April 2012

AEROSPACE AMERICA

Getting from gate to gate

UAV sector faces sweeping changes

On-orbit servicing: The new focus

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AEROSPACE AMERICA

April 2012

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NASA is developing technology and software aimed at streamlining all aspects of commercial flight, from departure to destination. Turn to page 28 for details. Image created by Romanet & cie. between 1890 and 1900.

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AIAA
American Institute of Aeronautics and Astronautics

Commentary

Opening the skies to UAVs

I recently served on a panel discussion on the topic "Exploring the Future of Unmanned Flight—Innovation and Imagination in the 21st Century," with colleagues from industry and the FAA. The presentations and the question-and-answer session that followed prompted consideration of the future of unmanned aerial vehicles and systems (UAV/UAS) and how commercial aviation will be affected by their presence. It seems fairly certain that UAS will transform the way we use aviation to improve our lives and generate economic benefit.

NASA researchers flying Global Hawks and Ikhanas already understand their value for science. Now, a new fleet of pilotless vehicles is helping to ensure our national security, and the success the military is experiencing with these systems is eliciting fresh enthusiasm among civilian entrepreneurs willing to invest in this technology.

So many tasks—weather and Earth observation, crop monitoring, law enforcement, even package delivery—someday could be accomplished with remotely piloted drones that cost less to operate than their crewed counterparts and whose configuration can be tailored to specific missions. The potential uses for UAS are limited only by our imagination.

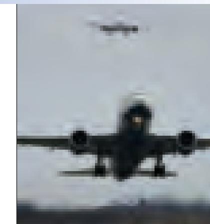
There are, of course, political, technological, and regulatory challenges to overcome before these flying robots are granted unfettered access to our national airspace system (NAS). If the business world ultimately is to profit from UAS, multiple government agencies, including the DOD, the Dept. of Homeland Security, the Federal Aviation Administration, and NASA must work together to lower the barriers to NAS access.

NASA's primary role is to look at technology solutions for integrating UAS in the airspace. Coordinated through its Aeronautics Research Mission Directorate's Integrated Systems Research Program, the agency's UAS work complements the contributions being made to the modernization of the nation's air traffic control system, widely referred to as NextGen. In fact, NextGen's advancements in satellite-based navigation and digital communication are the tools that will enable future UAS access to the NAS.

Technology alone cannot satisfy all of the unique requirements for opening our skies to these systems. We must address public safety concerns by ensuring that the vehicles' communications links to their control stations cannot be broken, that there is sufficient redundancy in all of their critical systems, and that they constantly maintain a safe distance from other aircraft.

Although NASA has been working on UAS technology for more than a decade, our current project to help integrate unmanned systems into the airspace is generating unprecedented interest from aviation's entrepreneurial and academic communities. Their strong desire is for government to make an immediate impact. This is a once-in-a-generation opportunity to conceive and nurture a nascent segment of the aviation industry that will create jobs, rev up the economic engine of our nation, and improve our quality of life.

Thomas B. Irvine
NASA Deputy Associate Administrator
Aeronautics Research Mission Directorate



ICAO: The best hope for settling carbon warfare

ITHE EU AND THE REST OF THE WORLD appear to be heading toward a trade war. Despite a wave of international—and some internal—opposition, the European Union remains adamant that all airlines flying into European airspace starting in March 2013 will have to buy tradable carbon credits as part of the EU's broader emissions trading system (EU-ETS).

In February, a group of 26 nations opposed to the EU scheme met in Moscow to discuss a range of possible countermeasures. These included stopping EU airlines from flying into the airspace of opposing nations, introducing unilateral ETS programs of their own, halting international aviation and other trade discussions with the EU, and denying EU states new airline routes.

Hardening opposition

Opposition to the EU's plan hardened at the end of last year with the failure of a case brought to the European Court of Justice (ECJ) by a U.S. association, Airlines for America. The association argued that the inclusion of U.S. airlines in the EU scheme infringed principles of sovereignty, the Chicago Convention, and the Kyoto Protocol. The ECJ disagreed.

As a result, the war of words between the EU and the rest of the world began to escalate at the start of the year. In February China banned its airlines from joining the EU-ETS program. At the 10th Ministerial Conference on Climate Change, held in New Delhi by BRIC countries (Brazil, Russia, India, and China) in February, there was universal condemnation of the measure.

According to a communiqué from the meeting: "Ministers noted with deep concern and reiterated their firm opposition to the inclusion of international aviation in the EU-ETS, which violates international law including the principles and provisions of the United Nations Framework Convention on Climate Change and runs counter to multilateralism. Ministers noted that the unilateral action by EU in the name of climate change was taken despite strong international opposition and would seriously jeopardize the international efforts to combat climate change."

Point of agreement

It seems therefore that little good is going to come from this escalating aviation confrontation between the EU and the rest of the world. But that is to misread, perhaps, the aviation political forces working away just beneath the surface. For there is one issue on which all sides—the EU, the U.S., the BRIC countries, airlines, and aircraft manufacturers—agree: The best place to resolve these matters is at the level of the International Civil Aviation Organization (ICAO). If ICAO can be mandated by governments to develop a global, workable emissions reduction plan, with binding targets and penalties, then all sides would benefit and the EU would modify its scheme to fit into a (probably) more diluted global program.

