Raytheon

Raytheon's APG-79 AESA radar was developed for the Navy F/A-18E/F, for new builds and as a retrofit replacement for the AN/APG-73. It provides increased detection and tracking ranges (vs. the mechanically scanned APG-73), multitarget tracking, a SAR mode, and preplanned product improvements. The latter includes a jamming

function to supplement the Super Hornet's IDECM (integrated defense electronic countermeasures) suite.

The first LRIP radar was delivered for flight testing in January 2005, with full-rate production approved in July 2007. The Navy's current plans have the APG-79 equipping more than 500 Super Hornets, including EA-18G Growler electronic attack aircraft, but this number could easily rise. In early 2011, Boeing and the Navy marked delivery of the 500th Super Hornet to the service's tactical aircraft fleet. In March 2011, Raytheon delivered the 250th APG-79 to Boeing. In February 2012, Raytheon reported that its manufacturing facility in Forest, Mississippi, was producing up to six radars a month, and is capable of doubling that rate. Total APG-79 program costs could reach or exceed $6 billion.

In February 2012, reports indicated Raytheon had been in discussions with Singapore about AESA radar upgrades for its air force's F-16C/Ds. Raytheon supplied APG-63(V)3 AESA radars for Singapore's F-15SG.

Northrop/Raytheon duopoly

Preceding the APG-79 was Raytheon's AN/APG-63(V)2 AESA, produced in limited numbers for USAF F-15Cs and arguably the first fighter AESA radar (Japan's F-2 J/APG-1 also claims that honor). With major production programs today for the F-15C/D, F-15E, and Super Hornet, Raytheon has been the market leader since last decade, at least in terms of numbers. But with JSF alone, Northrop Grumman will soon surpass Raytheon in funding value, ramping up to a potentially dominant position by the end of this decade.

Even if Raytheon wins the bulk of future F-16 AESA upgrades, we do not see how this situation could change. Available funding could grow somewhat if F-16 costs are greater than anticipated, but Northrop will likely win at least half of future F-16 funding, if only because it has built all 2,500+ of the APG-68s to be upgraded.

The APG-79 AESA was developed for the Navy F/A-18E/F.

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The road to Iron Dome

When Israel's Iron Dome successfully shot down hundreds of short-range artillery rockets launched from the Gaza Strip in November 2012, the system suddenly became the newest darling of the defense acquisition world.

Israeli technical expertise and U.S. financial backing had combined to produce a mobile network of interceptors, sensors, and command centers credited with saving lives on both sides of the conflict.

"No nation should have to live in fear of these kinds of attacks," Defense Secretary Leon Panetta declared at the Pentagon in late November during a joint press conference with Israeli Defense Minister Ehud Barak. "And that's why I'm very proud that our two countries cooperated so closely to field the Iron Dome anti-rocket system. Iron Dome performed—I think it's fair to say—remarkably well during the recent escalation. It intercepted more than 400 rockets bound for Israeli population centers, or a roughly 85% success rate overall."

Barak echoed that sentiment, saying, "Iron Dome really changed the landscape of the conflict and enabled us to act forcefully within a short timeframe, trying to

by Marc Selinger
Contributing writer

This Iron Dome launch in Tel Aviv was directed at an incoming rocket on November 17. Credit: Oded Ballilty.

Israel's antirocket system has performed impressively in meeting the major technical challenge of 'hitting a bullet with a bullet.' With financial support from the U.S., Israeli technical expertise has brought forth a capability that is already saving lives. Although just one element of a multi-layered system that has evolved over many years, Iron Dome has been effective enough to have significant potential for sales to other countries.

hit the target that should be hit, but minimize the damage to civilians on the other side, while our population…is continuously shelled by rockets and missiles from the Gaza Strip."

Iron Dome did not become a reality overnight, however. It came about only after years—some would say decades—of work to overcome the proverbial technological challenge of hitting a bullet with a bullet. And experts caution that the system is just one part of a multilayered capability that Israel must keep improving to stay ahead of the many threats it faces.

"There's a danger of Iron Dome becoming like the superhero," says defense and media consultant Randy Jennings of P-51 Consulting. "It's just one component of a large system."

Arrow

Although the 2006 Lebanon war helped jump-start Iron Dome's development, the seeds of its success were sown decades earlier. Some experts trace its roots all the

way back to the 1950s, when the U.S. began developing defenses to counter Soviet ballistic missiles. Although those early efforts were short lived, missile defense received a renewed boost in 1983, when President Ronald Reagan proposed the Strategic Defense Initiative (SDI), an elaborate system to defend against a full-scale Soviet nuclear attack.

In 1986, three years after SDI was unveiled, the U.S. and Israel agreed to jointly fund the Arrow weapon system to protect Israel against ballistic missiles with ranges of 125-600 mi. The program completed its first successful intercept test in 1994 and achieved initial operational capability in 2000.

Israel Aerospace Industries (IAI) leads Arrow's industry team, which also includes Boeing. The system currently consists of Arrow 2 interceptors and launchers, Green Pine and Super Green Pine radars, the Hazelnut Tree Launcher Control Center, and the Citron Tree Battle Management Center. The two-stage interceptor carries a 'blast fragmentation' warhead that destroys a target by exploding near it.

"It only has a few batteries, and Israel has decided not to publish how many are operational and where they are deployed," says Gabriel Scheinmann, visiting fellow at the Jewish Institute for National Security Affairs. "Press reports suggest there are two or three, mostly in the north and in the central regions of Israel."

Since 2001, the U.S. and Israel have been working to enhance Arrow through the Arrow System Improvement Program (ASIP). The U.S. has contributed almost $400 million to the system over the past five years.

Pentagon budget documents say ASIP "enhances capabilities against more stressing evolving regional threats by increasing the total defended area by approximately 50%." Israel recently deployed a Block 4 upgrade to better identify targets and is now enhancing Block 5 to increase the system's range. Block 5 will include a long-range detection suite consisting of the new unmanned airborne early warning system and the new Silver Oak radar.

Arrow has been touted as the world's first operational national missile defense system. But it was not intended for the kinds of short-range rockets fired by Hezbollah during the 2006 Lebanon war. After 55 Israelis died from rocket fire during that conflict, the Israel Ministry of Defense got behind Iron Dome, explained Scheinmann, who, along with Jennings, spoke in December 2012 at a U.S.-Israeli missile defense cooperation seminar at the Heritage Foundation in Washington, D.C.

Dome development

Israel's Rafael Advanced Defense Systems was chosen in 2007 over Lockheed Martin to lead Iron Dome's development. The program achieved its first intercept in a 2009 test and deployed its first battery in 2011. Although Israel developed and tested the system on its own, the U.S. Missile Defense Agency provided Israel with a total of $275 million to buy Iron Dome interceptors and other system components in 2011 and 2012.

Iron Dome batteries can be moved around the country on trucks and trailers, allowing Israel to adjust to changes in the multifront threat. The multimission radar, made by IAI subsidiary ELTA Systems, detects and tracks targets and determines their point of origin and destination. The system's Tamir hit-to-kill interceptors cost an estimated $30,000-$50,000 each and can counter rockets with a range of 2.5-45 mi. To conserve interceptors, the system is selective in what it shoot downs, meaning it intentionally lets through rockets it projects would not do any damage.

During the November 2012 Gaza conflict, Hamas fired a total of 1,500 rockets in an attempt to overwhelm Israel's defenses. But Iron Dome shot down 421 of the roughly 500 it deemed to be threats, and it

The Arrow 2 interceptor is deployed in Israel to defend against ballistic missiles. Credit: U.S. Missile Defense Agency.

Iron Dome fires the second of three missiles from the same battery to intercept Grad missiles fired from the Gaza Strip, as it defends an Israeli population center in the south of the country, on November 15, 2012. Credit: EPA/Jim Hollander.

allowed the other 1,000 rockets to land harmlessly in nonpopulated areas. Only six Israelis died, and the first three people killed did not follow instructions to take cover because they thought the rockets were out of range, Jennings says.

Scheinmann says Iron Dome intercepted not only rudimentary Qasam rockets, or 'pipes with wings,' but also bigger and longer range targets, such as the Soviet-developed Grad, the Iranian-developed Fajr-5, and Hamas's new M-75.

"Iron Dome has been nothing short of impressive," Scheinmann explains. "Sirens sounded in Tel Aviv and Jerusalem indicating incoming missiles, making more than half the Israeli populace subject to rocket fire. So, very simply, if it weren't for Iron Dome's ability to knock out some of the longer range missiles headed for Tel Aviv, the damage and number of casualties would have been much higher."

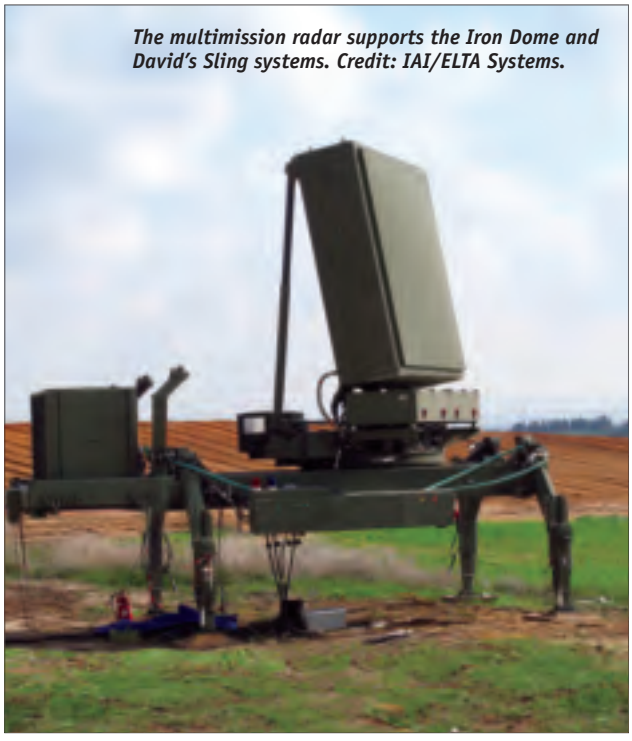
Iron Dome's success is credited with helping Israel avert the need to use ground forces to dismantle Hamas's rocket forces.

"Had the missile attacks on Tel Aviv or Jerusalem or even elsewhere caused casualties, you can bet that there would have been a ground invasion," Scheinmann says. "Fewer deaths mean that the government's hand isn't forced in the same way."

At press time, Israel had deployed five Iron Dome batteries and was planning to bring a sixth online early this year. A total of 13 batteries are envisioned to cover the entire country. And Israel continues to improve the system's performance and maintainability. "The needs are much larger than what we have right now, and we are determined to complete the system," Barak says.

Experts point out that Iron Dome did not go it alone in the Gaza conflict. As part of Operation Pillar of Defense, Israeli jets pounded rocket launching, manufacturing, and storage sites. The country also has built extensive fortifications that include a civilian warning system and hardened bomb shelters.

Nonetheless, Iron Dome was effective enough that it is seen as having significant



The multimission radar supports the Iron Dome and David's Sling systems. Credit: IAI/ELTA Systems.

David's Sling system includes a new, more capable interceptor.

potential for sales to other countries. India and South Korea have been mentioned as possible buyers, and Rafael and Raytheon have announced a partnership to market the system in the U.S.

David's Sling

To counter the longer range rockets and cruise missiles it could face in the future, Israel is currently pursuing the David's Sling system, which includes a new, more capable interceptor.

"Different heights and ranges of the trajectory force you to do other additional things, force you to do a new interceptor missile," says Israel Oznovitch, ELTA's business development and marketing manager for air surveillance and counter-rocket, artillery, and mortar. Cost also dictates that Iron Dome's interceptor be less expensive because "you're talking about thousands of targets for the Iron Dome and up to dozens of targets for David's Sling," he says.

The new Arrow 3 interceptor is launched in a 'hot ejection' test. Credit: IAI.

In 2006, Israel picked Rafael and Ray0theon to develop and build David's Sling. The system, also known as Magic Wand, uses the two-stage, hit-to-kill Stunner interceptor, which has a range of 45-125 mi. and can be redirected in midflight to adjust to changes in a target's trajectory. The Stunner can intercept a target over enemy territory, which will be especially important for rockets tipped with biological or chemical weapons. David's Sling also includes the missile firing unit, multimission radar, and Golden Almond Battle Management Center.

In November 2012 in southern Israel, the system had its first successful intercept, shooting down a Sparrow missile launched from an F-15. It will likely have another intercept test before becoming operational sometime this year or in early 2014, Scheinmann says. Israel hopes to deploy 10-12 batteries, each with 16 interceptors.

David's Sling, like Arrow and Iron Dome, enjoys not only strong support from Israeli and U.S. defense officials but also bipartisan backing on Capitol Hill. The U.S. has contributed almost $400 million over the past five years to help develop David's Sling, which the U.S. Missile Defense Agency and the Israel Missile Defense Organization jointly manage. Funding for such programs is expected to remain robust despite increasingly tight defense budgets in the U.S.

"As witnessed by the recent attacks on Israel from Gaza, the continued joint efforts of the U.S. and Israel in missile defense systems is critical to protecting this close U.S. ally and American interests in the region," Sens. Kirsten Gillibrand (D-N.Y.) and James Inhofe (R-Okla.) wrote in a December 2012 letter to leaders of the Senate Armed Services Committee. "The technology yields results that both of our militaries will utilize in our respective defense systems."

The senators sent a similar letter to the House Armed Services Committee. Congress and President Obama ultimately approved a bill authorizing hundreds of millions of dollars for Iron Dome, David's Sling, and Arrow in FY13.

"U.S. funding is fully matched by that of Israel," the two legislators wrote. "This is, in short, a win-win."

Arrow 3: Huge potential payoff

Although production of the Arrow 2 interceptor has ended, Israel and the U.S. agreed in 2008 to develop the next-generation Arrow 3 to defend the Jewish state against longer range ballistic missiles, particularly those from Iran.

Arrow 3, which includes the Arrow 3 hit-to-kill interceptor, the Super Green Pine Radar, and command and launch-control centers, is supposed to have twice the range of the legacy interceptor. Yet the new interceptor will cost $500,000 less and stand 3 ft shorter than the $2.7-million, 23-ft-tall Arrow 2.

"Arrow 2 was designed to intercept incoming threats during their later stages of flight, both outside of and in the Earth's atmosphere; therefore, it must carry more internal systems to perform in both environments, and is therefore heavier and more expensive," says Boeing spokesman Scott

Day. "Arrow 3 is designed to intercept incoming threats outside the Earth's atmosphere and contains more advanced technologies. Therefore, it can be made smaller, lighter, and less expensive."

Arrow 3's ability to intercept targets at longer ranges above the Earth's atmosphere will be particularly useful against missiles armed with nuclear weapons. Fallout from such weapons would be expected to disintegrate in space.

Arrow 3 is a 'shoot, look, shoot' system with a 'high divert capability,' meaning its interceptor "can be launched immediately after detection of the incoming missile into what is called a waiting space," explains Scheinmann. "Once the exact speed and trajectory are determined, Arrow 3's kill vehicle can then be redirected to the incoming target using a dual-pulse motor."

In 2009, Army Lt. Gen. Patrick O'Reilly, then director of the MDA, told the House Armed Services strategic forces subcommittee that Arrow 3 would be technologically challenging, putting it at "high risk" of schedule delays. However, he indicated that the payoff would be huge if the program succeeded.

"It is a more advanced design than we have ever attempted in the U.S. with our programs," O'Reilly testified. "That is due to the way that the seeker has great flexibility, and it has other propulsion systems. It will be an extremely capable system."

Expected to become operational in 2015 or 2016, Arrow 3 is supposed to allow Israeli forces to conduct multiple intercept attempts, first by Arrow 3 and then by Arrow 2. If Iran launched an ICBM, for instance, "Arrow 3 and the resulting systems behind it could give Israel 15-20 minutes to intercept, which obviously doesn't sound like a lot but is ages when it comes to missile defense," Scheinmann says. "Consider that [with] the stuff you had coming out of Gaza, residents had 15-30 seconds. You're talking leagues of difference here."

In 2012 tests, the Arrow 3's radar successfully tracked a simulated incoming missile, and the system successfully launched an interceptor.

The first Arrow 3 interceptor flight test is planned for early this year and will include separation of the kill vehicle against a simulated, computer-generated missile. The test was supposed to occur in 2012 but was delayed by an undisclosed malfunction in the interceptor. The problem has apparently been fixed, though government and industry officials in Israel and the U.S. did not answer questions about the matter.

The EL/M-2084 provides very accurate target location information throughout the targeted rockets' trajectories, enabling the interceptor-missile to be directed accurately toward its target.

Lasers

Israel once considered lasers as a potential defense against rockets. With the possibility of a speed-of-light, ultraprecise capability, Israel, in cooperation with the U.S. Army, showered millions of dollars on the Tactical High Energy Laser (THEL) system, developed by Northrop Grumman.

THEL, also known as Nautilus, showed promise in testing, shooting down 46 rockets, artillery shells, and mortar rounds from 2000 to 2004. But the Israelis ultimately concluded that bulky chemical lasers were too cumbersome for the battlefield. And they seem to have little interest in reviving such efforts, at least until solid-state laser technology becomes more mature.

Dan Wildt, Northrop Grumman's top executive for directed energy, says, "We believe we have laser solutions to enhance the defenses that Israel has fielded, to include very low cost-per-missile kill, and stand by to help if requested. However…we have not been requested to assist."

In a report accompanying the FY13 defense authorization act, members of Congress urged the Pentagon to begin transitioning directed energy technologies to operational weapon systems once such technologies have matured. They asked for a status report on directed energy development in conjunction with the president's FY14 defense budget request.

"I think that the next major leap will come in the form of directed energy, particularly against these shorter range rockets and missiles," says Baker Spring, a research fellow in national security policy at the Heritage Foundation.

But for now at least, the missile-based systems—Iron Dome, David's Sling, Arrow—remain supreme in Israel.

As aircraft automation increases and network-centric flying begins to link growing numbers of air and ground systems, the chances for human error and system failures also multiply. Proliferating information, including unfamiliar alerts on cockpit displays, can create confusion for pilots and endanger flight safety. Regulators who must devise rules for the safe operation of so many systems face mounting difficulties.

Writing the rules for network-centric flight

As network-centric flying becomes a reality, automated systems are multiplying rapidly, in both individual aircraft and the expanding networks that support them. From communications to navigation to sensor and malfunction alerts, constantly proliferating information has placed growing pressure on the cockpit crews who must receive and respond to it. The results have sometimes been fatal.

To ensure that regulators remain on top of the problem, the European Aviation Safety Agency (EASA) held a workshop in February on 'loss of control' (LOC). The goal was to produce a 'total systems approach' on new rulemaking to prevent LOC accidents that result from incorrect pilot responses to failures in the cockpit information system. The group assessed ways of integrating findings from several different studies, including its own automation policy, updated in January, and an International Council of the Aeronautical Sciences (ICAS) report.

Unfamiliar alerts

A major driver of this work was the loss of flight AF 447, an Air France Airbus A330-200, on June 1, 2009. The accident, which killed 216 passengers and 12 crew, occurred after the plane hit turbulence above the South Atlantic en route to Europe from Brazil. According to the BEA, France's air accident investigation agency, one impor-

tant cause of the crash was that inadequately trained pilots suddenly had to manage the automatic disengagement of the autopilot and autothrottle, as the flight control law switched from normal to alternate, presenting them with unfamiliar symbology on the flight director display.

The disengagement occurred when the Pitot tubes were blocked by ice crystals, leading to the temporary loss of reliable airspeed data. Human-machine interface issues, in other words.

EASA, an EU organization based in Cologne, Germany, has taken over responsibility for aviation safety regulation from national civil aviation administrations in EU states. As a result of the crash, it has developed a new automation policy that focuses "on crew-automation interaction and related issues in aircraft design, certification, training principles, and regulatory provisions." In addition, the organization has updated technical standards for Pitot tubes, proposing new certification standards for flight in icing conditions. It has also contributed to a research project on high-altitude icing.

Challenges multiply

One of the biggest challenges facing regulators around the world is the development of guidelines and procedures for aircraft designers and cockpit crew for occasions when elements of the automation system fail, and flight control and display systems are operating in degraded states. As work on this issue continues, a much greater challenge is on the horizon: establishing

by
Philip Butterworth-Hayes
Contributing writer

appropriate regulations and procedures to ensure that when the next iteration of advanced automation systems becomes operational—networking the automated cockpit systems with those on the ground—a safety case has been developed to allow for sudden, multiple failures and degradation of automated elements throughout the system.

Trajectory-based operations

At the heart of both the FAA's NextGen and the EU's SESAR (Single European Sky ATM Research) programs is the concept of trajectory-based operations (TBOs), where the plane's preferred trajectory is chosen by the aircraft operator based on speed, cost, or environmental performance. The aircraft then automatically flies to its destination via the most efficient route available, making constant changes to take advantage of prevailing weather and traffic conditions. The air traffic management (ATM) and aircraft computers update each other many times a minute via data link to make certain the optimum route is being flown at all times and the overall network can be adapted to ensure the safety and predictability of the entire system.

The benefits of introducing a network-centric system are substantial. "Current validation exercises and flight trials have demonstrated several reductions in average time spent in holding [by] up to 100%, reducing distance flown per flight by up to 6.34%, reducing the number of potential conflicts by 68%, and reducing average fuel consumption per flight by 11.42%," according to a SESAR report, "From Innovation to Solution," issued in February.

The current fundamental challenge is to agree to a common technical framework to support TBOs. This means building a robust, detailed TBO information network shared among all participants—ATM agencies, aircraft operators, airports—through a system-wide information management program (SWIM) where all the information relevant to four-dimensional TBOs is shared among authorized users.