"This would indeed be a remarkable achievement," explains Andrew Charlton of Geneva-based Aviation Advocacy. "If ICAO were forced to take action on this then the Europeans would deserve huge credit. Of the six or so options open to ICAO—such as introducing a global environmental taxation system—the option of developing a worldwide version of the European ETS is probably one of the better alternatives," says Charlton.

"About a decade ago, ICAO achieved a globally accepted balanced approach to noise that averted a conflict over Europe's unilateral plans. ICAO can do the same for climate change," said Tony Tyler, director general of the International Air Transport Association, the global group of scheduled airlines, speaking in February.

"The 2010 Assembly agreed to 15 principles for economic measures and

How the EU-ETS process works

The EU-ETS works on a 'cap and trade' principle. This means there is a cap, or limit, on the total amount of certain greenhouse gases that can be emitted, and that within this cap, companies receive emission allowances that they can sell to or buy from one another as needed. The limit on the total number of allowances available ensures that they have a value. According to the European Commission: "At the end of each year each company must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so."

Every first quarter of the year aircraft operators must submit verified air traffic activity and emissions reports for their previous year's operations. The reports are then checked by accredited verifiers, and then submitted to States' Competent Authorities for further checking and processing.

The number of allowances is reduced over time so that total emissions fall. In 2020 emissions will be 21% lower than in 2005. From this year overall CO_2 aviation emissions will be capped, initially at 97% of 2005 emissions levels, and from 2013 onward at 95%. Allocation of free allowances is based on 2010 traffic levels. Some of these allowances will be auctioned, but operators emitting more than their allocated amount of CO_2 will need to reduce emissions or procure extra allowances. A reserve of 3% of the total quantity of allowances will be allocated to new or fast-growing aircraft operators.

The EU-ETS will be further expanded to the petrochemicals, ammonia, and aluminium industries and to additional gases in 2013.

committed to develop a framework for a global trading or compensation scheme by the next assembly in the third quarter of 2013. There is widespread agreement that ICAO is on the right track," Tyler noted, "even if the pace of progress is not sufficient for some European politicians. What is needed is continued patience to enable the international process to run its course and for European states to be wholehearted participants in that process."

But both time and patience are running out.

The problem with the ICAO solution is that governments would need to inject pace and energy into the ICAO proceedings. ICAO's current strategy for dealing with the emissions challenge is to ask member states (national governments) to produce national action plans for reducing aviation-related CO_2 emissions to meet a set of commonly agreed aspirational targets—stabilizing CO_2 emissions at 2020 levels and achieving a 2% annual increase in fuel efficiency up to 2050. Member states have been invited to voluntarily submit their national action plans to ICAO by June this year.

Quiet preparations

It would take a transformation of ICAO to move from aspirations and voluntary actions to binding targets that would then have to be enforced. And while governments opposed to the EU-ETS have bzeen talking about the possibility of starting a global trade war around the issue, most of their airlines that would be impacted by the EU-ETS program have quietly been developing compliance strategies.

"Although many governments are opposing the ETS and several countries banned or are trying to ban their operators from participating in the scheme, it seems that most if not all airlines are in process of compliance," according to Julien Dufor of VerifAvia, a private company that verifies compliance by aircraft operators to the EU-ETS scheme. "The cost of noncompliance is so huge—€100 fine per carbon credit not surrendered by May 30, 2013, and seizure of the aircraft and/or an operating ban if an operator does not pay—that most operators worldwide prefer to comply with the regulations. It is an EU regulation, and operators must comply with it."

Most of the world's largest non-EU airlines are already complying with the requirement to monitor their emissions. "Last year around 900 operators submitted a tonne-kilometer report and probably around 1,200 submitted an annual emission report. This year I anticipate maybe around 1,500 operators will submit an annual emissions report. It is difficult to know exactly how many operators are affected by EU-ETS, because many on the list are exempt or no longer fly to the EU or simply ceased to operate. The list has around 4,500 operators listed," Dufor points out.

Counting the cost

There are widely differing views as to the impact of the EU-ETS on airline operating costs. British Airways' parent company, International Airlines Group, has estimated that the scheme will cost it €90 million this year. Russia's Aeroflot has said it could cost them €800 million by 2025. Thomson Reuters Point Carbon, an information and market analysis group, estimates that all airlines will face a bill of €505 million for this year under the ETS.

The speed with which airlines grow and the cost of carbon are two of the key issues that will impact the final price. Current indications are that the EU-ETS might not cost airlines as much as they had first feared. While traffic grew 8.9% in Europe in 2011 over 2010—much faster than the global average of 5.1% measured by ICAO—this year traffic levels are likely to be far lower. Economic problems within the Eurozone, the slowdown in low-cost airline growth with the market reaching maturity, continuing political problems in the Middle East, and new government taxes on air passengers will all tend to depress air traffic growth in Europe.