Work on requirements, protocols definition, and the security aspects of SWIM has begun. However, it is a complicated process. It is highly likely that the organizations responsible for developing, managing, and operating SWIM will be spread among a range of air navigation service providers and industry. Gaining the support of all aviation system participants—including airports and the military—will need to be planned, and all must agree on targets for financing and implementation. And with so many different sectors involved, one of the biggest challenges is to ensure that, in safety terms, nothing falls between the cracks.

Ground-based networks will also have to deal with growing amounts of information as cockpit automation increases.

Important differences

NextGen, SESAR, and other TBO-powered network management systems under development throughout the world, especially in Australia, are broadly the same. However, there are some important differences in philosophy and timescales.

The real challenge will be to make NextGen and SESAR interoperable in the last step of their implementation, according to a paper presented by two companies, Engility and IDS (Ingegneria Dei Sistemi), at the September 2012 ICAS meeting in Brisbane, Australia. The major difference, according to the paper, concerns the calculation of the controlled time of arrival (CTA) that an aircraft must meet; in the SESAR concept of TBO, the CTA negotiation is based on possible limitations associated with aircraft performance and environmental conditions.

"This approach assumes that the aircraft has the best knowledge of [its] future trajectory and therefore the trajectory predicted by the flight management system (FMS) is the most accurate. Once the final CTA constraint is agreed upon, the aircraft will meet it through the required time of arrival (RTA) capability of the FMS. On the other hand, in the concept proposed for NextGen, the ground system calculates the first CTA, uplinks it to the aircraft, and starts the negotiation."

"The mistake that SESAR and NextGen could make is having the entire system in place without having studied enough the command and control transitions and the optimisation of the separation," said Planzer.

Failures and ripple effects

One of the two key enabling technologies that will allow for this future network-centric-based ATM approach is the data link system. It will allow the free flow of massive amounts of data between the ground and the air and the related software protocols that will ensure pilots and controllers have the exact amount of data—neither too much nor too little—to make the right decisions at the right time, even when parts or all of the system are in degraded mode.

Unfortunately, even in the most well-thought-through and rigorous automated systems, unforeseen failures can happen,

Automation survey highlights crew concerns

EASA has released the findings of its Cockpit Automation Survey, which aims to identify which aspects of the cockpit automation process cause the greatest concern to flight crews. The findings, in priority order, include the following:

•Basic manual and cognitive flying skills tend to decline because of lack of practice, and a pilot's feel for the aircraft can deteriorate.

•Unexpected automation behavior—engagement or disengagement of automatisms in an inappropriate context or uncommanded transition (mode reversion, for instance) may lead to adverse consequences.

•Pilots interacting with automation can be distracted from flying the aircraft. Selection of modes, annunciation of modes, or flight director commands may be given more importance than value of pitch, power, roll, and yaw and so distract the flight crew/pilots from flying the aircraft.

•Flight crews may spend too much time trying to understand the origin, conditions, or causes of an alarm or of multiple alarms, which may distract them from other priority tasks and from flying the aircraft.

•Diagnostic systems are limited in terms of dealing with multiple failures, with unexpected problems, and with situations requiring deviations from standard operating procedures.

•Unanticipated situations requiring crew to manually override automation are difficult to understand and manage, create a surprise or startle effect, and can induce peaks of workload and of stress.

•For highly automated aircraft, problems may occur when transitioning to degraded modes (for example, when multiple failures require manual or less automated flight).

•Data entry errors (either mistakes or typing errors) made when using electronic flight bags in addition to avionics systems may have critical consequences.

and the system must be made robust enough to deal with these. In a cockpit there is almost a finite number of possible failures that can be planned; but across a global networked system, where a small failure in one sector could have unknown consequences down the line, this is a far more complex issue.

"These kinds of systems are just too, too complicated to assess, simulate, and validate for us to fully understand what failures will do across the system," according to Marc Baumgartner, SESAR/EASA coordinator for the International Federation of Air Traffic Controllers' Associations.

"The solution to a crisis will be much more radical than what we know in order to keep the system resilient. If we don't have any separated and independent mode of recovery and we have everything integrated, there is only one solution—empty the skies. The system will be automated to such an extent that if the data link or a transmission breaks down, the chances of this happening will be much less than before; but if it does break down, the solution will be much more radical, shutting down the system for four to five hours. Maybe this will become acceptable, in the same way that we have become used to snow storms closing airports in the northern hemisphere, or monsoons in the south."

Certification and timing

Regulators are addressing several important concerns the aviation community has regarding the current level of cockpit automation. When these concerns are translated from piloting a single aircraft to the entire aviation network, encompassing air and ground linked information systems that allow for reduced separation distances between aircraft in the air, problems facing regulators start to multiply quickly. With the first SESAR and NextGen technologies moving to the deployment phase, one key challenge that must be addressed urgently is at what stage safety regulators will need to be involved in certifying a TBO-based system as safe in operational and degraded states.

"We cannot regulate on systems in development," said Patrick Goudou, EASA's executive director, at the first World ATM Congress in Madrid in February. "Realistically it takes three to four years for any new regulations to be adopted." And with networked systems, a new regulatory approach is needed to ensure the safety of 'seamless' integrated air and ground systems.

Command and control issues

So far, most regulations are developed in 'silos,' said Goudou, with airworthiness regulations drawn up in a different regulatory environment from those for ATM and airport safety. But in a seamless TBO network, responsibility for keeping aircraft safely apart will most probably shift from the cockpit (via automated aircraft self-separation systems) to the ground as the aircraft descends from its cruise height down toward the airport.

"There has to be a concept of operations that identifies command and control and under what circumstances command and control moves, and the precision and process under which it moves," says Neil Planzer, vice president-ATM at The Boeing Company. "In a TBO system the cockpit would have to process a lot more information, and there would have to be simultaneous information being processed in a ground-based command and control system. So there are circumstances where you will allow a trajectory separation to occur between aircraft by aircraft, and there are times when that won't work, so you must identify those."

It is this change from aircraft-based separation management to ground-based separation management—as the aircraft approaches the airport—that will require some of the most exhaustive safety research. So if there is any degradation of the system, it will automatically fall back to a ground-based management mode.

Thus, if the programs are to meet their tough timescales, regulators will need to be much more proactive. Specifically, they must work with developers now to explore the safety-case implications of this new mode of operation, rather than waiting until the system has been developed before starting the certification process.

And this, perhaps, is the heart of the issue. Both regulators and system developers will need to work together on creating TBO concepts much earlier in the process of system definition than has been possible in the past. The strategic TBO concept calls for much greater levels of automation in communications and systems management—at the level of both individual aircraft and overall airspace management. But this will work only if developers and regulators can agree on the most appropriate fall-back measures for different system degradation events as early as possible in the development phase.

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Plan B for ExoMars

ExoMars is ESA's program to send a rover of its own to the Martian surface to search for signs of life, past or present. Mounting fiscal pressures, however, have caused the U.S. to pull out of the international program. Yet despite budgetary constraints, ESA intends to press ahead with its plans, and has turned to Russia as its new partner in the project.

by Mark Williamson
Contributing writer

The early 21st century will go down in space history as a time of sustained and successful activity on and around the red planet. With good reason, much of the limelight has been stolen by NASA, but this does not mean it will have Mars's rust-red surface to itself in the coming decade—not if ESA has its way.

Keen to follow in the tracks of Sojourner, Spirit, Opportunity, and now Curiosity, Europe's space community has been preparing a Mars rover mission for many years. ESA's Science Program Committee formalized plans in 2005 when it approved ExoMars as the agency's second Mars mission (its first was the Mars Express orbiter, launched in June 2003).

This challenging, arguably audacious mission was dedicated not simply to 'following the water' (the tag line to NASA's Mars program) but also to the search for life (ExoMars is a contraction of Exobiology Mars). As this was the first time since the Viking missions of the mid-1970s that a spacecraft had been designed specifically for this purpose, it attracted the interest of NASA scientists and eventually the promise of a contribution by way of a 'free launch.'

But when NASA pulled out of the program last year—apparently for budgetary

reasons—ESA was faced with a not uncommon predicament: how to afford to send a spacecraft to Mars.

Ticket to ride

Anyone who has followed humankind's love affair with Mars exploration knows that mission failure is almost as common as success. And the budgetary challenge of these big-ticket programs is almost as complex as the technical aspects…as the short history of ExoMars shows only too well.

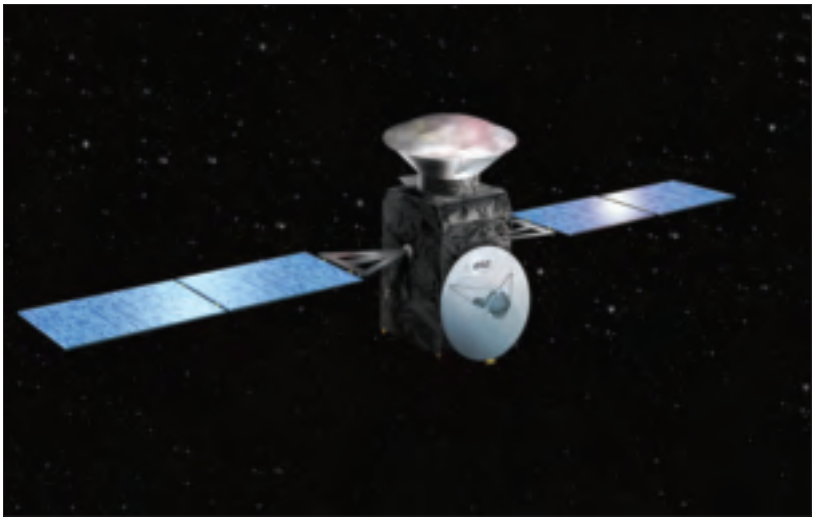
Three years after the formal approval of the mission, in the run-up to the November 2008 ESA Ministerial Conference—one of the periodic meetings where the funding fates of Europe's space dreams are decided—the future of ExoMars hung in the balance. Coming straight from the conference, ESA Director General Jean-Jacques Dordain presented a positive picture of commitment within Europe, but had to admit that member states had signed up to only €1 billion of the €1.2 billion required. As this included about €150 million for an Ariane 5 launch, his plan was to negotiate a launch contribution from either the U.S. or Russia to help balance the budget.

In 2009, at the time of *Aerospace America*'s last review of the mission (see "ExoMars: Europe rises to the challenge," May 2009, page 38), Roscosmos (Russia's space agency) was expected to launch ExoMars on a Proton as part of a 'no-exchange-of-funds agreement.' By June, however, the tide had turned toward a NASA agreement to use an Atlas V, although this would involve a mass-trimming exercise by spacecraft contractors.

The arrangement featured a dual-launch mission: A Mars orbiter and lander would be launched on an Atlas V in January 2016, followed by a rover in May 2018 (viable launch windows for Mars open roughly every two years). The rub was that ESA still needed to solicit a missing €150 million from its member states, but was obliged to wait until a ministerial meeting planned for 2012. However, even before ministers could confirm the dates in their diaries, President Barack Obama's plan to cut NASA's FY13 budget removed NASA from the equation.

It was not the first time ESA was let down by NASA (and it will not be the last, as long as NASA's strings are pulled by politicians in Washington). But it did not make it any easier to plan the timescales required for a complex planetary mission.

As ever, interactions between the heads

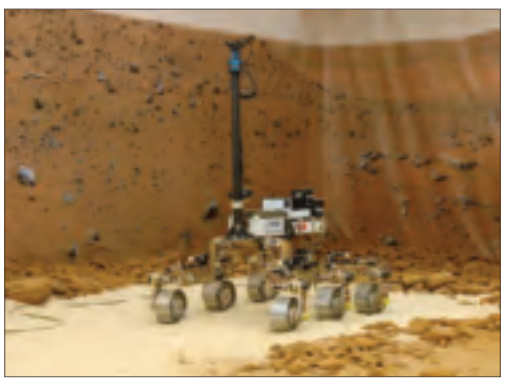


Instruments for the trace gas orbiter that were to be provided by NASA will now come from Russia.

of the respective agencies remained professional, even cordial, as evidenced at the regular plenary at the 63rd International Astronautical Congress, held in Naples in October 2012. Understandably, apart from a reference to the "fiscal crisis," NASA Administrator Charles Bolden avoided mention of ExoMars, preferring instead to celebrate the successful landing of Curiosity in August. Dordain was clearly disappointed that "Charlie could not come with us as planned," but was "confident in finding a solution with Russia" by the end of the year. Dordain's view of NASA's decision to fund its own Mars lander for 2016—a mission known as InSight—was not recorded.

The current plan

In the latest revolution of this wheel of fortune and misfortune, plans now call for collaboration with Russia. Roscosmos is expected to provide the Proton launch vehicles for the 2016 and 2018 missions as well as some of the spacecraft hardware. The new partnership with Russia was formally approved at the ESA Ministerial Council of November 2012, but the issue of funding shortfalls remained. Dordain is hoping to negotiate a transfer from other parts of the ESA science budget and hopes to close the budget sometime this year.



Astrium's Locomotion Performance Model, Bruno, sits in the Astrium Mars Yard. Credit: EADS-Astrium.

Although not funding ExoMars directly, the U.K. government's decision to increase its ESA spending by 25% over the next five years—an astonishing (albeit welcome) commitment given the general fiscal environment—should make Dordain's life a little easier. In fact, he joked during a press briefing at the Ministerial Council that he would be speaking English, rather than French, for the rest of his days.

Mission evolution

So how does the ESA/Roscosmos version of ExoMars differ from the ESA/NASA variant?

On the former 2016 mission, a trace gas orbiter and an entry and descent module provided by ESA would have been launched together on an Atlas V procured by NASA. According to Vincenzo Giorgio, ExoMars project manager at Thales Alenia Space (TAS) Italy, prime contractor for both ExoMars missions, "The [new] 2016 mission is the same as the previous one except that the instruments previously provided by NASA for the orbiter are now replaced by Russian instruments."

Likewise, says Giorgio, there is also a new plan for the 2018 mission, which would have comprised a NASA carrier module and a joint ESA/NASA rover delivered by a NASA-procured Atlas. Replacing these elements will be "a European carrier (with some Russian contribution), a fully European rover, and a Russian-led descent module (with European contributions to guidance, navigation, and control, the parachute system, and the Doppler radar)." The message to NASA should be clear: With a little help from its friends, Europe can get to Mars without you.

In fact, this is far from the first change to the ExoMars concept. As originally foreseen in 2005, it featured a single, all-European lander/rover mission with communications and data relay provided by NASA's Mars Reconnaissance Orbiter (MRO), which was launched that year. But delays to ExoMars, itself originally intended to launch in 2011, put MRO a bit beyond its 'use-by date' for a 2016 or 2018 mission, obliging ESA to develop a dedicated orbiter.

The 2016 mission will study the Martian atmosphere from orbit and demonstrate the feasibility of several technologies critical to atmospheric entry, descent, and landing (EDL), which, as Giorgio points out, is "the

key to any future human exploration of Mars." The mission will also provide an orbiting telecommunications platform for relaying data between Earth and spacecraft on the surface. The 2018 mission will carry an autonomous European rover capable of extracting soil samples from as deep as 2 m below the surface, and analyzing chemical, physical, and biological properties.

Asked whether the dual mission produced additional engineering challenges, Giorgio was clear: "In general, there is no additional challenge in splitting the mission in two. In fact, including an entry, descent, and landing demonstrator on a first mission, without the rover, will provide useful GNC experience for the second mission with the rover."

Speaking at a TAS press lunch held at the Naples IAC, Luigi Pasquali, deputy CEO for TAS-Italy, admitted that ExoMars had been "a tough program," but he was upbeat about the future: "The schedule is in line, the risks are managed. We expect no surprises, even from Moscow," he said.

In addition to its prime contractor role, TAS-Italy is also responsible for design of the 2016 EDL demonstrator module EDM) and provision of its computer and radar altimeter, key components for the landing phase. TAS-France is responsible for design and integration of the orbiter module.

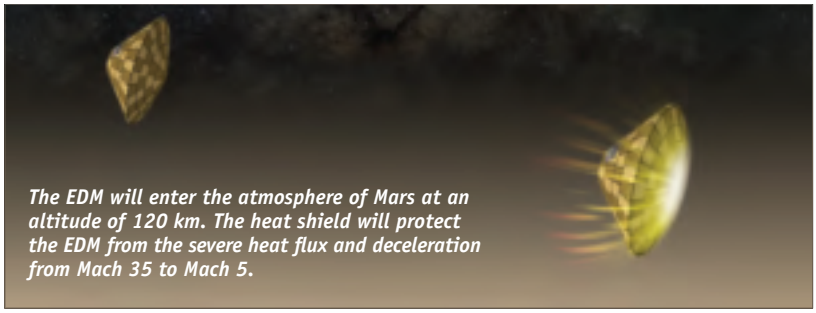
TAS is also developing the analytical laboratory drawer, which will carry instruments for the Pasteur scientific payload on the rover. But the design and development of the rover itself has, from the beginning of the program, been assigned to EADS Astrium, based in Stevenage, U.K.

Autonomous rover

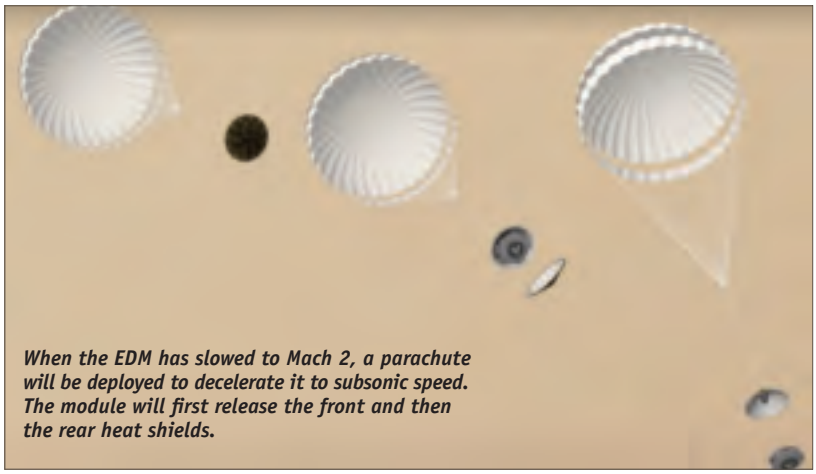
Interestingly for Astrium, its responsibility has increased as a result of NASA's withdrawal. According to Paul Meacham, systems engineer for the ExoMars rover vehicle project, "Since the joint rover with NASA has gone, we are designing the complete rover vehicle without using NASA-supplied elements." Moreover, he adds, "The rover has returned to its original size, which is approximately a quarter of the area of Curiosity and about a third of the mass (1.6 m long, 1.3 m wide, 2.0 m high, and 300 kg)."

As per the original design, one of the key technical requirements for the rover is its autonomy, or as Meacham puts it, "the ability of the rover to drive itself and maximize the distance travelled per day without support from the control center back on Earth." This autonomy is useful, because Mars can be as much as 20 light-minutes from Earth—meaning a signal warning the rover to 'mind that boulder' could come too late—and also because it reduces the standing army required to drive and 'babysit' the rover. The plan is to communicate with the rover, via the orbiter, twice a day, transmitting commands to its onboard computer and receiving telemetry and science data collected on its travels.

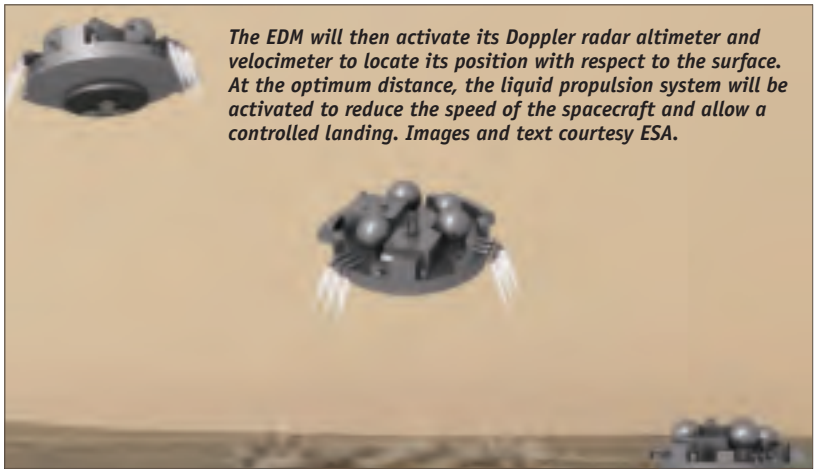
Meacham views this technology as particularly critical, because ExoMars will be Europe's first rover. "It was important to raise its maturity level early in the project," he says. For this reason, quite apart from



The EDM will enter the atmosphere of Mars at an altitude of 120 km. The heat shield will protect the EDM from the severe heat flux and deceleration from Mach 35 to Mach 5.



When the EDM has slowed to Mach 2, a parachute will be deployed to decelerate it to subsonic speed. The module will first release the front and then the rear heat shields.



The EDM will then activate its Doppler radar altimeter and velocimeter to locate its position with respect to the surface. At the optimum distance, the liquid propulsion system will be activated to reduce the speed of the spacecraft and allow a controlled landing. Images and text courtesy ESA.

ESA's ExoMars Rover provides key mission capabilities: surface mobility, subsurface drilling and automatic sample collection, processing, and distribution to instruments.

any side issues of partnership and funding, Astrium has continued to develop the technology and has "reached an important milestone: the demonstration of the complete autonomous system working on a prototype rover in a representative environment," according to Meacham.

Specifically, the demonstration was undertaken last September by Astrium's locomotion performance model prototype rover, Bruno, at the 'Stevenage Mars Yard facility.' The next step is to write the flight software that will control the actual ExoMars rover during its mission.

The design challenge for an autonomous rover includes enabling it to recognize terrain features, avoid hazardous areas, and plan a traverse with due regard to errors in its locomotion system, such as wheel slippage and steering errors. The ExoMars rover will navigate using a visible-wavelength stereo imaging system to build a 3D model, or 3D map, of the local environment, while onboard software plots a safe route across it.