The emergence of the EU-ETS has led to higher ticket prices, with increases ranging from €0.25 per flight for short hauls to €3 for transatlantic services. EUROCONTROL, the Brussels-based air traffic management agency, has modeled the impact of the ETS on traffic growth and calculates it will reduce traffic by around 0.3% by 2017, compared to what it would have been without it.

And the price of emitting a tonne of carbon, which has been in the €$12-€15 range for the past year or so, is also lower than first forecast. At the end of February this year it was just under €9.

Either way there is still a lot of negotiating to be done. The EU has said it would exempt countries if they have 'equivalent measures' in place to reduce airline carbon emissions. There is little evidence that this is taking place, although Australia and New Zealand have announced plans to merge their ETS programs in 2015 shortly after Australia has moved to a market-based carbon trading regime.

In the EU-ETS program, 85% of allowances will initially be handed out free, and the first emissions bills will not be issued until 2013. But if the matter is to be resolved at the ICAO level before EU-ETS reaches a point of no return, the governments concerned have only a few months to start the process of mandating ICAO to develop a global, binding ETS system.

Philip Butterworth-Hayes
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Events Calendar

APRIL 23-26
Fifty-third AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference; 20th AIAA/ASME/AHS Adaptive Structures Conference; 14th AIAA Nondeterministic Approaches Conference; 13th AIAA Gossamer Systems Forum; 8th AIAA Multidisciplinary Design Optimization Specialist Conference. Honolulu, Hawaii.
Contact: 703/264-7500

MAY 7-10
Reinventing Space Conference, Los Angeles, California.
Contact: 703/264-7500

MAY 14-18
Twelfth Spacecraft Charging Technology Conference, Kitakyushu, Japan.
Contact: Mengu Cho, 81 93 884 3228; cho@ele.kyutech.ac.jp

MAY 22-24
Global Space Exploration Conference, Washington, D.C.
Contact: 703/264-7500

MAY 22-25
Fifth International Conference on Research in Air Transportation, Berkeley, California.
Contact: Andres Zellweger, 301/330-5514

JUNE 4-6
Eighteenth AIAA/CEAS Aeroacoustics Conference, Colorado Springs, Colorado.
Contact: 703/264-7500

JUNE 4-6
Nineteenth St. Petersburg International Conference on Integrated Navigation Systems, St. Petersburg, Russia.
Contact: Prof. V. Peshekhonov, +7 812 238 8210; elprib@online.ru; www.elektropribor.spb.ru

JUNE 7
Aerospace Today...And Tomorrow—An Executive Symposium, Williamsburg, Virginia.
Contact: Grant Belden, grantb@aiaa.org

JUNE 18-20
Third International Air Transport and Operations Symposium and Sixth International Meeting for Aviation Product Support Process, Delft, The Netherlands.
Contact: Adel Ghobbar, 31 15 27 85346, a.a.ghobbar@tudelft.nl

JUNE 19-21
AIAA Infotech@Aerospace Conference, Garden Grove, California.
Contact: 703/264-7500

JUNE 25-28
Twenty-eighth Aerodynamics Measurement Technology, Ground Testing, and Flight Testing Conferences, including the Aerospace T&E Days Forum; 30th AIAA Applied Aerodynamics Conference; Fourth AIAA Atmospheric Space Environments Conference; Sixth AIAA Flow Control Conference; 42nd AIAA Fluid Dynamics Conference and Exhibit; 43rd AIAA Plasmadynamics and Lasers Conference; 44th AIAA Thermophysics Conference. New Orleans, Louisiana.
Contact: 703/264-7500

Correspondence

I read Mr. Butterworth-Hayes' article, **High-speed rail will impact airliner markets** (February, page 4). Of course it will, and there's nothing wrong with that. Where the distance and time favors a HSR solution, it will prevail. Airlines ought to concentrate on markets that do not favor an HSR solution.

The tone of the article is way too close to a competition mentality; us versus them. The AIAA should not be in the position of supporting class warfare. If anything, AIAA should be taking the lead to see how aerospace technologies can help and improve HSR endeavors.

I hope we will see no more of these kinds of articles on this subject.

Allan J. MacLaren
mdnmaclaren@aol.com

Reply by author: I just read this, and I'm glad to receive feedback on what I write, however negative. Rather than promoting class warfare, I was attempting to give a global view of the state of competition between rail and air around the world—which is real, and in Europe is very intense—as aviation organizations worry about the amounts of government subsidies (which some estimate at up to $26 billion a year) going into HSR services in competition with airlines (which receive nothing). I think this is a valid issue to raise.

I see the institute's global warming chickens are coming home to roost. In **High-speed rail will impact airliner markets**, Mr. Butterworth-Hayes states that one of the reasons governments are subsidizing high-speed rail is the perception that trains are more environmental than planes. I'm certain that the idea that planes are contributing to global warming is a large part of this perception.

As anyone with an Internet connection can quickly find, planes contribute less than 2% of mankind's yearly release of CO2. AIAA should be shouting this from the rooftops since it means that even ceasing to fly entirely would have virtually no effect. Instead they are publishing policy papers that make it appear that the link between CO2 and global warming is more established than the data support.

With Europe now actually imposing carbon taxes on airlines and the immense effect that a U.S. carbon tax on airlines or fuel would have on the travel industry and our industry, we should be telling lawmakers and the public that air travel is not the problem, if there even is a problem. Instead it appears that some are taking advantage of the current public concern to gain grant money without considering the effect on the future of the industry. Perhaps we'll all be travelling to Europe on high-speed boats soon.

Joseph Sheeley
sheeley@lighttube.net

Reply by author: I agree with Mr. Sheeley that in the instance of high-speed rail vs airline competition, perceptions have always tended to count more than the weight of empirical data. In many parts of Europe and Japan the aviation community is resolving the issue by trying to capitalize on fast-train networks rather than to compete with them.

Given the strength of political feelings in this area, many aircraft operators in Europe may perhaps believe this is the only way forward.

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Every month I read at least the editorial in the magazine, and you must be commended since it usually contains excellent and vital information and opinions for the aerospace community. However, the February editorial, **The power option**, has some misinformation and an annoying aspect in the communications of the Pioneer and Voyager missions.

In the mid 1970s I was the trajectory engineer on the navigation team for the Pioneer 10 and 11 missions at JPL. Even though the Pioneer missions were sponsored by the Ames Research Center, ARC utilized JPL for their navigation operations and the entire Nav team were JPL (Caltech) employees.

Your editorial states "Pioneer 10 and Pioneer 11 were launched in April 1973 to study the asteroid belt…." Actually, the Pioneer 10 spacecraft was launched on March 3, 1972 and the Pioneer 11 spacecraft was launched on April 6, 1973. These launch dates were separated by the 13 month window for consecutive launch opportunities to Jupiter.

The Pioneer Navigation Team at JPL consisted of only about seven or eight people working among the approximately 5,000 people at JPL doing JPL programs at that time. We would always take second class or lower status at JPL whenever there was any communication or considerations on unmanned space missions at JPL. This was always annoying, but at least in the greater science community and usually in the unbiased media, we were treated appropriately.

It was therefore amusing and somewhat annoying to me that you began your editorial with a paragraph on the Voyager spacecraft instead of the Pioneer spacecraft. The Pioneer vehicles were launched several years earlier than Voyager, were the first to leave the Earth vicinity (I believe) using RTGs, both had a flyby of Jupiter years before the Voyager spacecraft, and were the first to achieve solar system escape velocity, making Pioneer 10 the first man-made artifact (I believe) to leave our solar system. Note the Pioneer 11 spacecraft encounter with Jupiter was in December 1974—almost three years before the first Voyager was launched. Even the letter P occurs before the letter V in our accepted alphabet.

All letters addressed to the editor are considered to be submitted for possible publication, unless it is expressly stated otherwise. All letters are subject to editing for length and to author response. Letters should be sent to: Correspondence, Aerospace America, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, or by e-mail to: elainec@aiaa.org.

Your editorial appears to provide a chronology of planetary spacecraft using RTGs, so it awoke old annoyances that yet again a Voyager instance captured first billing when it should have been listed second.

Mike Helton

Editor's note: *Mr. Helton was not the first to point out the error, but he was the first to offer the interesting history.*

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The cover story for the January issue, by J.R. Wilson, **What's next for U.S. human spaceflight?** (page 24) ends by referring to a quote from Neil Armstrong:

"'...Our choices are to lead, to try to keep up, or to get out of the way. A lead, however earnestly and expensively won, once lost, is nearly impossible to regain.'" Armstrong concluded in his rare public appearance before Congress, "'America cannot maintain a leadership position without human access to space.'"

In the same issue, **Exploration in an uncertain decade** by astronaut Thomas D. Jones (page 16) suggests:

"If NASA is to keep human spaceflight from sliding further down the list of national priorities, it should propose and execute near-term achievements that build steadily toward lunar and asteroid exploration a decade hence....NASA should look to practical demonstrations...of how robotic and human exploration can open up new areas of commercial and industrial activity—exploration payback."

Not everyone agrees that there really is a need for men in space. The article "Rockets galore" on page 73 of the January 7 issue of *The Economist* discusses the Chinese intent to send men to the Moon. The article ends with the statement:

"Ultimately, manned space flight is futile. All the scientifically and practically important stuff can be done by robots. Nevertheless, symbols count. If the next man (or woman) on the Moon is Chinese, many people will see it as a sign that America has been surpassed again."

I suggest that the proponents of space travel have some heavy sales work to do to convince a nation striving desperately to recover from a severe recession that a symbolic man-in-space program is an appropriate use of limited resources. I suggest that it may be necessary to say out loud what we all know but don't like to admit—such a program can be partially justified as an effective jobs program—a high-tech WPA program, if you will.