A novel element of the rover's design is the ability to 'wheel walk.' Bruno's six wheels have lateral crampon-like features, known as grousers, to prevent slippage. They allow it to move one wheel at a time, with the others anchored, to climb particularly steep or slippery slopes.

Where planetary rovers are concerned, a combination of software simulation and physical model testing—in facilities such as the Mars Yard—is required. Based on knowledge from previous missions, a team of soil scientists at Cranfield University has even developed a replica Martian soil. The effort is part of an ESA project to improve the performance of future rovers to be used for testing the ExoMars flight model rover.

Model depicts the entry, descent, and landing demonstrator.

Of course, however clever the platform and navigation systems, it is the payload they support that will deliver the science results. Despite the change in partners, the ExoMars surface science payload remains largely unaltered. It comprises an analytical laboratory called Pasteur fed by a subsurface drill, and a robotic arm equipped with surface sampling and analysis tools. As Giorgio confirms, the main scientific goal of ExoMars also remains the same: "The search for life." Moreover, he adds, "the possibility to drill and take samples up to 2 m below the surface is the real difference between ExoMars and the Curiosity rover."

Despite the funding and organizational problems, prime contractor TAS has managed to "reuse most of the work done before, such as engineering analysis, breadboards, and technological developments," notes Giorgio. This, he says, has led to a "credible schedule" for the 2016 mission that has been scrutinized by a number of ESA independent reviews; and even some of the core elements for the 2018 mission, such as the drill and the sample preparation and distribution system, are in an advanced stage of development.

The rover's design lifetime is 218 Martian sols (about 230 Earth days), but experience with NASA rovers boosts expectations for a much longer operational lifetime. The autonomous, agile locomotion and 2-m drill make it tempting to compare the ExoMars rover with a human geologist (albeit one who never eats, sleeps, or complains). John Zarnecki, professor of space science at the U.K.'s Open University, summed up the rover's advantages when he spoke to *Aerospace America* in 2009: "ExoMars has three unique selling points: longevity, mobility, and depth. The rover will be able to cover a kilometer a day—by comparison, the U.S. rovers currently on Mars [Spirit and Opportunity] have done about seven miles over the years they have been there."

Benefits for Europe

Clearly ExoMars is important for Europe, ESA, and its industrial contractors. This is shown, not least, by Dordain's continual efforts to keep the program alive in times of financial austerity, when drilling into the surface of Mars is easily criticized as an unnecessary drain on resources. It would have been much easier to cancel the program, justify previous expenditure as 'technological R&D,' and leave Mars to the Americans.

But Europe has a long history in space

and a significant heritage in ground-breaking deep-space missions—including the first comet interceptor (Giotto) and the first entry vehicle to land on another planet's moon (Huygens). ESA's development of a fleet of small, medium, and heavy-lift launch vehicles—in the guise of Vega, Soyuz, and Ariane—proves Europe's intention to remain autonomous as a space power, while at the same time seeking cost-saving international collaboration in its programs. ExoMars is simply the latest manifestation of this long-term policy.

Indeed, representatives of the key contractors are under no misconceptions regarding the importance of the program. "ExoMars provides a unique opportunity for Europe, and Thales Alenia Space, to play a major role in the field of space exploration," says Giorgio. "I believe that any future major objectives, such as Mars sample return or human exploration, will be possible only through international cooperation, and we have to be ready by bringing heritage and real experience to the table. ExoMars will allow this."

Says Meacham, "The goal of Astrium's involvement in ExoMars is to support European exploration of the solar system and position ourselves for Mars sample return. Also, we want to promote the major role of the U.K. in robotic exploration. The technology and experiences gained through developing the ExoMars rover are applicable to future planetary rovers/landers, which puts us in a good position to design and build the missions of the future."

In fact, a U.K. contribution to NASA's InSight lander is already in development. A seismometer payload (SEIS-SP), led by Imperial College London and Oxford University, is designed to detect any 'Marsquakes,' map boundaries between rock strata, and help determine the existence of a liquid or solid core. Principal investigator Tom Pike notes, "InSight will be the first mission to look at the deep interior of another planet."

Popular destination

Historically, Mars may have proved a difficult target (since 1960, only 18 of some 43 attempts to reach the planet have succeeded), but as techniques and technology have developed, the 'hit rate' has improved and Mars remains a popular destination.

In addition to the missions already under way and in development by NASA (including the Maven orbiter and the InSight lander), the agency's Mars Program Planning Group (MPPG) has endorsed a future Mars sample return mission. Tasked with evaluating options for the 2018-2024 launch windows, the MPPG produced four possible concepts for rovers and orbiters under NASA's 'Mars Next Decade' banner, and it comes as no surprise that the innovative Skycrane system, used to lower Curiosity to the surface, is the 'hot tip' for the delivery mechanism.

Speaking in an IAC technical session, Miguel San Martin, head of GNC for the Mars Science Laboratory mission (which includes the 1-ton Curiosity rover), explained that Skycrane was the only practical way to get such a heavy rover to the surface at a survivable touchdown velocity (less than 0.75 m/sec). Moreover, it offered the additional advantage of delivery to a rough surface, because it was Curiosity's six articulated wheels themselves that performed the touchdown. As a result, according to San Martin, NASA is looking forward to using its Skycrane technology for future missions and estimates that a landed mass of up to 1.5 tons could be accommodated.

Separately, Bolden confirmed the view that Skycrane constituted a "technological breakthrough for use in future Mars missions and that NASA was continuing to "perfect the technique." However, he also characterized EDL as "a perishable skill," implying that the agency is keen to fly another Skycrane-delivered Mars probe before they forget how to do it!

As for the imperfect science of international collaboration, Bolden sought to encourage NASA's international partners with a claim that "NASA does not plan to do anything alone" in Mars exploration. Unsurprisingly, given its current budget problems and the growing national deficit, the expectation is that NASA will need help to get those Mars rocks back to Earth.

For this reason alone, NASA will be following progress on Europe's ExoMars mission with interest, possibly even a little envy. Considering the program's proven ability to rise from the ashes of budgetary firestorms, it might have been better named Phoenix…but that name had already been taken by the Mars lander of 2008.

The underlying message is that, despite the financial crises around the world, space agencies are still keen—and can find the money—to explore Mars using unmanned spacecraft. One day we might also see the love affair with Mars extended to manned missions…but that's another story.

The ExoMars drill will be able to take samples from 2 m below the surface.

Out of the

25 Years Ago, April 1988

April 25 Using a Scout D booster from Vandenberg AFB, the Navy launches two Oscar navigation satellites into a polar orbit 600 mi. above the Earth. The satellites provide navigational data as accurate as 0.1 n.mi. throughout the globe. NASA, *Astronautics and Aeronautics, 1986-1990*, pp. 169-170.

50 Years Ago, April 1963

April 2 The USSR launches its Luna 4 probe on a Molniya-L vehicle in an attempt the make the first soft landing on the Moon. Soviet scientists are also hoping to "verify the hypothesis about the existence of complex organic substances on the Moon." However, the spacecraft fails to perform a course correction and misses the Moon, instead remaining in Earth orbit. *Flight International*, April 11, 1963, p. 501.

April 2 Explorer 17, also known as the S-6 atmospheric structure satellite, is successfully launched on a Thor Delta vehicle from Cape Canaveral, Fla. The 410-lb spherical satellite will give scientists their first opportunity to obtain instantaneous real-time atmospheric density measurements using several independent measuring systems during a single day. *Flight International*, April 11, 1963, p. 488.

April 2 A BOAC Comet inaugurates the first direct air service between London and Auckland, N.Z. The flight takes a day and a half. *Flight International*, April 11, 1963, p. 491.

April 9 Douglas Aircraft announces it will produce the twin-engine sweepback-wing DC-9 airliner for relatively short flights of about 1,000 mi. First manufactured in 1965, it also makes its maiden flight that year. It becomes very successful, achieving a service life of more than 41 years, with over 2,400 units built. The final DC-9 is delivered in 1982. *Flight International*, April 18, 1963, p. 563; DC-9 file, NASM.

April 10 The VJ-101C, a German V/STOL aircraft, makes its first free flight. Powering the plane are swiveling Rolls-Royce RB.145 engines at the tips of its wings and RB.108 lift engines in its fuselage. *Flight International*, April 25, 1963, p. 590.

April 13 Balloonists Ed Yost and Don Piccard achieve the first hot-air balloon crossing of the English Channel, ascending from Rye in Sussex, England, and landing at St. Georges, near Calais, France. The flight, sponsored by the French magazine *Via*, takes them less than 3 hr. Their 60,000-ft^3 balloon is made in the U.S. by Raven Industries of Sioux Falls, S.D. Earlier channel crossings have been made by gas-filled, non-hot-air balloons. *Flight International*, April 25, 1963, p. 591.

April 17 University of Maryland researcher Whilden P. Breen Jr. finally exits a small windowless, soundproof test chamber at the University's Space Research Laboratory at College Park, Md., where he has lived and worked since Nov. 17, 1962. His five-month stay in the chamber is an experiment conducted under a NASA grant to study the psychological effects of long-duration trips to planets such as Mars. Breen's story is later published in *Life* magazine. *Flight International*, May 2, 1963, pp. 651, 654; *Life*, May 17, 1963, pp. 119-120.

April 18 The Northrop X-21A laminar flow control research aircraft makes its first flight from the Norair Division's Hawthorne, Calif., plant to Edwards AFB, Calif., where the laminar control tests are to take place. *Aviation Week*, April 22, 1963, p. 37.

April 18 The Titan 1 ICBM becomes operational at Lowry AFB, Colo. The missiles are kept in underground silos, making Lowry the Air Force's first missile base of this kind. D. Daso, *U.S. Air Force: A Complete History*, p. 428.

April 22 Aviatrix Jacqueline Cochran flies her Lockheed Jetstar, named Scarlett O'Hara, across the Atlantic from Gander, Newfoundland, to Shannon, Ireland, becoming the first woman to pilot a jet across the

Past

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

Atlantic. She also sets 68 other records on the flight. D. Daso, *U.S. Air Force: A Complete History*, p. 428.

April 26 A reunion for P-47 Thunderbolt pilots, known as the 'jug drivers,' takes place in New York City. *Flight International*, April 11, 1963, p. 489.

And During April 1963

—It is reported that the complete aircraft parts for two MiG-21 fighters received in India from the USSR have been fully assembled and the planes test flown. Soviet representatives are also in India to advise on the establishment of a factory there for the manufacture of these aircraft. *Flight International*, April 4, 1963, p. 452.

75 Years Ago, April 1938

April 16 Henry Ford, who bought the Wright brothers' old home and bicycle shop and moved them to Dearborn, Mich., dedicates them as museums before a large assembly that includes many aviation notables. *Aviation*, May 1938, p. 52; *Aircraft Year Book, 1939*, p. 465.

April 16-22 British pilot H.F. Broadbent sets the final prewar Australia-England light plane solo flight record in a Percival Vega Gull. Broadbent covers the 9,612-mi. distance from Sydney to Lympne, England, in 5 days 4 hr 21 min. P. Lewis, *British Racing and Record-Breaking Aircraft*, p. 311.


H.F. Broadbent

April 18 French pilot Edmée Jarland achieves a new women's world glider altitude record of 3,395.16 ft at Beynes-Thiverval, France, flying an Avia 40 P. *Aircraft Year Book, 1939*, p. 465.

April 19 Lt. Col. Robert Olds flies a Boeing Y1B-17 with a crew of eight from Langley Field, Va., to March Field, Calif., in 10 hr 27 min, surpassing the previous time for military planes over this route by 16 min. *Aircraft Year Book, 1939*, p. 465.

April 20 U.S. rocket pioneer Robert H. Goddard launches a rocket that carries a National Aeronautics Association (NAA) barograph to certify the rocket's altitude. An NAA observing committee headed by Col. D.C. Pearson witnesses the launch near Roswell, N.M. The 18-ft-tall liquid-fueled rocket reaches an average height of 4,215 ft. E. Goddard and G. Pendray, eds., *The Papers of Robert H. Goddard*, pp. 1150-1155, 1667.

April 21 The Navy delivers the Brewster XF2A-1 Buffalo fighter to the Langley Memorial Aeronautical Lab. This marks the start of full-scale wind tunnel testing that leads to a 31-mph increase in the aircraft's speed. It also leads to NACA testing of other high-performance Army and Navy aircraft. The data gathered in these tests are directly applicable to the design of new aircraft. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 36.

April 22 Capt. Edward V. Rickenbacker, famed WW I flying ace, purchases Eastern Air Lines from North American Aviation for $3.5 million. He and his backers outbid TWA for control. *Aircraft Year Book, 1939*, p. 465; *Aviation*, April 1938, p. 52.

100 Years Ago, April 1913

April 15 Brazilian President Hermes da Fonseca is said to be the first head of any government to make a flight in a plane, when U.S. pilot David McCullough takes him up in a Curtiss flying boat over Rio Bay. *Aerial Age*, May 1913, p. 16.

And During April 1913

—The National Museum in Washington, part of the Smithsonian Institution, is among the first museums to exhibit aviation artifacts, including Samuel P. Langley's 1896 steam driven 'aerodrome,' a model of James Stringfellow's 1868 triplane, Octave Chanute's 1901-1902 gliders, and the first airplane purchased by any government, a Wright machine bought by the Army in 1909. *Aerial Age*, April 1913, p. 8.

THE UNIVERSITY OF ALABAMA

DEPARTMENT OF AEROSPACE ENGINEERING AND MECHANICS

Seeks applications for multiple faculty positions in aerospace systems

The Department of Aerospace Engineering and Mechanics at The University of Alabama invites applications for three tenure track faculty positions in the area of Aerospace Systems, with particular emphasis on computational modeling and simulation of phenomena relevant to fixed wing aircraft. Applicants for the positions at the rank of tenure-track Assistant Professor will be considered, although exceptional candidates may be considered for the rank of Associate Professor. Successful applicants are expected to: develop a strong externally funded research program, demonstrate a commitment to excellence in teaching and mentoring of both undergraduate and graduate students, collaborate with current faculty members, and provide service to the profession, university, college and department.

Applicants must have an earned doctorate degree in aerospace engineering or a closely related field. Applicants are to submit: a letter of application including contact information for at least three professional references, a detailed CV, a statement of teaching interests, and a statement of research interests (with clearly stated plans for securing external funding). All application materials must be submitted via The University of Alabama's employment website (https://facultyjobs.ua.edu). Successful candidates will begin employment in 2013. Review of applications will begin immediately and continue until the positions are filled. Inquiries should be addressed to Dr. John Baker, Department of Aerospace Engineering and Mechanics, Box 870280, The University of Alabama, Tuscaloosa, AL 35487-0280 or sent by e-mail to john.baker@eng.ua.edu.

With 14 faculty members, the department currently enrolls approximately 190 undergraduate students in the BS program and 60 graduate students in the MS and PhD programs. The University of Alabama is located on a beautiful 1,168 acre residential campus in Tuscaloosa, a dynamic and resilient community of over 150,000. The area offers excellent climate and abundant outdoor recreation. The Tuscaloosa community provides rich cultural, educational, and athletic activities for a broad range of lifestyles. More information can be found at www.ua.edu and www.ci.tuscaloosa.al.us. With technology-oriented government/industrial research centers (including the U.S. Army's Redstone Arsenal and the NASA Marshall Space Flight Center) in north Alabama and a growing aviation industrial sector (including Airbus aircraft manufacturing and engineering centers) in south Alabama, The University of Alabama is centrally located in Alabama's north-south aerospace corridor.

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Faculty of Aerospace Engineering
Meir Hanin International Memorial Prize

The Faculty of Aerospace Engineering at the Technion announces the Meir Hanin International Memorial Prize of US$10,000 from the Hanin Endowment, in memory of Prof. Meir Hanin, a prominent researcher in theoretical aerodynamics and member of the Faculty of Aerospace Engineering from 1955 to 1999.

The prize is awarded once every two years for substantial scientific and/or technological achievements in aerospace sciences. Nominees from any country, regardless of religion, race, sex, or nationality, must have some association with the Technion and can only be nominated by the following: Technion faculty members, previous Hanin Prize winners, members of the Israel Academy of Sciences and Humanities, Presidents and Members of the Board of Institutes of Higher Learning, and CEO's of companies specializing in aerospace products.

Nominations, together with all relevant supporting material, should be sent to Prof. Yaakov Oshman, Dean of Aerospace Engineering, Technion – IIT, Haifa 32000, Israel (dean.ae@technion.ac.il) by May 31, 2013.

The prize will be awarded in February 2014 at the Israel Annual Conference on Aerospace Sciences, which the winner must personally attend. In addition, he/she will give at least two public lectures at the Technion.

(The Hanin Endowment will cover the winner's accommodation and travel expenses.)

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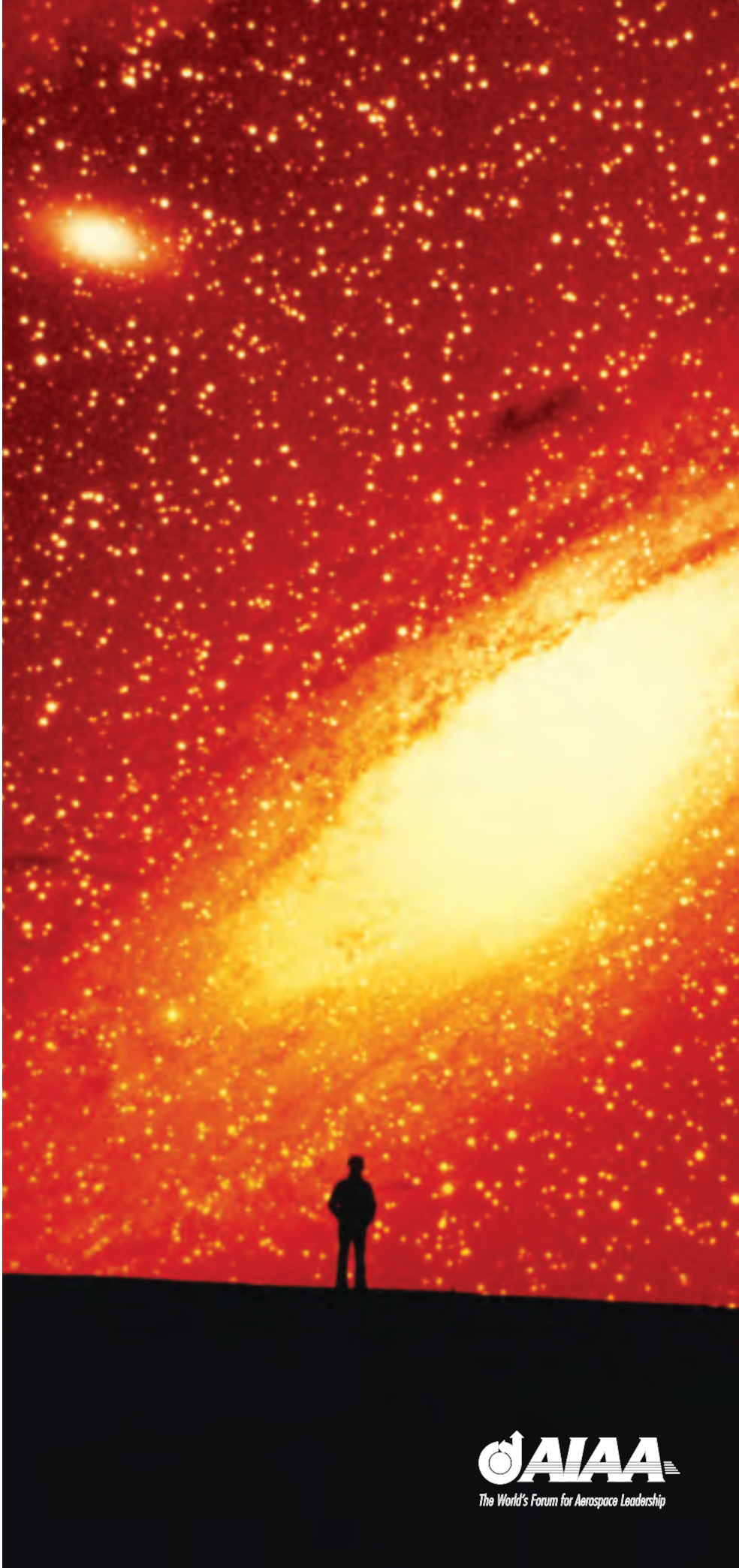

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Rising Leaders in Aerospace Forum co-chairs Darin Haudrich (left) and Matt Cannella (right) with Laura McGill, Deputy Vice President of Engineering, Raytheon Missile Systems—one of the featured speakers at the Rising Leaders forum at the ASM meeting in January. Details of this successful new event are on page **B6**.

APRIL 2013

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

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				
8–11 Apr	**54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** (Jan) **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)		
24–26 Apr	**Experiments and Simulation of Aircraft in Ground Proximity – A Symposium on the Occasion of the Installation of the New Moving Belt of the DNW-LLF**	Zwolle, The Netherlands (Contact: Siggi Pokorn, siggi.pokoern@dnw.aero, +31 527 248520, http://gss2013.dnw.aero)		
8 May	**2013 Aerospace Spotlight Awards Gala**	Washington, DC		
13–16 May	**Reinventing Space Conference**	Los Angeles, CA (Contact James Wertz, jwertz@smad.com; www.reinventingspace.org)		
15–17 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)** (Mar)	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)		
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**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
10–12 Sep	**AIAA SPACE 2013 Conference & Exposition**	San Diego, CA	*Sep 12*	**31 Jan 13**
24–25 Sep†	**Atmospheric and Ground Effects on Aircraft Noise**	Sevilla, Spain (Contact: Nico van Oosten, nico@anotecc.com, www.win.tue.nl/ceas-asc)		
6–10 Oct†	**32nd Digital Avionics Systems Conference**	Syracuse, NY (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)		
14–16 Oct	**31st AIAA International Communications Satellite Systems Conference (ICSSC) and 19th Ka and Broadband Communications, Navigation, and Earth Observations Conference**	Florence, Italy (Contact: www.icssc2013.org)	*Feb 12*	**31 Mar 13**
2014				
13–17 Jan	**AIAA SciTech 2014 (AIAA Science and Technology Forum and Exposition 2014)**	National Harbor, MD		**5 Jun 13**
Featuring **22nd AIAA/ASME/AHS Adaptive Structures Conference · 2nd AIAA Aerospace Sciences Meeting · 15th AIAA Gossamer Systems Forum · AIAA Guidance, Navigation, and Control Conference · AIAA Modeling and Simulation Technologies Conference · 10th AIAA Multidisciplinary Design Optimization Specialist Conference · 16th AIAA Non-Deterministic Approaches Conference · 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference · 7th Symposium on Space Resource Utilization · 32nd ASME Wind Energy Symposium**				
1–8 Mar†	**2014 IEEE Aerospace Conference**	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)		
30 Apr	**2014 Aerospace Spotlight Awards Gala**	Washington, DC		
5–9 May	**13th SpaceOps Conference**	Pasadena, CA	*May 13*	
26–28 May	**21st 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)		
16–20 Jun	**AVIATION 2014 (AIAA Aviation and Aeronautics Forum and Exposition)**	Atlanta, GA		**12 Nov 13**
Featuring **20th AIAA/CEAS Aeroacoustics Conference · 30th AIAA Aerodynamic Measurement Technology Conference · AIAA/3AF Aircraft Noise and Emissions Reduction Symposium · 32nd AIAA Applied Aerodynamics Conference · AIAA Atmospheric Flight Mechanics Conference · 6th AIAA Atmospheric and Space Environments Conference · 14th AIAA Aviation Technology, Integration, and Operations Conference · AIAA Balloon Systems Conference · 22nd AIAA Computational Fluid Dynamics Conference · AIAA Flight Testing Conference · 7th AIAA Flow Control Conference · 44th AIAA Fluid Dynamics Conference · AIAA Ground Testing Conference · 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference · 21st AIAA Lighter-Than-Air Systems Technology Conference · 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference · AIAA Modeling and Simulation Technologies Conference · 45th AIAA Plasmadynamics and Lasers Conference · 45th AIAA Thermophysics Conference ·**				
28–30 Jul	**Propulsion and Energy 2014 (AIAA Propulsion and Energy Forum and Exposition)**	Cleveland, OH		**Nov 13**
Featuring **50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference · 12th International Energy Conversion Engineering Conference**				
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**
Featuring **AIAA/AAS Astrodynamics Specialist Conference · AIAA Complex Aerospace Systems Exchange · 32nd AIAA International Communications Satellite Systems Conference · AIAA SPACE Conference**				

To receive information on meetings listed above, write or call 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/.

AIAA Courses and Training Program

DATE	COURSE	VENUE	LOCATION
2013			
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	
21–24 May	**Inflight Icing and Its Effects on Aircraft Handling Characteristics**	The Ohio Aerospace Institute	Cleveland, OH
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	**Verification and Validation in Scientific Computing**	Fluids Conferences	San Diego, CA
18–19 Jul	**Liquid Propulsion Systems—Evolution and Advancements**	Joint Propulsion Conference	San Jose, CA
18–19 Jul	**A Practical Introduction to Preliminary Design of Air Breathing Engines**	Joint Propulsion Conference	San Jose, CA
18–19 Jul	**Missile Propulsion Design and System Engineering**	Joint Propulsion Conference	San Jose, 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
10–11 Aug	**Guidance of Unmanned Aerial Vehicles**	AVIATION 2013	Los Angeles, CA
10–11 Aug	**Systems Engineering Verification and Validation**	AVIATION 2013	Los Angeles, CA
17–18 Aug	**Emerging Principles in Fast Trajectory Optimization**	GNC 2013 Conferences	Boston, MA
17–18 Aug	**Recent Advances in Adaptive Control: Theory and Applications**	GNC 2013 Conferences	Boston, MA
10–12 Sep	**Human Engineering Principles for Flight Deck Evaluations**	Univ. of Tennessee Space Institute	Tullahoma, TN
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—INSPIRED AND ENERGIZED

Michael Griffin, AIAA President

Last year our friend Neil deGrasse Tyson produced an important video, "We Stopped Dreaming." The Internet buzzed with commentary: "Amazing," "Inspirational," "What are we waiting for?" With well over a million views on YouTube, Neil's video clearly struck a nerve. While I agree with all of the above adjectives, I would contend that we aerospace professionals have not stopped dreaming. The people who worked on *Curiosity*, some for a decade, never stopped dreaming. The people who worked to develop the International Space Station, across more than a dozen nations and over a quarter of a century, certainly never stopped dreaming. And the students working today to build their knowledge, capabilities, and credentials are doing so because they are driven by the same dreams of flight in all its forms, and how it can make the world a better place, as were all of us who are now at a stage where we look back fondly on those student days.

I believe that the gap between our dreams, our vision of what could be, and today's reality is not caused by any lack of passion or a vision, but by our inability to explain in simple terms what we do, why it matters, and exactly how hard it is. Clearly, Neil Tyson knows how to do this. Very few of the rest of us share that trait.

But even if many of us do not know how to share and explain our dreams, I know the inspiration that lies behind them is there because you, our AIAA members, have told us so. In the fall of 2012 we conducted focus groups at two of our conferences, and later followed up with discussions with Section members. These discussions focused on what the aerospace profession means to the people who work in it, what is inspiring about it, what are the current perceptions of AIAA, and what an ideal organization would look and act like. Our goal in this research was to understand AIAA's "why"—why does it exist, what are the organization's unwavering core beliefs?—and to understand also how we might better communicate the Institute's value to the larger aerospace community.

What we heard may not surprise you: aerospace professionals are passionate about what they do, they share a problem-solving mindset, are intrigued by learning something new. The ideal organization was described as a leader—broad, inclusive, intentional, active and energetic. Respondents felt strongly that their work is essential to society, and that the profession could use a champion to voice the many contributions of the aerospace profession to the economy, national security, and everyday life.

Our challenge as an Institute is to live up to your expectations. That begins with re-establishing AIAA's leadership role, not only as a technical leader—that must and will remain our core strength, the single factor that most distinguishes our Institute from others—but also as a relevant catalyst, connector, and champion for the aerospace profession. To do so, we must not stray from our purpose, the one that was at the heart of the union of IAS and ARS fifty years ago this February and the one that drives us today: to ignite and celebrate ingenuity and collaboration across the entire aerospace profession.

AIAA is committed to making certain that people inside and outside our profession are inspired by and energized about what's going on in aerospace. We're broadening our events, using social media to reach new audiences, helping to organize state-level aerospace days, and taking our concerns to Capitol Hill. We are working to make sure aerospace professionals are recognized for their contributions through our awards and Fellows programs. We're focusing on the future, whether that's the changing face of the industry or the people who work in it, ensuring that diverse voices are heard and that our young professionals can find enduring value in their AIAA membership. All of this contributes to making the dream a reality. Our dream is to make a difference, and aerospace does.

I'm certain there are a few communicators like Neil deGrasse Tyson in our membership just waiting for the right time and the right message. Both are here now.

ANNUAL BUSINESS MEETING NOTICE

Notice is hereby given that the Annual Business Meeting of the American Institute of Aeronautics and Astronautics will be held at The Westin Alexandria, Alexandria, VA, on Thursday, 9 May 2013, at 12:00 PM.

Klaus Dannenberg, AIAA Corporate Secretary

COMMEMORATING 50 YEARS OF CONSOLIDATION

A few members have recently inquired about the origin of the AIAA logo. The following is a reprint of an article that appeared in the February 1964 issue of *Aeronautics & Astronautics*, the previous name of *Aerospace America*:

Institute's Official Emblem Selected

After months of careful scrutiny of many designs, the symbol shown above has been selected to represent the AIAA and has won approval by President William H. Pickering as the Institute's official emblem.

The design will be used extensively on literature prepared by the Institute, on its letterheads, and will appear as well on membership cards and certificates and the membership pin.

Commenting on the selection, Dr. Pickering observed, "The choice of this emblem, symbolizing the fields of aeronautics and astronautics encompassed by AIAA activities, marks a milestone in our history and should be the hallmark of a dynamic and growing organization for years to come."

The symbol was created by the nationally known firm of Walter Dorwin Teague Associates, designers of the interiors of many Boeing airliners, and four New York World's Fair buildings. Eight organizations took part in the design competition.

A senior member of the firm, W. Dorwin Teague, is a long-standing member of the Institute.

INAUGURAL RISING LEADERS IN AEROSPACE FORUM DEEMED A SUCCESS!

Recently, AIAA completed its first ever Rising Leaders in Aerospace Forum, in conjunction with the 51st Aerospace Sciences Meeting in Grapevine, TX, 7–10 January. The forum offered the next generation of young aerospace leaders, age 35 and under, access to top aerospace leaders and their perspectives, and multiple opportunities for networking with those leaders and their peers.

Darin Haudrich from the Boeing Company, and Matt Cannella from the University of Colorado Boulder, Rising Leaders in Aerospace Forum co-chairs, began the forum by welcoming all attendees. A keynote speech by Sandy Magnus, AIAA Executive Director conveyed that everything you need to be a good leader you learned when you were in kindergarten. She reminded the forum participants that while they should never lose sight of why they entered the aerospace arena, their work–life balance is important and shouldn't be forgotten.

On Day 2 of the forum, attendees took part in the Leadership Exchange and Networking Reception. Hosted by the AIAA Young Professional Committee, the Leadership Exchange, or "speed networking" event, gave attendees the opportunities to interact with leaders from government, industry, and academia. The networking event provided participants the opportunity to meet top leaders and ask questions in a relaxed and personal environment. Joshua Locke from Spirit AeroSystems participated in the networking event, stating: "This was my favorite part of the entire AIAA conference. It was great to be put in an atmosphere where the mentors/experienced professionals were outside of their normal environment so that as young professionals we were not having to deal with attempting to meet and talk to them while they are catching up with old friends they see at the conference."

Day 3 of the forum featured an address by Daryl Pelc, Vice President of Engineering and Technology, Boeing Phantom Works. Mr. Pelc discussed professional development in a changing aerospace environment. He advised participants to set goals in four areas: professional, financial, physical, and family, and to keep a victory list of achieved goals. Mr. Pelc also urged participants to get involved in both professional and personal communities to enhance their career and professional network.

The fourth day of the forum concluded with a luncheon, with keynote address from Laura McGill, Deputy Vice President of Engineering, Raytheon Missile Systems. Ms. McGill described the numerous lessons she has learned throughout her career, including dealing with failures and successes, to taking different opportunities that came her way even if they were different disciplines within her work. She reminded the forum participants to "make every day count!"

Prithvi Lopez, president of the AIAA student branch at the University of Michigan summed up the Rising Leaders in Aerospace Forum, "I personally gained more in those few hours at the events than I have over the past couple of years while trying to figure out what direction I would like my career to take. I have also heard much of the same from the other Michigan students that were fortunate enough to attend as well. We have all made some lasting contacts that will serve us well for many years for career choices and career advice and are grateful for the opportunity."

AIAA would like to thank The Boeing Company for sponsoring the Rising Leaders in Aerospace Forum at the 51st AIAA Aerospace Sciences Meeting.

WISCONSIN CHAPTER HOLDS ROCKET SCIENCE FOR EDUCATORS WORKSHOP

The Wisconsin AIAA chapter provided another great outreach program for teachers recently. Based on past success, NASA and the Wisconsin Space Grant Consortium (WSGC) awarded the AIAA Wisconsin section a 2012 grant to support K–12 outreach. AIAA Wisconsin members Todd Treichel, Dr. Bill Farrow, and Dr. Martin Chiaverini combined their efforts to conduct a Rocket Science for Educators workshop specially designed to provide K–12 teachers with ideas, knowledge, and techniques for promoting science using both solid fuel and water-powered rockets.

The goal of the Rocket Science for Educators workshop was to assist schools in implementing rocket science into respective math or science curriculums. The 2013 workshop was held in Milwaukee, WI, with much appreciated assistance provided by Milwaukee School of Engineering (MSOE) personnel and facilities. Each educator who participated in this free workshop received a set of rocket science materials they could take back to their respective schools.

AIAA Wisconsin's wants to get young students excited about math, science, and technology education by making it exciting, empowering, and fun for the students.

AIAA member Jonathon Slightam prepares payload capable rocket for launch.

K–12 educators build water fueled rockets.

AIAA-Wisconsin instructors Dr. Bill Farrow (front left) and Todd Treichel (front right) in the Rocket Science for Educators group photo taken in Milwaukee, WI.

RUGGIERO HONORED WITH 2013 SPERRY AWARD

Dr. Eric Ruggiero from GE was the 2013 recipient of the Lawrence Sperry Award. The Lawrence Sperry Award is presented for a notable contribution made by a young person, age 35 or under, to the advancement of aeronautics or astronautics. This award honors Lawrence B. Sperry, pioneer aviator and inventor, who died in 1923 in a forced landing while attempting a flight across the English Channel. Dr. Ruggiero received the award at the 2013 AIAA Aerospace Sciences Meeting in Grapevine Texas on 8 January 2013, for his innovation and leadership in turbo-machinery seals technology. He was interviewed by Ryan Rudy (Chair, Young Professional Committee [YPC]) and Kimberly Hicks (Deputy Chair).

Ryan Rudy (RR): Can you give us a bit of background about yourself? What led you into engineering?

Eric Ruggiero (ER): I grew up in southern New Hampshire, in a small town called Kingston. I am probably one of the only persons in my entire family who enjoys math and science. When I was in 7th grade, I have a particular memory in mind: in our homeroom classroom we had one of these charts that had "skills you learn in school" and "professions" on the other axis. There were only two professions that actually had dots all the way across the board meaning you used every skill you learned in school—either becoming a medical doctor or an engineer. That sparked my interest in learning more about "what does it mean to be an engineer?" and I made sure my Sanborn Regional High School courses aligned me on that kind of scientific track going into an engineering field. I enjoyed the technology aspect; that is what drew me in the most. And now, looking back, that is absolutely my passion. That, and working with people—which is why I love engineering and the job that I have right now.

Kimberly Hicks (KH): How did you become involved in sealing technologies?

ER: All right, so that's a fun story. I went to Virginia Tech and got all three degrees there—bachelor's through Ph.D. in mechanical engineering. When I started at Virginia Tech I knew I wanted to be an engineer, but I didn't know what field. I really fell in love with mechanical engineering when I was introduced to piezoelectric materials in the Center for Intelligent Material Systems and Structures my Freshman year at Virginia Tech. If you fast forward a couple of years, my undergraduate research led into "why don't you stick around to do a masters?" and that rolled into "why don't you continue onto a Ph.D.?" That's how I got into adaptive structures, and that was how I first was introduced to AIAA and my research career. In January 2005, I was nearing the end of my Ph.D., and I was interviewed by Imdad Imam at GE Global Research. His group was called the Performance Technologies Laboratory, and his lab worked primarily in developing advanced seal concepts for all of GE's businesses, whether it be aviation, energy, or oil and gas. I went to New York for my interview with the intent of "just to interview" because I didn't really see a great fit. I came away from my interview blown away by the depth of the people that were there; it was much different than the perceptions on industrial research I had heard in academia … in a very positive way. But still, background-wise I was kind of on the edge. When I came back from that interview, my wife, Jennifer, and I had a heart to heart about what is most important to us as we transitioned into "life beyond Blacksburg," … one of the biggest things for us is family. The research position at GE won out because it was geographically close to both sides of our family. So I accepted the job offer at GE Global Research, and I threw myself into the Performance Technologies Lab and started working on turbomachinery seals. I love the breadth of problems, and the depth and challenge of the problems that came with working for Imdad.

KH: So as you got into the sealing technologies, who were the most influential people that mentored you and helped shape where your career is today?

ER: Shortly after joining GE, I asked Chris Wolfe, who at the time was a senior engineer within the Performance Technology Laboratory, if he would mind serving as my mentor. Now it was a little unusual because sometimes folks might not feel comfortable asking for a mentor within their own group. But what I really appreciated about Chris was that he had spent a number of years working in GE's business side and he also had a healthy element of the research center under his belt in terms of experience. Chris introduced me not only to sealing technology but also how the business works, how the research center works, and how to find success with all the different moving parts that go into building a research program. I really credit him for getting me started on the right foot and such a strong foundation at the research center. I'd also like to acknowledge Imdad Imam, the manager who hired me, because he has never been afraid to throw a lot of responsibility to early hires within his teams and have them take on big challenges early on in their career as opposed to, say, waiting. It takes a lot of faith and trust in your team and in the person that you are asking to do that, and Imam has done this with just about everyone that has joined his team. In my own particular case, he provided me with opportunities, especially with GE Oil & Gas, to work on very large programs that were very closely tied to product. These programs had very tight schedules, but they also gave me an opportunity to make an impact in an immediate way. It was a wonderful set of opportunities that I am very appreciative of.

KH: Can you tell us a bit more about your specific area of research that you work in, a little bit more about the particulars of what you do?

ER: My first stint was with GE Oil & Gas. I worked with Nuovo Pignone to develop advanced seals for their compressor product line. The compressors we worked on are typically used for the generation of LNG. In particular, we worked on developing a new seal for what is called the tertiary seal; this seal is located on the ends of the compressors and its purpose is to prevent lubrication oil from migrating across the shaft of the compressor and gumming up the most critical seals of the machine (which are called the dry gas seals). You don't want any of that gas to leak out because of environmental concerns, hence the dry gas seals operate with incredibly tight running clearances. The dry gas seals are not very tolerant to liquids, so that's why you have these tertiary seals to act as a buffer between the compressor bearing cavities and the dry gas seals. We worked on developing a brush seal alternative solution to the existing tertiary seal technology. A brush seal is as its name implies – it looks like a paintbrush in terms of having a bristle pack that is attached to the stationary housing of the compressor and the bristles kiss the rotor of the compressor to form a seal. The bristles act like little cantilever beams and track the rotor throughout the operation of the compressor; thus, the brush seal is very tolerant to these types of dynamic excursions. So we proved over a couple year program that the brush seal was an attractive solution because it was very robust to such transients and it was competitive with the best in class tertiary sealing technology available at the time. So that was my introduction to the sealing world.

Meanwhile, the other fun thing I got to do was bring my smart materials background to the world of seals. I was always curious about what a seal would look like if I looked at a seal through the lens of a controls engineer. I put together a technology development program where we inserted a fiber optic sensor into a brush seal and we were able to demonstrate that we could track temperature with it, track the displacement of the bristle pack, and do some other cool things that had never really

Above: Eric Ruggiero receiving the Sperry Award from Paul Nielsen. Top right: Mr. Ruggiero with Ryan Rudy, Chair, YPC. Bottom right: Mr. Ruggiero with Kimberly Hicks, Deputy Chair, YPC.

been explored before. That was a lot of fun because it was just kind of a crazy idea. We've got mechanisms in place at GE Global Research where you can present your crazy ideas and get a little pot of money to go off and try to make them happen. We strung together a number of tests which eventually led to an engine demonstration. Nothing beats seeing your ideas come to life on an engine.

Most recently, starting about three years ago, there was an opportunity to have an advanced seal technology development effort for our aviation business. So I got to work on bringing together multiple advanced seal design concepts for our next generation aircraft engines. With that program underway, the opportunity came up for me to apply as a lab manager within the research center and to work for Todd Wetzel. My lab is the Turbine Heat Transfer Technologies Laboratory. As a lab manager at the research center I have a team of the world's best experts in gas turbine heat transfer and my team's responsibility is to design, build, test, and innovate on the latest and greatest cooling technologies that go into our gas turbine products.

KH: What advice do you have for students considering entering the aerospace field?

ER: If you already have the passion for technology and you're going into engineering, my advice for young engineers is to not be afraid to make mistakes. A lot of times I find as I speak and interact with grad students that they're very tentative in trying new things. Sometimes it is because of fear of failure. My first failure at GE had a huge impact on my life because I was given the chance to learn from my mistake and to rebound and make it a success. If young engineers had more of that "I'm just going to try it out attitude" then things would just get done quicker. Engineers would learn more, faster, and we would get to the right solutions in a much more expedient way compared to just waiting and always trying to take the conservative route. In summary, "be bold".

KH: How do you keep busy outside of work and AIAA?

ER: I've been happily married for just over eleven years now and my wife, Jennifer, and I have two children: Mason who will be 8 this year and my daughter Megan who will turn 5 in just a couple months. Really my family is my life outside of my nine to five job. We try to do as much we can as a family. Outside of that I love to play basketball. I'm a very competitive person so I like to do a lot of sports. I also enjoy billiards. I'm now coaching my son's second grade teams, both soccer and basketball, which I'm enjoying tremendously. I also enjoy professional baseball, and it's a lifelong goal of mine to see all of the MLB ballparks.

KH: What role has AIAA played in your career?

ER: Getting involved early on in grad school with the adaptive structures technical committee was really my introduction to AIAA. I love the passion present when you get together in a technical committee room. The idea of getting brilliant people together in the same room that have great ideas for how to advance the state of the art of technology – that really is what made a lasting impression on me. That helped me to grow my network, which led to other walks of life.

KH: If you had to say, what are your top three value added reasons to be an AIAA member, what would they be?