Franklin Roosevelt's WPA during the Great Depression was a bottom-up system. It placed money at subsistence levels in the pockets of the laborers at the bottom. There was only a limited jobs multiplier when the laborers spent their money for groceries. The WPA-like effect from the manned space program was a top-down system which placed very large amounts of money in the pockets of corporations, managers, engineers, etc. The resulting expenditures for goods and services were high enough that the recipients could spend on homes, automobiles, higher education, travel, etc. Those expenditures were then spent by builders, laborers, etc., resulting in a much larger jobs multiplier than that attained under the Roosevelt plan.

Those who like to characterize such spending as a 'trickle-down' system don't really understand. The people at the bottom don't need a trickle; they need a flood. The genius of the man in space program was that the resulting cash flows were much more than a trickle and something of scientific significance was done as well.

I suggest that the people that we send to sell the future of the man-in-space progam are too often the astronauts, who will be primary beneficiaries. We will be providing a new generation of very expensive toys (some would say obscenely expensive toys) for their use. Can we get someone of note from the robots-in-space community, say from JPL, to make a statement supporting the ability of a man in space to do something that can't be done by robots? With examples, please.

Palmer Hanson
pohmwh@earthlink.net

Reply by J.R. Wilson To me, the argument that a robot can do everything a man can do, only better, is a kind of alternate universe perspective. A robot, for the near future, at least, cannot say 'Aha!' or wonder what's over the next hill. True, human operators on Earth can, but looking at feeds or even video with the short delay times of a lunar mission, or the longer delays with interplanetary destinations severely limits or even removes the immediacy of human response and real-time situational awareness. Humans on site can go off script—which is where the vast majority of scientific discoveries have been made.

But there are other factors just as important: international leadership and prestige, national pride, exciting possibilities that encourage the nation's youth to take the hard courses so they can be part of that future, the tremendous impact of technologies developed for space that find multiple applications to life on Earth....

JFK's Moon program stimulated generations of scientists, engineers, inventors, writers. It kept us ahead of our major 20th century rival—and was a major nail in the coffin of the Soviet Union, which ultimately collapsed in the face of U.S. technological superiority across the board.

Today, the question is whether we will retain that edge over our major 21st century rival or abandon all we have gained to our rivals—in this case China—and drop from superpower to back-alley observer.

There also is a hard-wired component of the human psyche: the urge to explore, to see what's over the next hill, firsthand. This is the basic instinct that propelled homo sapiens from the caves to spread to every corner of the Earth. And should that drive ever die—or be stunted—then our nation will fall into the dustbin of history.

Nor do I believe any other current or near-term spacefaring nation will provide our species with the sense of accomplishment and possibility the U.S. space program—manned and unmanned, but primarily the former—has given the world. An American on the Moon or Mars or anywhere else is seen as "a giant leap for Mankind." A child anywhere on Earth can look at the U.S. manned space program and know there is opportunity there.

Is it a modern WPA jobs program? No. It does create jobs—hundreds of thousands if not millions of jobs, far beyond the direct needs of the program. But those are jobs—actually, careers—driven by the marketplace, with futures and good incomes, opportunities that attract people, especially children, to personal growth.

"Ultimately, manned spaceflight is futile. All the scientifically and practically important stuff can be done by robots." That is one of the saddest things I've ever read. It dismisses human instincts, abilities, needs and accomplishments. Manned spaceflight is no more futile—and so far less dangerous—than any previous human exploration. Indigenous populations might disagree, on a purely personal level, but human exploration is never futile. Had early explorers used robots rather than going into the unknown in person, it is unlikely human civilization would have survived to the 21st century—BC.

Reply by Tom Jones Mr. Hanson asks for some sales work from advocates of human space exploration, to help him make sense of the cost of NASA's current human spaceflight programs in light of the nation's deficit troubles. I would like to assist:

Plainly, Americans wish to see a continued U.S. presence in space, and politicians, however imperfectly, reflect that priority in the budget because of the real and perceived value of human spaceflight. Our elected representatives attach enough importance to U.S. human spaceflight that they have consistently funded such a program for over 50 years.

NASA's budget of approximately $8 billion annually for human spaceflight (about 0.2% of the federal budget) is hardly the cause of our deficit woes. Zeroing out human spaceflight will make only an imperceptible dent in the $1.3-trillion deficit the president proposes to run this year.

Those funds protect our current initiatives in space and set the stage for future exploration. We have just completed an international space station for a cost approaching $100 billion. Research aboard should deliver a future return on our investment, but we do need to maintain a crew there to conduct research and get the payoff. Likewise, investing in our current commercial crew transport program will restore U.S. domestic access to the ISS and lower the long-term cost of reaching the station.

As NASA develops the means to reach beyond LEO, we solve engineering and scientific problems that serve to maintain a vigorous industrial base. This delivers to the nation a managerial and technical competitive edge that transfers directly to national defense and related technology leadership. There is no better way to stimulate our high-tech sector—other than with a war—than with a challenging program of human spaceflight.