ER: Numbers one, two, and three would be networking. The fact that within AIAA you get these pockets of technical excellence that then take the form of not just technical committees but also as conferences – I think that's a great purpose for why AIAA should exist. You bring people of like mind together that have creative ideas and different thoughts and AIAA provides structure so that you can then develop the state of the art of technology. I really think that that is an important role that AIAA should be playing. And I think that they do.

KH: What is your perception of AIAA's engagement of younger members?

ER: For me personally, because my advisor, Dan Inman, who has and continues to be so actively involved with AIAA, I was able to align my professional career with a lot of the values that drive technical committees. I got exposed to the environment of what defines success within the Adaptive Structures technical community, and so I was able to model my own career after what well established folks had already done.

In terms of engagement I would say, then, that what I have seen of late is that the engagement is on an upward trajectory. I do enjoy the YP e-newsletters that get sent out. I enjoy reading those and seeing what is going on. For me in my new role as a lab manager I am always looking for the world's best talent, so when you guys [AIAA] are highlighting people my ears perk up because they could potentially be the next GE global research employee, coming from a recruiting stand point. That monthly letter at least tunes me in to know that there are YP activi-

ties going on. Prior to that publication coming out it was only because I was actively involved that I knew things were going on. The other thing that I enjoy seeing is from conferences: I open up the program and I see that there are dedicated sessions for YPs and invitation-only events for YPs. I think that is a fantastic opportunity you guys are providing to that community to say "hey look, we embrace you, we want you to be excited about this and to be actively engaged and to continue being actively engaged beyond turning 36 years old".

Networking and introducing yourself takes energy. It is something you have to pursue. It doesn't just fall into your lap just because you show up at a conference. Everyone needs to understand that this is a fantastic opportunity here, but you have to take the initiative to make it happen and to start connecting those dots that otherwise might not be connected in your life. If you don't realize that, then I can see where people can just sit back and say "oh man, AIAA, (or any professional society) you're not doing anything for me". If you don't put your energy into it then it's really hard to get any energy out of it.

KH: What do you think either the YPC or AIAA as an institute could do better? Where is there room for improvement? In terms of engaging YPs and getting them involved and showing them the value of membership?

ER: The newsletter is the right thing. The YPC needs to keep that up. The networking events that you sponsor at various conferences – I don't think you can advertise those enough to get people engaged. You need a level of personal invitation. If there are either existing young professionals, or potential young professionals, your network has to be broad enough that you can actually tap people on the shoulder and say, face to face, "Hey, I really want you to come to this networking event." I don't know if there is an opportunity where you invite some of these young professionals who are in that 30 to 35 category to present to other AIAA sections. The result of such opportunities would be twofold: one would be to try and strengthen the person's resolve as to why the person is a member of AIAA; and two, at the same time, give other young professionals a chance to hear what role AIAA has meant to someone else and how it is linked to success.

KH: Is there anything else you would like to add?
ER: I can say, reflecting on my career, especially at the research center, I love the people that I work with, and I love the challenge of the technological problems that we are tackling every day. You have to love the people that you work with and love the technology that you are working on. If you have these two elements, you'll find success no matter where life takes you.

AIAA DEPUTY EXECUTIVE DIRECTOR DANNENBERG ELECTED AS CORRESPONDING MEMBER OF THE INTERNATIONAL ACADEMY OF ASTRONAUTICS

Dr. Klaus Dannenberg, deputy executive director and AIAA Fellow, has been elected to the International Academy of Astronautics (IAA) as a Corresponding Member of the Engineering Section. Before joining AIAA as its deputy executive director in 2005, Dr. Dannenberg had over 37 years of experience in a multitude of engineering and business roles in the aerospace community. His contributions were in the application of information technology to complex aerospace and defense problems, primarily in the development of guidance, navigation, and control systems for launch vehicles, spacecraft, tactical missiles, and aircraft, and in the development of C3I systems and large-scale training and simulation networks. Dr. Dannenberg was inducted during the Academy's annual dinner on 18 March 2013, in Paris, France.

From left to right: Dr. Dannenberg with Dr. G. Madhavan Nair (President, IAA), Yannick d'Escatha (President, CNES), Jean-Michel Contant (Secretary General, IAA—behind d'Escatha), and Professor Antonio Viviani (Seconda Universita di Napoli).

Twenty other AIAA members were elected to the IAA in 2012.

Corresponding Members Basic Sciences Section
Mike Gruntman, AIAA Associate Fellow

Corresponding Members Engineering Section
Shoichiro Asada, AIAA Senior Member
Mengu Cho, AIAA Senior Member
David W. Dunham, AIAA Senior Member
David Finkleman, AIAA Fellow
James Graf, AIAA Associate Fellow
Fazle Hussain, AIAA Fellow
Alfred Ng, AIAA Senior Member
Pat L. Patterson, AIAA Senior Member
Igor V. Sorokin, AIAA Senior Member

Members Engineering Sciences Section
Tibor Balint, AIAA Senior Member
Byoungsoo Kim, AIAA Member
Giorgio Saccoccia, AIAA Associate Fellow
Haruki Takegahara, AIAA Senior Member
Ronald E. Turner, AIAA Senior Member
Jingli Yang, AIAA Senior Member

Corresponding Members Life Sciences Section
Ernest H. Wu, AIAA Senior Member
Members Life Sciences Section
Oliver Ullrich, AIAA Senior Member

Corresponding Members Social Sciences Section
James Keravala, AIAA Senior Member

Members Social Sciences Section
Yanhua Wu, AIAA Senior Member

The IAA brings together the world's foremost experts in the disciplines of astronautics on a regular basis to recognize the accomplishments of their peers, to explore and discuss cutting-edge issues in space research and technology, and to provide direction and guidance in the nonmilitary uses of space and the ongoing exploration of the solar system. Visit http://iaaweb.org.

ANNOUNCING THE *JOURNAL OF AEROSPACE INFORMATION SYSTEMS*

Ashok Srivastava, Editor-in-Chief, Journal of Aerospace Information Systems

The following is an excerpt from the editorial that was published in the January issue of *Journal of Aerospace Information Systems* (formerly *Journal of Aerospace Computing, Information, and Communication*). Please visit Aerospace Research Central (**arc.aiaa.org**) for more information about this journal.

At the end of May 2012, I joined the *Journal of Aerospace Computing, Information, and Communication* (*JACIC*) as Editor-in-Chief with the intent of creating a premier journal focusing on the theoretical developments, novel applications, and case studies regarding the information systems that have become the foundation of modern aerospace systems. The extensive use of computing and information systems has extended the capabilities, performance, autonomy, and resilience of aerospace systems to unprecedented levels. As was noted by Prof. Lyle Long, the founding editor of *JACIC*, the fields represented by the journal would form a fifth pillar in aerospace engineering along with aerodynamics, propulsion, structures, and dynamics and control ("Computing, Information, and Communication: The Fifth Pillar of Aerospace Engineering," *JACIC*, Vol. 1, No. 1, Jan. 2004). Indeed, some studies indicate that the software for a modern commercial aircraft accounts for about 50% of the entire cost of the aircraft, thus lending significant support for his visionary assertion.

To focus the *JACIC* on the research regarding the information systems on aerospace applications the AIAA Publications Committee has approved the following change to the scope of the journal:

> This journal is devoted to the dissemination of original archival research papers describing new theoretical developments, novel applications, and case studies regarding advances in aerospace computing, information, and communication systems. Topics include aerospace systems and software engineering; verification and validation of embedded systems; the field known as 'big data,' data analytics, machine learning, and knowledge management for aerospace systems; human-automation interaction and systems health management for aerospace systems. Applications of autonomous systems, systems engineering principles, and safety and mission assurance are of particular interest. The journal also features Technical Notes that discuss particular technical innovations or applications in the topics described above. Papers are also sought that rigorously review the results of recent research developments. In addition to original research papers and reviews, the journal publishes articles that review books, conferences, social media, and new educational modes applicable to the scope of the journal.

Along with the new scope described above the Committee approved the new title of *Journal of Aerospace Information Systems* (*JAIS*). As part of the transition to the new title and scope of the journal, we created a new team of Associate Editors (see journal masthead at **arc.aiaa.org**). These individuals are highly accomplished in their fields. I am delighted that the team is comprised of outstanding and dedicated individuals who are committed to the mission of the journal.

CALL FOR PAPERS FOR *JOURNAL OF AEROSPACE INFORMATION SYSTEMS* SPECIAL ISSUE ON "AEROSPACE AND MECHANICAL APPLICATIONS OF REINFORCEMENT LEARNING AND ADAPTIVE LEARNING BASED CONTROL"

The *Journal of Aerospace Information Systems* (formerly the *Journal of Aerospace Computing, Information, and Communication* (*JACIC*)) is devoted to the applied science and engineering of aerospace computing, information, and communication. Original archival research papers are sought that include significant scientific and technical knowledge and concepts. The *Journal* publishes qualified papers in areas such as aerospace systems and software engineering; verification and validation of embedded systems; the field known as "big data," data analytics, machine learning, and knowledge management for aerospace systems; and human-automation interaction and systems health management for aerospace systems. Applications of autonomous systems, systems engineering principles, and safety and mission assurance are of particular interest. Articles are sought that demonstrate the application of recent research in computing, information, and communications technology to a wide range of practical aerospace problems in the analysis and design of vehicles, onboard avionics, ground-based processing and control systems, flight simulation, and air transportation systems.

Key research areas included in the special issue are:

- Learning with limited data and/or in domains for which obtaining data is expensive or risky
- Real-time reinforcement learning with resource constraints (e.g., limited memory and computation time)
- Use of reinforcement learning for risk sensitive or safety critical applications
- Scaling reinforcement learning to multi-agent systems
- Distributed reinforcement learning
- Adaptive learning-based control in the presence of uncertainty

These areas are only indicative. The special Issue is also open to manuscripts that are relevant to the applied science and engineering of aerospace computing, information, and communication but do not fit neatly into any of the above areas. We do envisage, however, that successful manuscripts will include experimental results, or at least sophisticated simulations of real-life mechanical or aerospace systems.

Reinforcement learning and learning-based adaptive control are powerful techniques to perform planning and control for systems with significant model errors and uncertainty. In the computer science community many benchmark types examples have been tackled successfully, showing the advantage of these learning techniques. The goal of this special issue is, however, to assemble high-quality papers that highlight the use of these techniques in more complex aerospace and mechanical engineering applications. In particular, papers are encouraged that demonstrate the use of these learning-based planning and control approaches on physical systems operating in real-world situations with significant disturbances and uncertainties. Classes of uncertainties could include modeling error, uncertainty due to environmental/external effect, hybrid/switched dynamics, sensing/actuation errors, noise, sensing/actuation failures, and structural damage/failures. Model-free and model-based control/planning techniques should highlight online long-term learning through construction and exploitation of (approximate) models of the agent, the environment, value functions, state/action constraints, etc. Long-term learning could be characterized by improved tracking, improved mission-score, online generation of optimal policy, predictive ability, and accurate prognosis.

Examples of classes of planning and reinforcement learning techniques include, but are not limited to: approximate dynamic programming, temporal difference learning, adaptive function approximation techniques, planning under uncertainty, intelligent exploration scheme, and learning with risk mitigation.

Examples of classes of control techniques of interest include, but are not limited to: indirect adaptive control, hybrid direct/indirect adaptive control, dual-control, adaptive model predictive control, direct optimal adaptive control using reinforcement learning, learning-focused neuro-adaptive and neuro-fuzzy control, nonparametric control. In general, papers that leverage exploitation of predictive ability of online learning and adaptation are encouraged, whereas papers that focus on adaptation based on reactive short-term learning would risk being outside the scope of this issue.

Organizers

Dr. Jonathan P. How is the Richard C. Maclaurin Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology. He received a B.A.Sc. from the University of Toronto in 1987 and his S.M. and Ph.D. in Aeronautics and Astronautics from MIT in 1990 and 1993, respectively. He then studied for two years at MIT as a postdoctoral associate for the Middeck Active Control Experiment (MACE) that flew on-board the Space Shuttle *Endeavour* in March 1995. Prior to joining MIT in 2000, he was an Assistant Professor in the Department of Aeronautics and Astronautics at Stanford University. He has graduated 36 Ph.D. students while at MIT and Stanford University on topics related to GPS navigation, multi-vehicle planning, and robust/hybrid control. Current research interests include the design and implementation of distributed robust planning algorithms to coordinate multiple autonomous vehicles in dynamic uncertain environments; reinforcement learning for real-time aerospace applications; and adaptive flight control to enable autonomous agile flight and aerobatics. Professor How was the planning and control lead for the MIT DARPA Urban Challenge team that placed fourth, he was the recipient of the 2002 Institute of Navigation Burka Award, a Boeing Special Invention award in 2008, the 2011 IFAC Automatica award for best applications paper, the AIAA Best Paper Award from the 2011 Guidance Navigation and Control Conference, and he is an Associate Fellow of AIAA and a senior member of IEEE.

Dr. Nicholas Roy is an Associate Professor in the Department of Aeronautics & Astronautics at the Massachusetts Institute of Technology and a member of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. He received his Ph.D. in Robotics from Carnegie Mellon University in 2003. His research interests include autonomous micro air vehicles, decision making under uncertainty, machine learning and human-computer interaction. He is the recipient of awards including the NSF Career Award, IEEE Robotics and Automation Society Early Career Award, and best paper award at the 2008 IEEE International Conference on Robotics and Automation. His research group received awards at the 2008 International Micro Air Vehicle and 2009 AUVSI International Aerial Robotics Competitions.

Dr. Alborz Geramifard is currently a postdoctoral associate at MIT's Laboratory for Information and Decision Systems (LIDS). He is also affiliated with the computer science and artificial intelligence laboratory (CSAIL). Alborz received his Ph.D. from MIT working with Jonathan How and Nicholas Roy on representation learning and safe exploration in large-scale sensitive sequential decision-making problems in 2012. Previously he worked on data efficient online reinforcement learning techniques at University of Alberta where he received his M.Sc. in Computing Science under the supervision of Richard Sutton and Michael Bowling in 2008. Alborz received his B.Sc. in Computer Engineering from Sharif University of Technology in 2003. His research interests lie at machine learning with the focus on reinforcement learning, planning, and brain and cognitive sciences.

Preparation of Manuscript

Before you submit to an AIAA journal, please review your manuscript to ensure that it meets the following requirements. If your manuscript does not meet the requirements on this list, it may be returned to you for further revision before it can be assigned to an associate editor.

1) Papers must be in single-column, double-spaced format.
2) Each full-length paper must have a summary-type abstract of 100 to 200 (maximum) words in one paragraph. The abstract should *NOT* state what the author *WILL* do, present, or discuss in the article. The abstract *MUST* summarize the research that was carried out and the major findings.
3) Papers with many symbols should have a nomenclature that defines all symbols with units, to be inserted between the abstract and the introduction. Acronyms should be defined in the text, not in the nomenclature.
4) An introduction that states the purpose of the work and its significance relative to the prior literature is required.
5) Equations should be numbered sequentially and not by section.
6) References should be introduced and in numerical order (not just by author name); websites should not be referenced but should be mentioned in the text or in a footnote.
7) Figure legends should be readable and based on AIAA format instructions.
8) Conclusions should be a detailed discussion of study findings. Do not introduce concepts not presented in text; do not refer to other work.
9) Grammar should be checked for clarity.

All manuscripts must be submitted through the Manuscript Central site: **http://mc.manuscriptcentral.com/aiaa-jacic**.
The review process will follow the standard AIAA procedures, but will be managed by the Associate Editor. Each submitted manuscript will undergo a full review process involving at least three reviewers.
Submitted articles will be candidates for both *JAIS* and/or a possible forthcoming volume in AIAA's Progress in Astronautics and Aeronautics book series on this topic. Participation in the book may require some additional editorial development of your material beyond its finished state for the journal, but relevant content should not be held back from a journal article. For use as a book chapter, the addition of introductory text and some basic tutorial framing may be necessary in order to put an article in context and enhance the ability of less-experienced readers to access the material. AIAA staff will provide guidance in ensuring that appropriate permissions releases and copyright paperwork are in place for all works.

Deadline: Submissions are due by **15 August 2013**.
Publication Date: The anticipated publication date of the special issue is **January 2014**.
Journal Website: http://arc.aiaa.org/loi/jacic
Contact Email: jhow@mit.edu

Alborz is the recipient of the NSERC postgraduate scholarships 2010–2012 program.

Dr. Girish Chowdhary is currently a postdoctoral associate at the Massachusetts Institute of Technology's Laboratory for Information and Decision Systems and the School of Aeronautics and Astronautics. He received his Ph.D. from Georgia Institute of Technology in 2010 where he was a member of the UAV Research Facility. Prior to joining Georgia Tech, Girish worked as a research engineer with the German Aerospace Center's (DLR's) Institute for Flight Systems Technology in Braunschweig, Germany. Girish received a MS degree in Aerospace Engineering from Georgia Tech in 2008, and a BE with honors from RMIT University in Melbourne, Australia, in 2003. His research interests include adaptive and fault tolerant control, machine learning and Bayesian inference, vision-aided navigation, decentralized control of networked systems, and collaborative planning and learning. He is interested in applications in aerospace guidance, navigation, and control, manned/unmanned aerial vehicles, autonomous ground vehicles, mechanical systems, and automated drilling. He is the author of over 50 peer-reviewed publications.

Dr. Thomas Walsh is currently a postdoctoral associate at the Massachusetts Institute of Technology's Laboratory for Information and Decision Systems (LIDS). He received his Ph.D. from Rutgers University in 2010 under the direction of Prof. Littman. His thesis research was on efficient Reinforcement Learning with compact models. Thomas was previously a research associate with the Center for Educational Testing and Evaluation at the University of Kansas where he conducted machine learning research in the field of Education. He was also a postdoc at the University of Arizona where he worked on learning from demonstrations. He received his B.S. in Computer Science from the University of Maryland, Baltimore County (UMBC). His research interests include rich representations for RL, apprenticeship learning, planning in stochastic domains, and using AI techniques in Educational modeling.

OBITUARIES

AIAA Fellow Emeritus Curtiss Died in September 2012

Howard "Pat" Curtiss, an Emeritus Professor of Mechanical and Aerospace Engineering at Princeton University, died 20 September 2012. He is remembered as a pioneering researcher in the field of helicopter dynamics and aerodynamics and as an exceptional teacher and advisor to his students. His lifelong fascination with flight was both infectious and exciting.

Professor Curtiss was highly regarded for his contributions to understanding the complexities of helicopter forces and motions. He was director of the Princeton University Dynamic Model Track for nearly 30 years and a leading theorist. He was responsible for the design and construction of the 750-ft-long track and directed all experimental activities at the track for several decades. The track was essentially an inverse wind tunnel, which allowed an accurate portrayal of the boundary layer in ground effect. Numerous models of helicopters and V/STOL aircraft were tested over the years, the XC-142 and Sikorsky's ABC helicopter among them. Professor Curtiss published pioneering studies on helicopter rotor blade motion, authored influential work on control system design, and was the co-author of a highly regarded textbook, *A Modern Course in Aeroelasticity*.

Curtiss served as a consultant for many aerospace companies, including Sikorsky, Agusta Helicopters, Kaman Aerospace, and Piasecki Aircraft. He was in great demand as a lecturer throughout his career. For many years, he co-taught the widely acclaimed summer course, Helicopter and VSTOL Technology, with Barnes McCormick at the Pennsylvania State University. In 1985, he was appointed as an honorary professor at the Nanjing Aeronautical Institute. In the following years, he served as visiting research fellow at Glasgow University and the Technical University of Braunschweig. In 2000, Professor Curtiss delivered the American Helicopter Society's Nikolsky Honorary Lecture, named for his thesis adviser, Alexander Nikolsky.

Most recently, Professor Curtiss designed a new helicopter rotor blade that significantly improves the load-carrying ability, cruising speed, and range of Sikorsky S-61 helicopters. With no modification to the powerplant, the main rotor provides a startling 2,000-lb increase in load-carrying ability, and it allows a significant increase in both cruising speed and range, challenging the performance of state-of-the-art helicopters. The rotor blades are manufactured by Carson Helicopters, and are used on the "Marine One" helicopter fleet used by the President as well as by the British navy.

Professor Curtiss's technical contributions are only surpassed by the influence he had on his undergraduate and graduate students. He combined an enthusiasm for his field with sparkling wit and patience with those new to a complex and sometimes bewildering topic. Many of his students became professors, researchers, administrators, and leaders in industry and government.

While Curtiss became a professor emeritus in 1998, he remained an active force in helicopter research and development. The titles of the two most recent Ph.D theses advised by Professor Curtiss are "High frequency directional axis dynamics of helicopters with ducted tail rotors" (Kothmann, 2000) and "The effect of rotor motion on the induced velocity in predicting the response of rotorcraft" (Keller, 1998).

Professor Curtiss completed a B.A.E. at Rensselaer Polytechnic Institute in 1952 and his Ph.D. at Princeton University in 1965. After participating in Naval R.O.T.C. Training, he was commissioned and served as a Line Officer on the U.S.S. *Mississippi*, from 1952 to 1954. He was the Editor of the *Journal of the American Helicopter Society* from 1972 to 1974. He was a Fellow of the American Helicopter Society and the American Institute of Aeronautics and Astronautics and a 54-year AIAA member.

AIAA Senior Member Hubbarth Died in January

William F. Hubbarth died on 3 January. He was 82 years old.

Mr. Hubbarth received his B.A. from The College of Wooster in 1952 and his master's and Ph.D. degrees in 1953 and 1956, respectively, from Ohio State University. After graduation, Mr. Hubbarth started at IBM's Federal Systems Division Human Factors Program in Owego, NY. In 1968 he was transferred to Los Angeles.

In 1970 his group teamed with North American Aviation for Phase B of the Apollo Space Program. During this time Hubbarth was in Huntsville for two years before returning to Owego to finish the program. He then went on to work on the Manned Orbital Laboratory (MOL) program to team with the Air Force for astronaut training for the Space Shuttle Program. During this period, he became a member of the AIAA Space Committee.

The MOL program transferred Hubbarth to IBM's Federal Systems Division in Westlake Village, CA, to continue his team's work with the Air Force astronaut training program. Hubbarth retired in 1994 when Federal Systems was sold to Loral.

AIAA Associate Fellow Davidson Died in January

Dr. Julian Davidson, founder of Davidson Technologies and benefactor of the U.S. Space & Rocket Center's Davidson Center for Space Exploration, died on 31 January. He was 86 years old.

Before founding aerospace and defense company Davidson Technologies in 1996, Davidson was Deputy Program Manager of Ballistic Missile Defense for the U.S. Army, and was the first director of the Advanced Ballistic Missile Defense Agency.

Davidson and his wife, Dorothy, donated $2 million to boost fundraising efforts for the 68,000-square-foot, $22 million Davidson Center for Space Exploration at the U.S. Space & Rocket Center. The Davidson Center, opened in 2008, houses a restored original Saturn V rocket—one of three remaining in the world—and has become a premiere tourist attraction in North Alabama. The Davidsons also donated $2 million toward construction of the Davidson Center for the Arts at the Huntsville Museum of Art. The new wing opened in 2010.

AIAA Senior Member Brubaker Died in February

William C. "Bill" Brubaker died on 12 February. He was 91 years old.

Mr. Brubaker earned a bachelor's degree in aeronautical engineering at Tri-State College in Angola, IN. A U.S. Army Air Corps veteran of World War II, he was responsible for performing clearances of flights from one field to another in Texas and for sending Army Headquarters materials from one base to another via teletype.

He was an aeronautical engineer at Glenn L. Martin Co. (Martin Marietta Corp., now Lockheed Martin Corp.) for 25 years, where he did designing, stress analysis, weights and dynamics on commercial and advanced military aircraft and all 12 of the Gemini launch vehicles. He worked on Apollo 1 through Apollo 12. During his three years at Bellcom, he was a technical adviser for several NASA manned space program missions, including Skylab, the first manned laboratory in space. He was listed on the Gemini monument and the Apollo monument at the U.S. Space Walk of Fame in Florida. For 20 years, he worked on automobile and

school bus safety at the U.S. Department of Transportation in the National Highway Traffic Safety Administration.

In 1991, as a Maryland licensed professional engineer, Mr. Brubaker worked with the state of Maryland and received approval to voluntarily teach "A World in Motion" science program that he helped develop with the Society of Automotive Engineers. This work earned him an annual Bill Brubaker Scholarship with the SAE, and 17 scholarships for high school graduates attending Maryland engineering schools have been awarded. He was also awarded the first Dr. William G. Agnew Award at SAE for his world-in-motion work, which went statewide in Maryland in 1992. In 2007, Altoona Area High School gave him a Distinguished Alumni Award for all his work in space and motion. Mr. Brubaker was a 47-year member of AIAA.

AIAA Associate Fellow Laub Died in February

Bernard "Bernie" Laub, age 73, passed away on 12 February.

Mr. Laub attended New York University, where he graduated with a masters degree in Aerospace Engineering. He started his career with Avco Everett Research Laboratories in Everett, MA, worked in ablative materials used to protect atmospheric entry vehicles, and received international recognition for his work.

Over nearly five decades, that saw Mr. Laub move from Avco to Aerotherm Corp. to NASA Ames Research Center, he led and managed numerous projects on the development, testing, and modeling of ablative materials ranging from AVCOAT (used to protect the Apollo capsule) to high-density materials used in ballistic missiles. After the end of the Strategic Defense Initiative (SDI) program, he moved to NASA where he helped re-establish and mentor a vibrant R&D program on the next generation of ablative materials for US space missions.

Mr. Laub's untiring efforts were recognized by NASA with the Distinguished Service Medal in 2008, and by the AIAA with its Thermophysics Award in 2012. He was an AIAA Associate Fellow.

AIAA Senior Member Bernier Died in February

Robert E. Bernier, a European representative for NASA based in Paris during the Apollo missions 1969–1972, passed away on 17 February 2013. He was 77 years old.

Mr. Bernier was a graduate of Rensselaer Polytechnic Institute with a degree in aeronautical engineering and worked on early liquid rocket engine theory with General Dynamics Convair Astro Corporation; he later worked with the GE and Martin Companies.

Following his employment with NASA, Mr. Bernier was Assistant Vice President at COMSAT, pioneering satellite communications, in particular early satellite dish initiatives. Bernier served as COMSAT's representative to Saudi Arabia 1982–1983. Bernier later represented French aerospace and telecommunications company Alcatel Espace in the United States.

AIAA Fellow Robert C. Goetz Dies At 75

Lockheed Martin Skunk Works® retired vice president of Engineering Robert C. Goetz died February 18, 2013, at his home in Friendswood, Texas. He joined Lockheed in 1987 after a very productive 29-year career at NASA, from which he retired as deputy director of Johnson Space Center in 1987.

Goetz started at NASA Langley Research Center in 1959, after receiving his B.S degree in aeronautical engineering from Georgia Institute of Technology. Initially he did research in hypersonic aero elasticity. In 1967 he received his M.S. degree in engineering mechanics from Virginia Polytechnic Institute. From 1973 to 1983 he held a series of engineering management positions at Langley. He then was appointed deputy director at Johnson Space Center.

Joining the Lockheed Skunk Works® in 1987 as deputy director of Engineering he advanced to director and then to vice president of Engineering in 1992. During his thirteen years at Lockheed and Lockheed Martin he skillfully nurtured a multidiscipline organization intensely involved in advanced technology development and its rapid practical application to numerous programs, including the X-35 Joint Strike Fighter prototype aircraft and several classified programs.

Goetz was a Fellow of the American Astronautical Society and of the American Institute of Aeronautics and Astronautics. In 1981 he received the NASA Exceptional Service Award for "Outstanding contributions to Space Shuttle technology and for direction of a broad range of analytical and experimental certification efforts for STS-1." He was elected to the Academy of Distinguished Alumni at Georgia Tech.

CALL FOR NOMINATIONS

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

Any AIAA member in good standing may serve as a nominator and are highly urged to carefully read award guidelines to view nominee eligibility, page limits, letters of endorsement, etc. AIAA members may submit nominations online after logging into **www.aiaa.org** with their user name and password. You will be guided step-by-step through the nomination entry. If preferred, a nominator may submit a nomination by completing the AIAA nomination form, which can be downloaded from www.aiaa.org.

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. Five signed letters of endorsement (including 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 Design Engineering Award recognizes design engineers who have made outstanding technical, educational, or creative achievements that exemplifies the quality and elements of design engineering. (Presented odd years)

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

Aerospace Software Engineering Award is presented for outstanding technical and/or management contributions to aeronautical or astronautical software engineering. (Presented odd years)

Children's Literature Award is presented for an outstanding, significant, and original contribution in aeronautics and astronautics. (Presented odd years)

Dr. John Ruth Digital Avionics Award recognizes outstanding achievement in technical management and/or implementation of digital avionics in space or aeronautical systems, including system analysis, design, development, or application. (Presented odd years)

Excellence in Aerospace Standardization Award recognizes contributions by individuals that advance the health of the aerospace community by enabling cooperation, competition, and growth through the standardization process. (Presented odd years)

Faculty Advisor Award is presented to the faculty advisor of a chartered AIAA Student Branch, who in the opinion of student branch members, and the AIAA Student Activities Committee, has made outstanding contributions as a student branch faculty advisor, as evidenced by the record of his/her student branch in local, regional, and national activities.

Gardner-Lasser History Literature Award is presented for the best original contribution to the field of aeronautical or astronautical historical nonfiction literature published in the last five years dealing with the science, technology, and/or impact of aeronautics and astronautics on society.

History Manuscript Award is presented for the best historical manuscript dealing with the science, technology, and/or impact or aeronautics and astronautics on society.

Information Systems Award is presented for technical and/or management contributions in space and aeronautics computer and sensing aspects of information technology and science. (Presented odd years)

Intelligent Systems Award recognizes important fundamental contributions to intelligent systems technologies and applications that advance the capabilities of aerospace systems. (Presented odd years)

Lawrence Sperry Award is presented for a notable contribution made by a young person to the advancement of aeronautics or astronautics. The nominee must be under 35 years of age on **December 31** of the year preceding the presentation.

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 presented 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)

Pendray Aerospace Literature Award is presented for an outstanding contribution or contributions to aeronautical and astronautical literature in the relatively recent past.

Structures, Structural Dynamics and Materials Award is presented for an outstanding sustained technical or scientific contribution in aerospace structures, structural dynamics, or materials. (Presented even years)

Survivability Award recognizes outstanding achievement or contribution in design, analysis implementation, and/or education of survivability in an aerospace system. (Presented even years)

Summerfield Book Award is presented to the author of the best book recently published by AIAA. Criteria for the selection include quality and professional acceptance as evidenced by impact on the field, citations, classroom adoptions, and sales.

Sustained Service Award recognizes sustained, significant service and contributions to AIAA by members of the Institute. A maximum of 20 awards are presented each year.

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

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

19th AIAA/CEAS Aeroacoustics Conference (34th AIAA Aeroacoustics Conference)

26–29 May 2013
RAMADA Hotel Berlin-Alexanderplatz
Berlin, Germany

Synopsis

The AIAA/CEAS Aeroacoustics Conference has established itself as the premier international forum for the field of aeroacoustics. It offers scientists and engineers from industry, government, and universities an exceptional opportunity to exchange knowledge and results from current studies and to discuss directions for future research. The program's technical content will include theoretical, numerical, and experimental contributions that describe original research reults and/or innovative design concepts.

American Institute of Aeronautics and Astronautics (AIAA)

AIAA is the world's largest technical society dedicated to the global aerospace profession. With more than 35,000 individual members worldwide, and 90 corporate members, AIAA brings together industry, academia, and government to advance engineering and science in aviation, space, and defense. The Institute continues to be the principal voice, information resource, and publisher for aerospace engineers, scientists, managers, policymakers, students, and educators.

Council of European Aerospace Societies (CEAS)

CEAS includes 13 leading European professional aerospace societies, representing 35,000 members: Association Aéronautique et Astronautique de France, Asociación de Ingenieros Aeronáuticos de España, Associazione Italiana de Aeronautica e Astronautica, Central Aerohydrodynamic Institute Russian Aerospace Society, Deutsche Gesellschaft für Luft- und Raumfahrt, e. V., Hellenic Aeronautical Engineers Society, Finnish Society of Aeronautical Engineers, Netherlands Aerospace Association, Polish Society of Aerospace Sciences, Romanian Association of Aeronautics and Astronautics, Royal Aeronautical Society, Swedish Society of Aeronautics and Astronautics, and Switzerland Association for Aeronautical Sciences. CEAS supports the European aerospace community by promoting the highest standards of professional expertise and by facilitating the resolution of key issues that extend beyond the constraints of competitive commercial scenarios.

Special Events

Sunday Welcome Reception

Sunday, 26 May, 1830–1930 hrs

A welcome reception will be held on Sunday evening. Tickets are included in registration where indicated. Additional tickets are available for purchase for $33.

Accompanying Persons Program

Monday, 27 May, 0900–1000 hrs

An overview about chosen sightseeing possibilities will be presented. Individual event tickets can be booked at the registration desk.

Networking Lunches

Monday, 27 May, 1200–1400 hrs
Tuesday, 28 May, 1200–1400 hrs
Wednesday, 29 May, 1200–1400 hrs

Lunch is included in your registration fee where indicated. Network with your fellow attendees. Additional tickets are available for $27 for each lunch.

Conference Dinner

Tuesday, 28 May, 1930–2300 hrs

This year's conference dinner will be held in the Kalkscheune. The CEAS awards are scheduled to be presented during the dinner. Also recognized will be the winner of the Best Student Paper Competition. Tickets are included in your registration fee where indicated. Additional tickets are available for $113.

Technical Co-Chair, AIAA	**Technical Co-Chair, CEAS**	**Administrative Chair**
Philip J. Morris	Lars Enghardt	Philip Nickenig
Penn State University	DLR, Berlin	DGLR, Bonn

	Registration Type	By 1 May 2013 Conference Rate	By 1 May 2013 AIAA/CEAS Member	2–29 May 2013 Conference Rate	2–29 May 2013 AIAA/CEAS Member	Conference Sessions	Online Proceedings	Opening Reception	Daily Lunch	Tuesday Awards Dinner
Option 1	Full Conference with Online Proceedings	$1,061	$928	$1,195	$1,061	■	■	■	■	■
Option 2	Full-Time Undergraduate/Master's Student	$100	$67	$134	$100	■				
Option 3	Full-time Undergraduate/Master's Student with Networking	$327	$294	$361	$327	■		■	■	■
Option 4	Full-Time Ph.D. Student	$200	$134	$267	$200	■			■	
Option 5	Full-Time Ph.D. Student with Networking	$346	$280	$413	$346	■		■	■	■
Option 6	Full-Time AIAA/CEAS Retired Member	N/A	$67	N/A	$100	■		■	■	■
Option 7	Group Discount (per person)*	$835	$835	$955	$955	■	■	■	■	■
Option 8	BANC-III Workshop**	$140	$140	$200	$200					
Extra Tickets							$200	$33	$27/day	$113

Pricing subject to change.

*10% discount off AIAA/CEAS member rate for 10 or more persons from the same organization who register and pay at the same time with a single form of payment. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be received by the registration deadline of 29 May 2013.

** Registration free includes workshop participation only. Conference registration not included.

Third Workshop on Benchmark Problems for Airframe Noise Computations (BANC-III)

Thursday, 30 May 2013 (with an additional morning session on 31 May 2013 if necessary)

Sponsored by the Aeroacoustics and Fluid Dynamics Technical Committees, the BANC-III workshop will address the computations of unsteady flow and noise radiation for a select set of airframe noise configurations for which experimental data readily are available or are expected to be available in the near future. The BANC-III Workshop will build upon the foundation of the BANC-I and II Workshops to enable a more definitive assessment of the state of the art, including gap areas in the computations and measurements of airframe noise, as well as include a substantially stronger collaborative element involving multiple organizations from the outset.

Objectives of the BANC-III Workshop are to:

- Provide a forum for a thorough assessment of simulation-based noise-prediction tools in the context of airframe configurations, including both near-field unsteady flow and the acoustic radiation generated via the interaction of this flow with solid surfaces.
- Identify current gaps in physical understanding, experimental databases, and prediction capability for the major sources of airframe noise.
- Help determine best practices and accelerate the development of benchmark quality datasets.
- Promote coordinated studies of common configurations for maximum impact on the current state of the art in the understanding and prediction of airframe noise.

The BANC-III workshop will focus on problem categories 5 through 8 from the BANC-II workshop as described at: **https://info.aiaa.org/tac/ASG/FDTC/DG/BECAN_files_/BANCII.htm**.

The BANC-III workshop is open to all interested participants. Computation of the BANC-III configurations is not required to attend the workshop. A nominal registration fee (collected as an add-on option to conference registration) will cover workshop expenses including coffee and lunch.

To allow crucial future communications regarding the workshop, all workshop attendees must join the workshop mailing list by entering their contact information at: **https://info.aiaa.org/tac/ASG/FDTC/DG/BECAN_files_/BANCIII_NoI.htm**. All inquiries should be directed to Meelan.M.Choudhari@nasa.gov.

Conference Proceedings

Conference proceedings are available in online format only. The cost is included in the registration fee where indicated. If you register in advance for the online papers, you will be provided with instructions on how to access them. For those registering on site, you will be provided with instructions at that time.

Register on Our Website

All participants are urged to register online at **www.aiaa.org/aeroacoustics2013**. Registering in advance saves conference attendees time and up to $200. A check made payable to AIAA or credit card information must be included with your registration form. A PDF registration form is also available on the AIAA website. Print, complete, and mail or fax the form with payment to AIAA. Address information is provided. Payment must be received in order to process the registration form.

AIAA Programs

On-Site Conference Registration Hours

Sunday, 26 May 2013, 1700–1900 hrs
Monday, 27 May 2013, 0730–1700 hrs
Tuesday, 28 May 2013, 0730–1700 hrs
Wednesday, 29 May 2013, 0730–1600 hrs
Thursday, 30 May 2013 (Workshop only)

Hotel Reservations

The Aeroacoustic conference will be held at the RAMADA Hotel Berlin-Alexanderplatz. CEAS/DGLR have made arrangements for a block of rooms in the RAMADA in the heart of Berlin. The four-star hotel is located on the Alexanderplatz. From here you can experience close up one of Berlin's most significant public spaces and discover all of the attractions in walking distance.

RAMADA Hotel Berlin-Alexanderplatz
Karl-Liebknecht-Strasse 32
D- 10178 Berlin
Email: reservierung.alexanderplatz@ramada.de
Phone: +49 (0) 30 / 3010411 750
Fax: +49 (0) 30 / 3010411 759

Room rates are single: 99,-€ (including taxes); double: 109,-€ (including taxes). Please identify yourself as being with the AIAA/CEAS Aeroacoustics conference. These rooms will be held for AIAA until **13 April 2013** or until the block is full. After 13 April 2013, any unused rooms will be released to the general public. You are encouraged to book your hotel room early.

Cancellation Conditions: Cancellations have to be communicated in written form and are valid as soon as the hotel confirmed the decrease/cancellation as well in written form. If fixed booked rooms are not cancelled in due time, 90% of the appointed costs will be charged.

Further Information: Rooms are at your disposal from 1500hrs on arrival day and until noon on departure day. The use of our SPA is free of charge for hotel guests.

Things To Do In Berlin

Berlin is an exciting city of contrasts. Forever evolving, it can be explored in a countless variety of historical and modern attractions. Here are some suggestions: A galerie-tour in Berlin-Mitte, visiting the Government District, culinary tour, boat trip: Berlin has more bridges than Venice!

Conference Certificate of Attendance Available

Certificates of attendance will be provided on request.

U.S. Technology Regulations

U.S. Nationals (U.S. citizens and permanent residents) are reminded that it is their responsibility to comply with ITAR and Technology Transfer restrictions. Visit **www.aiaa.org** for details.

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, a valid student ID is also required.

Program-at-a-Glance

Monday, 27 May 2013

0800-0900 hrs
Plenary I – Progress in Prediction of Jet Noise and Quantification of Aircraft/Engine Noise Components
Speaker: Dr. Krishna Viswanathan, The Boeing Company, Seattle, WA

0900–1200 hrs
Acoustic/Fluid Dynamic Phenomena I: Flames & Scattering
Airframe/High-Lift Noise I
Community Noise & Sonic Fatigue
Computational Aeroacoustics I: Scattering & Propagation
Duct Acoustics I
Interior Noise/Structural Acoustics I: Experiments
Jet Aeroacoustics I: Experiments I
Jet Aeroacoustics II: Predictions I
Turbomachinery and Core Noise I

1200–1400 hrs
Monday networking lunch

1400–1800 hrs
Acoustic/Fluid Dynamic Phenomena II: Cavities I
Advanced Testing Techniques I
Airframe/High-Lift Noise II
Computational Aeroacoustics II: Landing Gear
Duct Acoustics II
Jet Aeroacoustics III: Experiments II
Jet Aeroacoustics IV: Analysis I
Propeller, Rotorcraft and V/STOL Noise I
Turbomachinery and Core Noise II

Tuesday, 28 May 2013

0800–0900 hrs
Plenary II – Aircraft Noise Reduction by Technical Innovations
Speaker: Dr. Ulf Michel, CFD Software GmbH, Berlin, Germany

0900–1200 hrs
Acoustic/Fluid Dynamic Phenomena III: Airfoil Noise
Airframe/High-Lift Noise III
Computational Aeroacoustics III: Fan & Airfoil Noise
Duct Acoustics III
General Acoustics I
Integration Effects and Flight Acoustics I
Jet Aeroacoustics V: Numerical Simulations I
Jet Aeroacoustics VI: Noise Reduction
Turbomachinery and Core Noise III

1200–1400 hrs
Tuesday networking lunch

1400–1800 hrs
Acoustic/Fluid Dynamic Phenomena IV: Cavities II
Airframe/High-Lift Noise IV
Computational Aeroacoustics IV: Methods & Equations
Duct Acoustics IV
General Acoustics II
Integration Effects and Flight Acoustics II
Jet Aeroacoustics VII: Experiments III
Jet Aeroacoustics VIII: Numerical Simulations II
Propeller, Rotorcraft and V/STOL Noise II

1930–2300 hrs
Conference Dinner

Wednesday, 29 May 2013

0800–0900 hrs
Plenary III – Identification and reduction of the noise produced by Falcon Business Jets
Speaker: Stephane Lemaire, Dassault Aviation, Paris, France

0900–1200 hrs
Acoustic/Fluid Dynamic Phenomena V: Bluff Bodies
Advanced Testing Techniques II
Airframe/High-Lift Noise V
Computational Aeroacoustics V: Boundary Conditions
Duct Acoustics V
Interior Noise/Structural Acoustics II: Analysis and Computation
Jet Aeroacoustics IX: Numerical Simulations III
Jet Aeroacoustics X: Experiments IV
Turbomachinery and Core Noise IV

1200–1400 hrs
Networking lunch

1400–1800 hrs
Acoustic/Fluid Dynamic Phenomena VI: Boundary Layers
Advanced Testing Techniques III
Airframe/High-Lift Noise VI
Computational Aeroacoustics VI: Other Applications
Duct Acoustics VI
Jet Aeroacoustics XI: Predictions II
Jet Aeroacoustics XII: Analysis II
Propeller, Rotorcraft and V/STOL Noise III
Turbomachinery and Core Noise V

Thursday, 30 May 2013

0800–1300 hrs
BANC-III Workshop

Friday, 31 May 2013

0800–1300 hrs
BANC-III Workshop

For complete conference information, please visit **www.aiaa.org/Aeroacoustics2013**.