Certainly, human spaceflight attracts human talent to our aerospace sector in a way that defense work or robotic exploration does not. Our high-tech base plainly benefited from the human team forged in the Apollo years, followed by the shuttle and space station. Challenging our best students with tough yet exciting problems at the frontiers of engineering and science plainly attracts talent in a way that developing better windmills or bullet trains does not. I was inspired in the 1960s to study science and math not so I could grow up to build better transistor radios than the Japanese, but so I might have the chance to follow in the footsteps of the Apollo astronauts. Our nation's determination to lead in space attracted tens of thousands like me to a technical education, and we have gone on to give our country another generation of leadership in civil aircraft manufacturing and defense technology.

The nation also benefits, as we have since Apollo, from a global perception that we are leaders in the most challenging, visible, and peaceful application of high-tech: space exploration achievement. Putting human explorers on the space frontier is the most visible expression of that leadership.

Why not just use robots to maintain this technical edge? First, other nations like China and Russia understand the prestige that flows from putting their explorers into space. Second, humans play a decisive role in solving the problems of space science and ensuring mission success. As I wrote in my March 2012 column, planetary scientist Steve Squyres, who supervised the missions of Mars rovers Spirit and Opportunity and is now chairman of the NASA Advisory Council, strongly backs human exploration. In 2009 he told a Space.com interviewer:

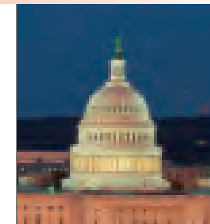
"You know, I'm a robot guy; it's what I have spent most of my career doing, but I'm actually a very strong supporter of human spaceflight. I believe the most successful exploration is going to be carried out by humans, not by robots.

"What Spirit and Opportunity have done in five and a half [now eight] years on Mars, you and I could have done in a good week. Humans have a way to deal with surprises, to improvise, to change their plans on the spot. All you've got to do is look at the latest Hubble mission to see that.

"And one of the most important points I think: Humans have a key ability to inspire [which] robots do not."

We can ensure these benefits continue to flow to our nation with a prudent investment in the future of human exploration. The Augustine committee in 2009 estimated we will need about another $3 billion annually to return Americans to deep space—perhaps $10 billion instead of the $8 billion we now budget. And remember, the U.S. budget total is $3.8 trillion.

The U.S. has the resources, even as we borrow $1.3 trillion per year, to invest a small fraction of its wealth in ensuring its competitive technological and educational edge. Our representatives and policy makers must choose national priorities, cut where necessary, and fund those areas that truly deliver benefits now and into the future. Human space exploration is one of those priorities where a modest investment will yield new discoveries, new wealth, and a secure future for our citizens.



Space, defense face funding uncertainties

By the end of this year, debates in Washington over budget, deficit, and debt issues are almost certain to grow louder, more emotional, and surely more divisive. What seems less likely is a solution.

The Obama administration's FY13 budget proposal is the focus of argument for now. Of special interest to Americans in the aerospace industry is one of the largest components of the Obama budget plan—defense—along with one of the smallest, NASA. The overall budget plan, so far, is mainly the topic of pronouncements—from the White House, the Pentagon, Capitol Hill, and industry. But this spring's congressional hearings will provide a public forum for opposing arguments. In the fall, after both parties have named their presidential candidates, the decibel level will go up as the November 6 election draws closer.

FY13 begins on October 1. Proposing a budget has evolved in recent years into one of the core duties of the Executive Branch. Enacting the budget into law always has been an essential function of Congress. Yet no one in Washington expects an FY13 budget to be legislated before the start of the new fiscal year, or before the election, and some observers wonder if government is capable any longer of handling the budget process at all.

Sen. Kelly Ayotte

But the difficulties go beyond questions about FY13, and beyond the elections. Instead of conditions that will make solutions more likely, the nation faces a 'perfect storm' of fiduciary challenges. For example, tax cuts from the Bush era are set to expire on December 31. In addition, the defense budget and spending on civilian programs will face a short-term sequester of $110 billion, one that will grow into much larger amounts in the long run. And the nation will again reach its statutory ceiling on debt, with another bitter debate expected over raising the federal debt limit.

With most Americans thinking about jobs and the economy, and not so much about the budget process (or even the war in Afghanistan), it is unclear whether presidential contenders will find traction by talking about defense or space policy.

Defense budget

Even if the candidates ultimately say little about it, the short-term debate in Washington this spring will spotlight the FY13 defense budget proposal, which cuts spending, retires aircraft, and cancels programs.

The proposed cuts are sufficiently harsh to upset lawmakers with military installations back home, yet not sizable enough to satisfy economists who want to see greater progress on deficits and debt.

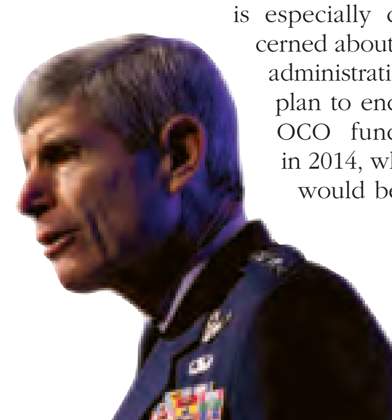
Sen. Kelly Ayotte (R-N.H.) called the cuts "draconian." In a visit to Pease Air National Guard Base in her home state, where she wants the Air Force to station some of its KC-46A air refueling tankers, Ayotte said she is "deeply concerned" about proposed cuts. She is on record as supporting former Massachusetts Gov. Mitt Romney in the upcoming election. She is also typical of many lawmakers in both parties who strongly support hometown Air National Guard (ANG) units.

But Thomas Kelway, a budget analyst for the Ralston Institute nonpartisan think tank, says the proposed reduction in defense spending is "only a drop in the bucket" and will not help with the big economic issues. Using a favorite Washington expression, Kelway says leaders in both parties are "kicking the can down the road," meaning that they are postponing tough decisions.

Pentagon plan

The Pentagon's 2013 base budget totals $525 billion, just $6 billion less than the current year's budget. Adjusted for inflation this is 2.6% below FY12 levels, the first real decrease—however slight—in the annual base budget in over a decade. The total does not include $88 billion for 'overseas contingency operations' (OCO), the term that encompasses 'transition activities' in Iraq, the war in Afghanistan, and procurement of MRAP (mine-resistant ambush-protected) vehicles. The OCO figure is fully $27 billion less than this year's. Congress declared a formal end to the war in Iraq as of December 25, 2010.

Gen. Norton Schwartz, Air Force chief of staff, says he is especially concerned about the administration's plan to end all OCO funding in 2014, which would belat-



Gen. Norton Schwartz

Some ANG units will lose their C-27J Spartan airlifters.

edly fulfill a 2008 Obama campaign promise to wrap OCO into the traditional defense bud-get. "We need this money to conduct operations," Schwartz told reporters in February, suggesting that the funds might simply go away rather than being transferred to the Pentagon ledger.

When the Pentagon budget figure includes defense-related expenditures elsewhere in government (the DOE's nuclear weapons program, for example), the proposed military spending total for FY13 ends up being almost $1 trillion.

While too large for some, too small for others, the budget cuts are real enough to the people affected by them. Chuck Holmes, a maintainer for the Maryland ANG in Baltimore, says his unit is "crestfallen" at being told it will lose its C-27J Spartan airlifters—along with about 200 jobs. Defense Secretary Leon Panetta hopes they will help persuade Congress to avert the statutory process known as sequestration, under which automatic, across-the-board cuts will slash an additional half-trillion in defense spending over several years, beginning with $110 billion next January.

The defense budget includes plans to retire 102 A-10C Thunderbolt II Warthogs.

Details of the FY13 defense budget plan were provided in this space last month before the document's formal release. They include cancellation of the Air Force's Global Hawk remotely piloted aircraft Block 30 program and divestiture of the entire fleet of 38 C-27Js. All of the latter are currently in five ANG units. Since last month, it has been learned that the plan also includes retiring 102 A-10C Thunderbolt II ground attack aircraft, called Warthogs by troops. This represents about a third of all A-10C airplanes in inventory, but the cut seems larger from the ANG viewpoint: The figure includes fully half of the 'Hogs' operated by the Guard.

Two Air Guard A-10C squadrons are untouched by the change, but five others in the 'reserve component'—the term that encompasses both the Guard and Reserve—would be eliminated. Many observers feel that the A-10C, which is a uniquely practical warplane for air-to-ground combat, is the wrong item to be cut. Once the ugly duckling of Air Force inventory, it has become something of a superstar in Iraq and Afghanistan. But the plane has little constituency on Capitol Hill: The company that manufactured Warthogs no longer exists.

Moreover, getting rid of A-10Cs would entail no program termination costs. The Pentagon appears to have cherry-picked programs for cancellation to avoid those pesky fees and the negotiations with industry that come with them. Panetta's staff wants to avoid the situation that arose with the Army's Future Combat System: Most components of the system were canceled in 2010, but discussions over termination fees with contractor Boeing are continuing today.

To avoid this problem, the DOD will simply allow some existing production contracts to expire even if it means taking delivery of new aircraft only to turn around and park them in the desert.

Air Force leaders including Gen. Schwartz learned early in the budget-making process that their branch of the service, especially its reserve component, would be the hardest hit in terms of program cancellations and the retiring of equipment. Now, air staff officers who worked on the plan are being accused of not doing enough consulting with state governors and ANG leaders before fashioning the cuts.

The budget proposal is an especially powerful blow to the Guard and highlights a widening breach between the active-duty force and Guard. Several state-level National Guard officials say they do not see the logic behind the proposed cuts. Together with officials at the New Hampshire base visited by Ayotte, they say they were left out of the decision-making process.

"This, to me, is totally out of character with the operating environment between the Air Force Reserve, the Air Guard, and the active Air Force," Maj. Gen. William Wofford, adjutant general of the Arkansas National Guard, told reporters in early February.

Maj. Gen. William Wofford

Gen. Craig McKinley

"Before, [the Guard] was always a full partner in the process, and this time it doesn't feel like a partnership." In a situation that is not atypical, Wofford's command includes a squadron of 18 A-10Cs at Fort Smith that is scheduled to deploy to Afghanistan in June and return in October. Those A-10Cs are on the list to be cut.