49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exposition
and
11th International Energy Conversion Engineering Conference

15–17 July 2013
San Jose Convention Center
San Jose, California

Conference Overview

In July 2013, two exciting conferences—the 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference (JPC) and the 11th International Energy Conversion Engineering Conference (IECEC)—will co-locate again to provide one major exposition for the aerospace propulsion and energy conversion communities. These conferences will provide a forum for the exchange of information on a larger scale than possible at separate events. The combined event will feature both programmatic and technical information while fostering a beneficial networking opportunity.

Why Should You Attend?

No matter where you go at the conference, there is always something happening—plenary sessions addressing critical topics on the future of the propulsion and energy industries; presentations on current state-of-the-art technologies; panel sessions that foster discussion and debate among stakeholders; keynote lectures by renowned speakers addressing relevant topics; special presentations on the exposition hall stage; a young professional reception or a unique off-site social activity—all of which provide an informational way to interact with industry colleagues and meet new contact s and potential customers.

Nowhere else will you get the depth and breadth of sessions on Propulsion and Energy Conversion than at the AIAA conferences in San Jose, California.

- Expand your knowledge as expert engineers and scientists share their latest research and development findings.
- Find out what lies ahead as senior leaders in industry discuss their programs and business challenges during the plenary and interactive panel sessions.
- Network, discuss challenges, and share ideas during technical sessions, luncheons, networking breaks, and social activities.

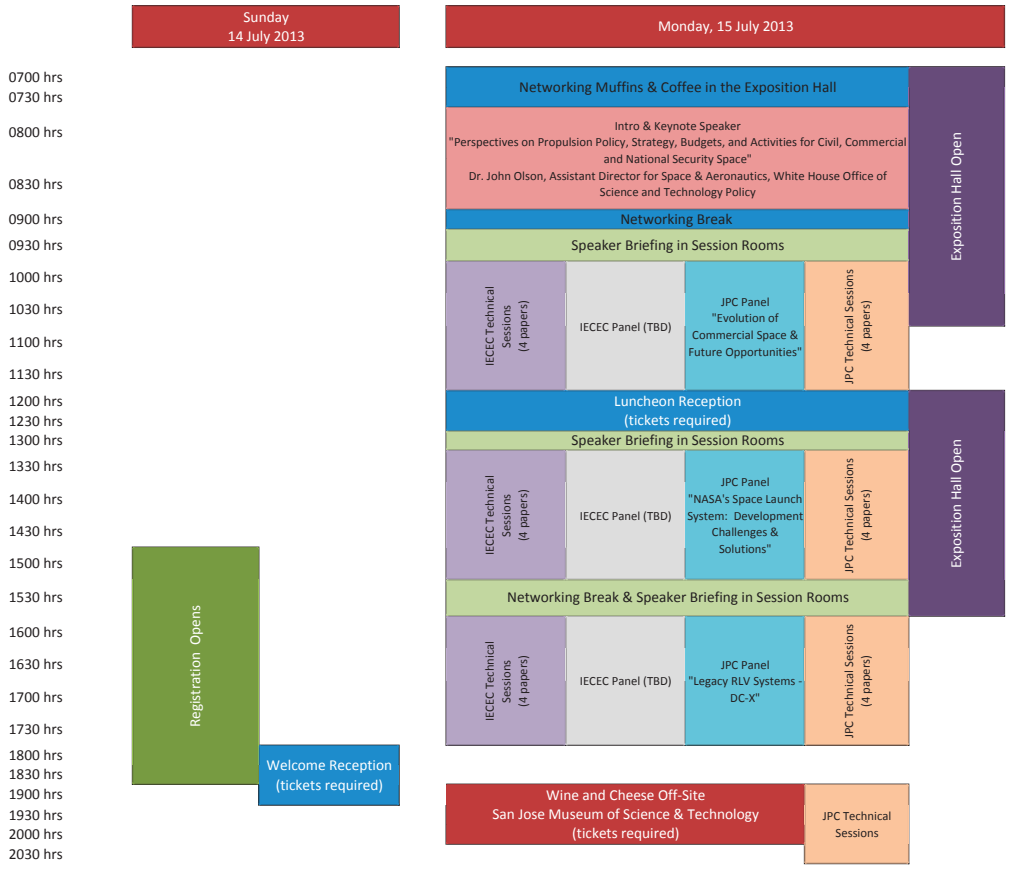
Keynote Sessions and Panels

Perspectives on Propulsion Policy, Strategy, Budgets, and Activities for Civil, Commercial, and National Security Space
Monday, 15 July 2013
Speaker: John Olson, Assistant Director for Space and Aeronautics, White House Office of Science and Technology Policy

Evolution of Commercial Space and Future Opportunities
Monday, 15 July 2013
Commercial space is a rapidly growing sector of the space economy. This panel will present a status of current commercial space efforts and challenges with a look forward to new and evolving opportunities.
Moderator: James Halsell, Technical Director, Aerospace Systems, Dynetics
Panelists: Kent Rominger, Vice President and Program Manager, ATK; Bob Richards, Vice President, Human Spaceflight Systems' Advanced Programs Group, Orbital Sciences; Ron Ramos, VP for Exploration and Missile Defense Systems, Pratt & Whitney Rocketdyne

The Future of Military Space Launch and How Affordability Will Factor In
Monday, 15 July 2013
Panelists: Steven Bouley, Vice President, Expendable Launch Systems, Pratt & Whitney Rocketdyne; Andrew Jackson, Atlas & Delta Structures Manager, ATK

NASA SLS Development
Monday, 15 July 2013
NASA's Space Launch System (SLS) is America's new exploration-class launch vehicle for missions beyond Earth's orbit—taking astronauts where no one has been before, as well as offering unmatched mass and volume capabilities for science missions. The SLS Program is making maximum use of existing RS-25 core stage engines and advanced developmental hardware in the form of the 5-segment solid rocket booster and the J-2X upper stage engine, with a clear plan for beginning flight operations in 2017. SLS chief engineers will share plans and progress, as well as innovations being infused into the program, such as modifying the Delta IV

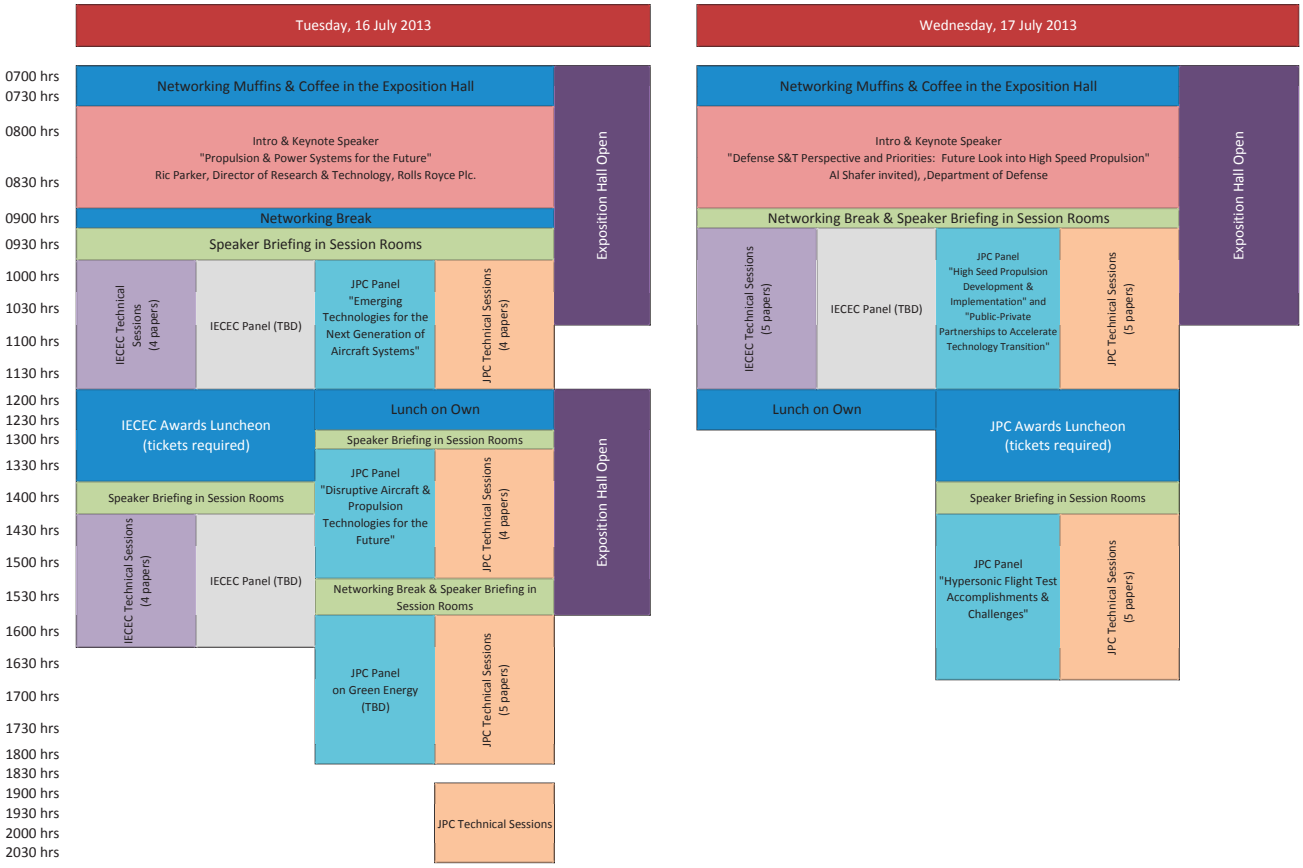


kick stage to propel the Orion crew craft to trans-lunar injection. These government and industry partners will discuss how the team is solving development challenges and is on track to deliver a safe, affordable, and sustainable infrastructure asset to support America's space agenda.
Moderator: Garry Lyles, Space Launch System (SLS) Chief Engineer, NASA MSFC
Panelists: David Wood, SLS Boosters Element Chief Engineer, NASA MSFC; Brian Simmons, SLS Boosters Chief Engineer, ATK Katherine Van Hooser, SLS Engines Element Chief Engineer, NASA MSFC; Doug Bradley, RS-25 Chief Engineer, Pratt & Whitney Rocketdyne; Rene Ortega, SLS Spacecraft & Payload Integration Chief Engineer, NASA MSFC; Frank McCall, SLS Deputy Program Manager and Chief Engineer, The Boeing Company

Legacy RLV Systems DC-X
Monday, 15 July 2013
The DC-X, or Delta Clipper Experimental, was an unmanned prototype of a reusable single stage to orbit launch vehicle built by McDonnell Douglas for the U.S. Strategic Defense Initiative Organization (SDIO) in the early 1990s. Later, the system was transferred to NASA and upgraded with advanced operations, structures, and propulsion technology and was renamed the DC-XA. The DC-X was never designed to achieve orbital altitudes or velocity, but instead to demonstrate the concept of vertical takeoff and landing using a revolutionary aircraft like operations approach. This session will discuss the lessons learned from the DC-X program and applicability to future space transportation systems.
Moderator: Jess Sponable, DARPA Program Manager, DARPA
Panelists: Peter Worden, Ames Research Center Director, NASA; William Gaubatz, Former DC-X Program Manager, McDonnell Douglas; Joaquin Castro, Business Development, Pratt & Whitney Rocketdyne; Stephen Cook, Director of Space Technologies, Dynetics

Propulsion & Power Systems for the Future
Tuesday, 16 July 2013
Keynote Address: Ric Parker, Director of Research and Technology, Rolls-Royce Plc.

Emerging Technologies for the Next Generation of Aircraft Systems
Tuesday, 16 July 2013
The panel will discuss government and industry perspectives on emerging aircraft systems technologies for the next generation.
Moderator: Fayette Collier, Project Manager, Environmentally Responsible Aviation, NASA Langley Research Center
Panelists: Rhett Jefferies (invited), CLEEN Program Manager, Federal Aviation Administration; Wes Lord (invited), Pratt & Whitney; Jason Parsons (invited), HEETE Program Manager, USAF AFRL/RQT; Kenneth Martin, Manager-Conceptual Design, Lockheed Martin



Disruptive Aircraft & Propulsion Technologies for the Future
Tuesday, 16 July 2013
The panel will discuss government and industry perspectives on disruptive technologies that will yield alternative propulsion cycles in a not distant future.
Moderator: Nateri Madavan, Deputy Project Scientist, Fixed Wing Project, NASA Ames Research Center
Panelists: Marty Bradley, Technical Fellow, The Boeing Company Research & Technology; Dale Carlson, General Manager, Technology Strategy, GE Aviation; Ryan Plumley, Program Manager, Revolutionary Configurations for Energy Efficiency, Air Force Research Laboratory; Louis Povinelli, High Speed Project Scientist, NASA John H. Glenn Research Center

Defense S&T Perspective and Priorities: Future Look into High Speed Propulsion
Wednesday, 17 July 2013
Keynote Speaker: Al Shafer (invited), Department of Defense

High Speed Propulsion Development and Implementation
Wednesday, 17 July 2013
Moderator: James Kenyon, Office of the Deputy Under Secretary of Defense (Science & Technology)
Panelists: Tom Fetterhoff, Technical Director, Test Division, Arnold Engineering Development Center; James Pittman, Manager, Hypersonics Project, Fundamentals Aeronautics Program, NASA Langley Research Center; Lynn Snyder, Manager, Advanced Concepts, Rolls Royce Liberty Works; Scott Cruzen, Manager, Technology Projects, Williams International; Curtis Berger, Director, Hypersonic Programs, Pratt & Whitney Rocketdyne; Steve Beckel, Director, Advanced Propulsion Business Development, ATK

Public-Private Partnerships to Accelerate Technology Transition
Wednesday, 17 July 2013
Moderator: Graham Warwick (invited), Sr. Editor – Technology, *Aviation Week*
Panelists: Alton Romig (invited), VP and GM, Skunk Works, Lockheed Martin; Dale Carlson (invited), General Manager, Technology Strategy, GE Aviation; Alan Epstein (invited), Pratt & Whitney

JPC Awards Luncheon Speaker
Speaker: Lt. Gen Ellen Pawlikowski (invited), USAF, Commander, US Space and Missile Systems

Hypersonic Flight Test Accomplishments and Challenges
Wednesday, 17 July 2013
Moderator: Mark Lewis, Director, Institute of Defense Analyses Science and Technology Policy Institute
Panelists: Charles Brink, X-51 PM; Douglas Dolvin, HiFIRE PM

	Registration Type	By 17 June 2013 Conference Rate	By 17 June 2013 AIAA Member	18 June–12 July 2013 Conference Rate	18 June–12 July 2013 AIAA Member	Conference Sessions	Online Proceedings	Welcome Reception	Exhibit Lunch	IECEC Awards Lunch	JPC Awards Lunch
Option 1	JPC Full Conference	$945	$785	$1,045	$885	■	■	■	■		■
	IECEC Full Conference	$945	$785	$1,045	$885	■	■	■	■	■	
Option 2	Full-Time Undergraduate Student	$60	$25	$70	$35	■					
Option 3	Full-Time Undergraduate Student with Networking-JPC	$232	$197	$242	$207	■		■	■		■
	Full-Time Undergraduate Student with Networking-IECEC	$232	$197	$242	$207	■		■	■	■	
Option 4	Full-Time Graduate or PH.D. Student	$110	$75	$120	$85	■					
Option 5	Full-Time Graduate or PH.D. Student with Networking—JPC	$282	$247	$292	$257	■		■	■		■
	Full-Time Graduate or PH.D. Student with Networking—IECEC	$282	$247	$292	$257	■		■	■	■	
Option 6	AIAA Retired Member Only—JPC	N/A	$60	N/A	$70	■		■	■		■
	AIAA Retired Member Only—IECEC	N/A	$60	N/A	$70	■		■		■	
Option 7	Discounted Group Rate*—JPC	N/A	$707	N/A	$707	■	■	■	■		■
	Discounted Group Rate*—IECEC	N/A	$707	N/A	$707	■	■	■	■	■	
Option 9	Continuing Education (CE) Course and Full Conference With Online Proceedings-JPC	$1,403	$1,293	$1,503	$1,393	■	■	■	■		■
	Continuing Education (CE) Course and Full Conference With Online Proceedings-IECEC	$1,403	$1,293	$1,503	$1,393	■	■	■	■	■	
	Extra Tickets						$200	$65	$55	$52	$52

Pricing subject to change.

Registration Information

All participants are urged to register online at **www.aiaa.org/jpc2013**. Registering in advance saves conference attendees time and up to $200. A check made payable to AIAA or credit card information must be included with your registration form. A PDF registration form is also available on the AIAA website. Print, complete, and mail or fax the form with payment to AIAA. Address information is provided. Payment must be received in order to process the registration form.

Early-bird registration forms must be received by **17 June 2013**, and standard registration forms will be accepted until **12 July 2013**. Preregistrants may pick up their materials at the advance registration desk at the conference.

All those not registered by **12 July 2013** may do so at the on-site registration desk by paying the on-site registration fee. All nonmember registration fees include a one-year AIAA membership.

Special Program Activities

As part of the JPC and IECEC Conference, other activities are planned to provide specific attendees valuable knowledge, experience, and interaction.

Welcome Reception

A welcome reception will be held on Sunday, 14 July 2013, 1800–1930 hrs, in the Exposition Hall at the San Jose Convention Center. Take this opportunity to engage new contacts and refresh old ones. A ticket for the reception is required and included in the conference registration fee where indicated. Additional tickets for guests may be purchased upon registration or on-site.

Networking Luncheon

Join us in the Exposition Hall on Monday, 15 July 2013 for a networking lunch. A ticket for the luncheon is required and included in the conference registration fee where indicated. Additional tickets may be purchased upon registration or on-site as space is available.

Recognition Activities and Lectureships

Recognizing the best in our profession for their outstanding achievement is one of the primary goals of AIAA. The JPC and IECEC Conferences feature a number of activities that help us honor achievements and contributions to the profession.

For those registration types that include Awards Luncheon tickets, the registrants who selected IECEC as their primary con-

Important session information for all attendees wishing to present or attend ITAR papers

AIAA Restricted Papers – ITAR Regulations Session Admittance Policy
(Revised 10/19/2012)

Several papers scheduled to be presented at this conference will be restricted papers governed by ITAR (U.S. International Traffic in Arms Regulations). If you plan to attend any presentations restricted by ITAR, you must bring proof of citizenship PLUS the other verification documents as shown below. Please note that only U.S. Citizens and U.S. Resident Aliens can be considered for attendance at these restricted presentations. Admittance to restricted sessions and access to restricted technical papers is implemented and controlled by ITAR .
All restricted session attendees (including speakers and session chairs for these sessions) MUST abide by the procedures and submittal of verification documents as noted below – **NO EXCEPTIONS**:

ATTENDEE CLASSIFICATION	IDENTIFICATION & PROOF OF EMPLOYMENT REQUIREMENTS
U.S. Government Employees	1. Proof of U.S. Citizenship (for example, passport, birth certificate, voters registration card, naturalization papers), **AND** 2. Personal photographic identification: U.S. Government/Military Photo ID badge, such as CAC card
U.S. Citizens	1. Proof of U.S. Citizenship (for example, passport, birth certificate, voters registration card, naturalization papers), **AND** 2. Personal photographic identification (passport, driver's license, etc.), **AND** 3. Certification credentials based on DD Form 2345 (see below for details)
Resident Aliens (U.S.)	1. Resident Alien Card, **AND** 2. Personal photographic identification (passport, driver's license, etc.), **AND** 3. Certification credentials based on DD Form 2345 (see below for details)

DD Form 2345 individual certification credentials (required for U.S. & Resident Aliens) MUST be from one of the following:

1. Copy of an approved and active DD2345 for the individual, **OR**
2. Copy of an approved and active DD2345 for the individual's employer PLUS evidence of current employment status with that employer (corporate ID, business card, etc.), **OR**
3. A listing of the individual's employer in the most recent DoD quarterly Qualified U.S. Contractor Access List PLUS evidence of current employment status with that employer (corporate ID, business card, etc.).

DD Form 2345 may be downloaded and completed online in order to apply for approval to be listed on the Qualified U.S. Contractor List, www.dlis.dla.mil/jcp. Allow at least 4-6 week (or longer) prior to the AIAA technical conference dates for you to receive the approval and be listed on the Qualified U.S. Contractor List.

How to get your ITAR Clearance:
Bring all of the above listed identification, proof of employment and certification credentials to the AIAA ITAR Registration Desk in the AIAA Registration area. Your documents will be verified and you will be provided with a stamp indicating your ITAR clearance. Photo ID will be checked against your ITAR badge before admittance is granted to any ITAR presentation.

Please be advised that all policies and procedures MUST be followed or admittance to restricted sessions will not be permitted.

ference will receive the Tuesday IECEC Awards Luncheon ticket and those who selected JPC as their primary conference will receive the Wednesday JPC Awards Luncheon ticket. Tickets are not exchangeable or refundable. The cost is included in the registration fee where indicated. Additional tickets may be purchased upon registration or at the on-site registration desk while supplies last.

New This Year!
ITAR Technical Sessions

New for this year, a limited number of papers will be presented in *U.S.-Only* technical sessions. In addition to your JPC/IECEC conference registration, a separate registration process will be required to attend these restricted sessions. Please see the detailed information on the ITAR Registration Grid above to determine your individual requirements.

Availability of ITAR Papers

A DVD containing the manuscripts from the ITAR sessions will be available for purchase on-site in San Jose to those who are registered to attend the ITAR Sessions. There will be no sale of these papers after the event.

Access to ITAR Sessions: Presenting a Paper, Chairing a Session, or Attending ITAR Restricted Presentation

Admittance to the restricted Technical Papers is controlled by U.S. International Traffic in Arms Regulations (ITAR). All paper attendees, presenters, and session chairs will need to register for the conference, and then on-site will need to visit the ITAR Registration Desk where they will be required to complete additional registration procedures. All persons wishing to enter the restricted session room **MUST** abide by the procedures and submittal of verification documents mandated by the DOD to attend, present. or chair ITAR-restricted sessions. **No Exceptions!**

Credentials

1) You must show proof of citizenship (most overlooked item) NO copies of passport accepted and Government ID is NOT sufficient proof for citizenship.
2) Present personal photo identification.
3) You must be a Federal Government Employee or you must be covered under a company or individual DD2345 certification. Please reference grid above for complete requirements

Continuing Education Courses

Let AIAA Continuing Education courses pave the way to your continuing and future success! As the premier association representing aeronautics and astronautics professionals, AIAA has been a conduit for continuing education for more than sixty years. AIAA offers the best instructors and courses, and is committed to keeping aerospace professionals at their technical best. Register for any course and attend the conference for FREE! (Registration fee includes full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.) The following courses will be held Thursday and Friday, 18–19 July, 0815–1700 hrs.

Liquid Propulsion Systems—Evolutions and Advancements

Alan Frankel, Dr. Ivett Leyva, and Patrick Alliot

Liquid propulsion systems are critical to launch vehicle and spacecraft performance, and mission success. This two-day course, taught by a team of government, industry and international experts, will cover propulsion fundamentals and topics of interest in launch vehicle and spacecraft propulsion; non-toxic propulsion; microsat and cubesat propulsion; propulsion system design and performance; and human rating of liquid engines. In keeping with the theme of the 2011 JPC, "Turning Propulsion Ideas into Reality", lessons learned from development and flight of components and systems will be discussed.

A Practical Introduction to Preliminary Design of Air Breathing Engine

Ian Halliwell and Steve Beckel

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.

Missile Propulsion Design and System Engineering

Eugene L. Fleeman

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

Networking Activities

Understanding the importance of networking with colleagues new and old, we have planned a series of activities during the conference that will help you connect with current colleagues and new acquaintances.

New This Year!

Early Morning Networking Break

Join us in the exposition hall each morning from 0700–0800 hrs for coffee and pastries, and great discussions. This event is open to all registered conference attendees.

Networking Coffee Breaks

Standalone coffee breaks are included to allow time for making new contacts, continuing discussions from technical sessions, visiting with the exhibitors, or checking in with the office while you are at the conference. Networking coffee breaks will be located in the Exposition Hall.

Online Proceedings

Proceedings for this conference will be available in online format. The cost is included in the registration fee where indicated. The online proceedings will be available on **8 July 2013**. Those registering on site will have access 24 hours after registering for the conference.

AIAA Registration and Information Center Hours

The AIAA Registration and Information Center will be located in the Exhibit Hall Foyer at the San Jose Convention Center. Hours are as follows:

Sunday, 14 July 1500–1900 hrs
Monday, 15 July 0700–1800 hrs
Tuesday, 16 July 0700–1800 hrs
Wednesday, 17 July 0700–1700 hrs

Registration for ITAR sessions will be accepted *on-site only*, during the following hours.

Monday, 15 July 0900–1800 hrs
Tuesday, 16 July 0700–1800 hrs
Wednesday, 17 July 0700–1500 hrs

Exposition

The exposition hall will host the Welcome Reception on Sunday night and remain open during the following hours throughout the week.

Sunday, 14 July	1800 – 1930 hrs
Monday, 15 July	0700 – 1100 hrs, 1200 – 1600 hrs
Tuesday, 16 July	0700 – 1100 hrs, 1200 – 1600 hrs
Wednesday, 17 July	0700 – 1100 hrs

AIAA Programs

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.

Premier Sponsor: Pratt & Whitney, A United Technologies Company; Pratt & Whitney Rocketdyne

Executive Sponsors: GE imagination at work; JACOBS

Welcome Reception Sponsor: LOCKHEED MARTIN

Attendee Bag Sponsor: Dynetics, The Power of Solutions

Lanyard Sponsor: SPACEX

Companies will be displaying an array of technology. The Exposition is the place to network and conduct business for all attendees, as well as attend presentations featured on the Presentation Stage. For more information about exhibiting at AIAA events, please contact:

Chris Grady, AIAA Exhibits Business Manager
703.264.7509
chrisg@aiaa.org

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.

Travel and Accommodations

AIAA has made arrangements for a block of rooms at the following hotels:

Hilton San Jose
300 South Almaden Blvd
San Jose, CA 95113
408.287.2100

Room rates are $179 for a standard room (single or double occupancy). Applicable taxes will apply. Book your rooms early! These rooms are will be held for AIAA until **24 June 2013** or until the room block is full, then released for use by the general public. There are a limited number of rooms available at the prevailing government per diem. Proper government ID is required.

San Jose Marriott Downtown
301 South Market Street
San Jose, CA 95113
408.280.1300

Room rates are $189 for a standard room (single or double occupancy). Applicable taxes will apply. Book your rooms early! These rooms are will be held for AIAA until **20 June 2013** or until the room block is full, then released for use by the general public. There are a limited number of rooms available at the prevailing government per diem. Proper government ID is required.

Sainte Claire
302 South Market Street
San Jose, CA 95113
408.295.2000

There are a limited number of rooms available at the prevailing government per diem. Proper government ID is required.

Help Keep Our Expenses Down (And Yours Too!)

AIAA group rates for hotel accommodations are negotiated as part of an overall contract that also includes meeting rooms and other conference needs. Our total event costs are based in part on meeting or exceeding our guaranteed minimum of group-rate hotel rooms booked by conference participants. If we fall short, our other event costs go up. Please help us keep the costs of presenting this conference as low as possible—reserve your room at the designated hotel listed in this Preliminary Program and on our website, and be sure to mention that you're with the AIAA conference. Meeting our guaranteed minimum helps us hold the line on costs, and that helps us keep registration fees as low as possible. All of us at AIAA thank you for your help!

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 display in open sessions to no-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.

Website: www.aiaa.org/jpc2013

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AIAA Fluid Dynamics and Co-located Conferences and Exhibit

24–27 June 2013
Sheraton San Diego Hotel
San Diego, California

This event includes the following conferences:

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

Hotel Information

AIAA has made arrangements for a block of rooms at the:
Sheraton San Diego Hotel
1380 Harbor Island Drive
San Diego, California 92101

Room rates are **$222** per night for single or double occupancy. For reservations, please call 1.866.716.8106. Please identify yourself as being with the AIAA conference. These rooms will be held for AIAA until **22 May 2013** or until the block is full. After 22 May 2013, any unused rooms will be released to the general public. You are encouraged to book your hotel room early.

REGISTER TODAY!

www.aiaa.org/aafluids

AIAA
The World's Forum for Aerospace Leadership

AVIATION 2013

12–14 AUGUST 2013

LOS ANGELES, CALIFORNIA

CHARTING THE FUTURE OF FLIGHT

Aviation is an essential component of the world economy and global security. The success of aviation is due to technological innovations that have provided an unprecedented level of capability, capacity, and efficiency.

AIAA AVIATION 2013 is a premier, forward-looking forum designed to showcase recent innovations and achievements in aviation, highlight new initiatives and plans, and address key issues that need to be resolved in order to define clear roadmaps for future progress.

- AVIATION 2013 engages those involved in the entire product life cycle from disciplinary research to product development to system operation and maintenance.
- AVIATION 2013 eliminates barriers by addressing the global nature of aviation requirements, opportunities, regulatory limitations, research activities, development programs, and operations.
- AVIATION 2013 provides the breadth and depth of content and audience participation that is necessary for tackling the issues critical to safeguarding and shaping the future of aviation.

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FIND ANSWERS

- What are the trends for commercial, military, business, general, unmanned, and rotorcraft aviation?
- What economic and investment considerations will affect the future of aviation?
- What major challenges face aviation – including operations, capacity, capability, efficiency, security, resource availability, and environmental issues?
- How will these challenges drive technology development and implementation?
- What are the key emerging technologies?
- What policy and regulatory issues may constrain aviation's development?
- What effect will globalization have on the future of aviation?

KEY TOPICS

- Developing the Market for Unmanned Aerial Systems
- Commercial Aviation: Global Outlook, Opportunities, and Challenges
- Military Aviation: Future Challenges Facing Military Aviation
- Business Aviation, General Aviation, and Rotorcraft: Global Outlook, Opportunities, and Challenges
- The Connectivity Challenge: Protecting Critical Assets in a Networked World
- The Energy Imperative
- Shaping the Discussion: Key Policy Issues

WHO WILL ATTEND?

- Chief Executives and Engineers
- Program and Project Managers
- Systems Integrators and Mission Planners
- Business Developers and Contractors
- Policymakers and Aviation Analysts
- R&D Engineers and Managers
- Primes, Subprimes, and Suppliers

THE LOCATION – LOS ANGELES, CALIFORNIA

Southern California is the largest aerospace industry base in the United States, generating 42% of California's $27 billion in aerospace revenue, and is likely to host a test site for commercial unmanned aerial vehicles by 2015. It is the perfect location for drawing attendees from the industry, government, military, and university sectors.

Help define a shared vision for the future that will continue to transform our economy, security, and way of life – be a part of AIAA AVIATION 2013!

AIAA is the world's largest technical society dedicated to the global aerospace profession. When you join AIAA, you gain countless opportunities to connect with more than 35,000 others in the field of aerospace science, engineering, systems, technology, management, and policy; achieve your educational and career goals; and inspire the next generation of explorers. Become an AIAA member today. **www.aiaa.org/join**

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The World's Forum for Aerospace Leadership

Upcoming AIAA Professional Development Courses

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 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 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 provides an array of practical examples and employs real-

time InterLab sessions. 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, beginning 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 course are 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)

The course provides an introduction to the concepts and technologies of modern space systems, which 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. 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 facilitates 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.

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

Turbulence Modeling for CFD (Instructor: David Wilcox)

The course begins with a 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. Starting with the simplest turbulence models this course charts a course leading to some of the complex models that have been applied to a nontrivial turbulent flow problem. It stresses the need to achieve a balance among the physics of turbulence, mathematical tools required to solve turbulence-model equations, and common numerical problems attending use of such equations.

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

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

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.

22–23 June 2013
This Continuing Education course is being held at the AIAA Fluid Dynamics and collocated conferences in San Diego, CA. 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 Fluid Dynamics 2013 courses, go to **www.aiaa.org/fluids2013.**

	Early Bird by 29 May	*Standard (30 May–21 Jun)*	*On-site (22 Jun)*
AIAA Member	$1278	$1378	$1478
Nonmember	$1388	$1488	$1588

Verification and Validation in Scientific Computing

(Instructors: William Oberkampf, Engineering Consultant, WLO Consulting and Chris Roy, Aerospace and Ocean Engineering Department, Virginia Tech)

The performance, reliability, and safety of engineering systems are becoming increasingly reliant on modeling and simulation. This course deals with techniques and practical procedures for assessing the credibility and accuracy of simulations in science and engineering. It presents modern terminology and effective procedures for verification of numerical simulations and validation of mathematical models that are described by partial differential equations. While the focus is on scientific computing, experimentalists will benefit from the discussion of techniques for designing and conducting validation experiments. A framework is provided for estimating various sources of errors and uncertainties identified both in simulations and in experiments, and then combining these in total prediction uncertainty. Application examples techniques and procedures are taken primarily from fluid dynamics, solid mechanics, and heat transfer. This short course follows closely the instructors' book *Verification and Validation in Scientific Computing* (Cambridge University Press, 2010).

18–19 July 2013
The following Continuing Education courses are being held at the 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and the 11th International Energy Conversion Engineering Conference in San Jose, CA. 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 JPC 2013 courses, go to **www.aiaa.org/JPC2013.**

	Early Bird by 17 Jun	*Standard (18 Jun–12 Jul)*	*On-site (13–18 Jul)*
AIAA Member	$1293	$1393	$1493
Nonmember	$1403	$1503	$1603

Liquid Propulsion Systems—Evolution and Advancements (Instructors: Alan Frankel, Business Development, Moog-ISP, Space and Defense Group; Dr. Ivett Leyva, Combustion Devices Group, AFRL/RZSA; Patrick Alliot, Senior Technical Expert, Space Engine Division of SNECMA)

Liquid propulsion systems are critical to launch vehicle and spacecraft performance, and mission success. This two-day course, taught by a team of government, industry, and international experts, will cover propulsion fundamentals and topics of interest in launch vehicle

and spacecraft propulsion; non-toxic propulsion; microsat and cubesat propulsion; propulsion system design and performance; and human rating of liquid engines. In keeping with the theme of the 2011 JPC, "Turning Propulsion Ideas into Reality," lessons learned from development and flight of components and systems will be discussed.

A Practical Introduction to Preliminary Design of Air Breathing Engines **(Instructors: Dr. Ian Halliwell, Senior Research Scientist, Avetec; Steve Beckel, Director for Advanced Propulsion, Alliant Techsystems (ATK) Missile Products Group)**
The course presents 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. 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.

Missile Propulsion Design and System Engineering **(Instructor: Eugene L. Fleeman, International Lecturer on Missiles)**
A system-level, integrated method is provided for the missile propulsion system design, development, analysis, and system engineering activities in addressing requirements such as cost, performance, risk, and launch platform integration. The methods presented are generally simple closed-form analytical expressions that are physics-based, to provide insight into the primary driving parameters. Sizing examples are presented for rocket-powered, ramjet-powered, and turbo-jet powered baseline missiles. Typical values of missile propulsion

parameters and the characteristics of current operational missiles are discussed as well as the enabling subsystems and technologies for missile propulsion and the current/projected state of the art. Videos illustrate missile propulsion development activities and performance. Attendees receive course notes.

10–11 August 2013

The following Continuing Education courses are being held at the AVIATION 2013 Conference in Los Angeles, CA. 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 AVIATION 2013 courses, go to **www.aiaa.org/aviation2013.**

	Early Bird by 15 Jul	*Standard (16 Jul–9 Aug)*	*On-site (10 Aug)*
AIAA Member	$1320	$1420	$1520
Nonmember	$1430	$1530	$1630

Guidance of Unmanned Aerial Vehicles

(Instructors: Dr. Rafael Yanushevsky, University of Maryland)

The developed course presents a rigorous guidance theory of unmanned aerial vehicles. It can be considered as the further development and generalization of the missile guidance theory presented in the author's book *Modern Missile Guidance* (2007). Guidance of the unmanned aerial vehicles (UAVs) differs from missile guidance; its goal is different. Moreover, since UAVs can perform a variety of functions, the goal depends on a concrete area of their application. To address a wide class of guidance problems for UAVs, a more general guidance problem is formulated and a class of guidance laws is developed. In addition, the obstacle avoidance problem for UAVs is discussed and avoidance algorithms are considered. The material of the course can serve as a basis for several graduate courses in the aerospace departments. It can be used by researchers and engineers in their everyday practice and will help them to generate new ideas in the area of unmanned aerial vehicles.

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.

17–18 August 2013

The following Continuing Education courses are being held at the Guidance, Navigation, and Control and collocated conferences 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 GNC 2013 courses, go to **www.aiaa.org/boston2013.**

	Early Bird by 22 Jul	*Standard (23 Jul–16 Aug)*	*On-site (17 Aug)*
AIAA Member	$1255	$1355	$1455
Nonmember	$1365	$1465	$1565

Emerging Principles in Fast Trajectory Optimization

(Instructors: I. Michael Ross, Professor, Program Director, Naval Postgraduate School, Monterey, CA, and Qi Gong, Assistant Professor, University of California, Santa Cruz)

The confluence of major breakthroughs in optimal control theory and new algorithms has made possible the real-time computation of optimal trajectories. This implies that mission analysis can be carried out rapidly with the only limitation being the designer's imagination. This course will introduce the student to the major advancements that have taken place over the last decade in both theory and algorithms for fast trajectory optimization. Students will acquire a broad perspective on recent developments in the mathematical foundations of trajectory optimization; "old hats" will also acquire a new perspective to some old ideas. The overall objective of this course is to outline the new foundations related to convergence of solutions that have emerged in recent years and the accompanying breakthroughs in general techniques for problem solving. These techniques are intended to enhance, not replace, special techniques that are in common use. Anyone involved in aerospace research will benefit from this course.

Recent Advances in Adaptive Control: Theory and Applications

(Instructors: Tansel Yucelen, Research Engineer, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Eric Johnson, Professor, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Anthony Calise, Professor of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Girish Chowdhary, Research Engineer, Georgia Institute of Technology, Atlanta, GA)

Research in adaptive control theory is motivated by the presence of uncertainties. Uncertainties may be due to a lack of accurate modeling data combined with modeling approximations that result in unmodeled dynamics. They may also be due to external disturbances, failures in actuation and airframe damage. Adaptive control is also motivated by the desire to reduce control system development time for systems that undergo frequent evolutionary design changes, or that have multiple configurations or environments in which they are operated. Model reference adaptive control (MRAC) is a leading methodology intended to guarantee stability and performance in the presence of high levels of uncertainties.

This course will present a review of a number of well-established methods in MRAC. Starting with MRAC problem formulation and an overview of classical robustness and stability modifications, this course will continue to introduce the adaptive loop recovery approach

that allows the approximate retention of reference model loop properties such as relative stability margins. The course will also present Kalman filtering in adaptive control, in which a Kalman Filter framework is used to update adaptation gains that enables meeting a given performance criteria without excessive tuning.

Two novel adaptive control laws are also presented: concurrent learning adaptive control and derivative-free adaptive control. Concurrent learning is a memory-enabled adaptive control method that uses selected recorded data concurrently with instantaneous measurements for adaptation. Concurrent learning guarantees exponential tracking combined with parameter identification for a wide class of adaptive control problems, without requiring persistency of excitation. Derivative-free adaptive control is particularly well suited for systems with sudden (and possibly discontinuous) change in uncertain dynamics, such as those induced through reconfiguration, payload deployment, docking, or structural damage. It provides superior adaptation and disturbance rejection properties, and computable transient and steady-state performance bounds.

The course will also discuss emerging results in connecting machine learning with adaptive control. A special section will be devoted to implementation and flight testing of adaptive control methods, including discussion of the pseudo control hedging methods for handling actuator dynamics and saturation. The course will conclude with discussing extensions to decentralized adaptive control, output feedback adaptive control, unmodeled dynamics, and unmatched uncertainties.

SCITECH 2014

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52nd AIAA Aerospace Sciences Meeting
AIAA Atmospheric Flight Mechanics Conference
15th AIAA Gossamer Systems Forum
AIAA Guidance, Navigation, and Control Conference
AIAA Modeling and Simulation Technologies Conference
10th AIAA Multidisciplinary Design Optimization Specialist Conference
16th AIAA Non-Deterministic Approaches Conference
55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference
7th Symposium on Space Resource Utilization
32nd ASME Wind Energy Symposium

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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 Information Systems* (formerly *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.

CONNECT

When you join AIAA, you gain countless **OPPORTUNITIES TO CONNECT WITH MORE THAN 30,000 OTHERS** in the field of aerospace science, engineering, technology, management, education, and policy.

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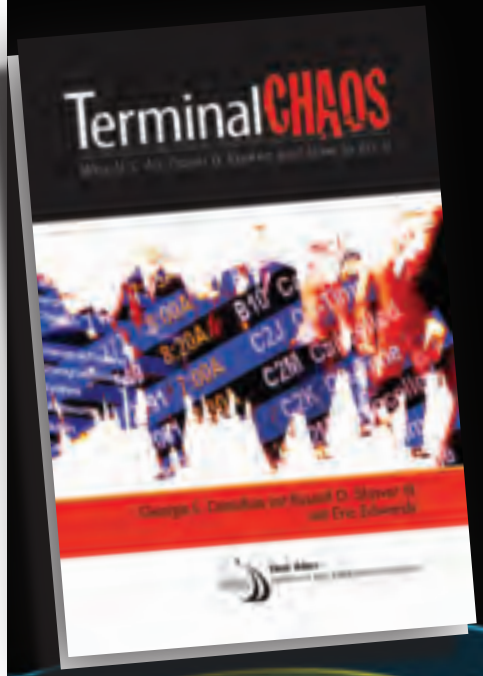
Terminal CHAOS

Why U.S. Air Travel Is Broken and How to Fix It

By **George L. Donohue and Russell D. Shaver III,**
George Mason University,
with Eric Edwards



Written with the airline passenger in mind, the authors arm the flying public with the truth about flight delays. Their provocative analysis not only identifies the causes and extent of the problems, but also provides solutions that will put air transportation on the path to recovery.

This is a very disturbing book—and it was intended to be. For the crisis in U.S. aviation is far more serious than most people imagine. Donohue and Shaver have given us the best prescription I've seen for fixing it.

– **Robert W. Poole Jr.**, Director of Transportation Studies at the Reason Foundation

Donohue and Shaver have taken an enormously arcane and complex set of issues and players and laid them all out very clearly and directly .... It's among the best and most thoughtful pieces written on the subject ... it's a very, very good—and mostly evenhanded—distillation of the background and causes of the current quagmire that will only worsen as time is allowed to pass with no real fixes in sight.

– **David V. Plavin**, former Director of Airports Council International–North America and former Director of the Port Authority of New York and New Jersey

The air transportation system is fixable but the patient needs urgent and holistic care NOW. Donohue and Shaver are the doctors, and the doctors are in! They have the knowledge and capability to work through this problem to success if we as a community want to fix the system.

– **Paul Fiduccia**, President of the Small Aircraft Manufacturers Association

An impassioned and controversial look at the current state of aviation in the U.S. by a former FAA insider. This is must read material for those concerned with how the aviation system affects them as an airline passenger.

– **Glen J. D. McDougall**, President of MBS Ottawa and former Director General, Department of Transport Canada

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