"Our troops are going into harm's way not knowing if their jobs will exist when they return," says Col. Mark Anderson, commander of the fighter wing at Fort Smith. He also says he is among the many who do not expect to see a budget decision by October 1. Under the budget proposal, Anderson's unit would shift to a nonflying assignment, which will leave about 400 pilots and maintainers jobless.

Guard General

Under the National Defense Authorization Act signed into law last December, the head of the Washington-based National Guard Bureau (NGB) now has a seat on the Joint Chiefs of Staff alongside service chiefs. Earlier legislation made the current incumbent, Gen. Craig McKinley, the first four-star general in the 236-year history of the Guard, which began as a body of separate, state militia units. The NGB chief's incumbency is expected to alternate between an Army National Guard and an Air Guard officer.

McKinley is an airman. Because of the importance of back-home Guard installations to Capitol Hill lawmakers, he is under pressure to lobby against the cuts, putting him at odds with Air Force boss Schwartz, who until December was his voice on the JCS.

In state capitals around the country, governors and adjutants general are quietly saying they view McKinley less as a spokesman for their concerns than as an accomplice with the air staff. Altogether, the ANG will lose 286 aircraft, five bases, and 5,100 guardsmen under the proposal. At the local level, almost everyone in national government, including Guard leaders in Washington, are seen as inflicting the FY13 plan without enough thought.

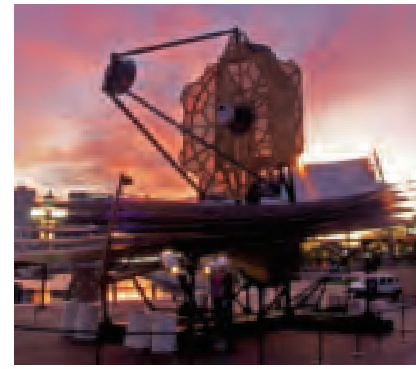
NASA numbers

As part of the FY13 proposal, NASA is slated to receive $17.71 billion, a decline of 5.4% from its high-water mark in 2010 and $59 million less than the FY12 figure.

"There's no doubt tough decisions had to be made, here at NASA and all across government," the agency's administrator, Charles Bolden, told reporters at a Washington event in mid-February. Bolden added that NASA has "a stable budget that allows us to support a diverse portfolio of human exploration, technology development, science, aeronautics, and education work." Now that the space shuttle program has ended, he is seen as presiding over an agency that has relatively little support from Congress, the press, or the public.

The FY13 plan for NASA puts the squeeze on planetary science while spending more on human spaceflight, including funds for the Space Launch System, a heavy-lift booster rocket mandated by Congress. 'Losers' at NASA include the agency's robotic Mars mission. The budget plan offers just $1.2 billion for unmanned exploration of Mars and other bodies in the solar system.

NASA Administrator Charles Bolden



Full-scale models of the JWST have been on display for a while, but the real thing still has years to go before it will be ready.

A potential 'winner' may not actually be one at all. Receiving $627.6 million in the FY13 plan (a roughly 20% increase from the current year) is the James Webb Space Telescope. This giant 7-ton, 21-ft-diam. infrared device, which is six times larger than the 22-year-old Hubble telescope, has suffered delays and cost overruns.

Named for the NASA administrator who crafted the Apollo program, the JWST is meant to capture the oldest light in existence and to reveal secrets of how the universe was formed. Its price tag has zoomed from $500 million to $8.8 billion, and its planned launch has been delayed from 2013 to 2018. NASA says it is 100 times as powerful as Hubble, a telescope that has given astronomers thousands of stunning images of the cosmos. Ted Thornhill wrote in Mail On-Line that the JWST "is costing the U.S. space agency so much money that it is acting like a financial black hole, sucking funds away from other projects and threatening their future."

More to the point, the telescope is an inviting target. Last summer, House appropriators led by Rep. Frank Wolf (R-Va.) recommended scrapping the project. But it survived and received $529.6 million for FY12. Despite its inclusion in the FY13 proposal and its expected value to science, JWST remains a highly visible target for lawmakers looking to achieve savings.

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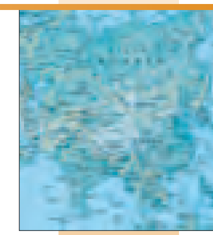

The lure of Eastern promise

IT'S OFFICIAL: CHINA HAS BEEN OPENLY rolling out the welcome mat for foreign pilots to help plug a gap caused by rapid aviation expansion at home and a training system that cannot pump out new pilots fast enough. The country has recently been holding job fairs and exhibits in the U.S. to take advantage of the downturn in America's airline industry. The vacancies China is looking to fill are across the board, so far as captain and copilot jobs are concerned, and include airline and corporate aviation work. But it is not just numbers China wants—international standards are very much on the airlines' and regulators' minds.

This is not the first time Chinese airlines have sought foreign pilots: There was a tiny influx in the early 2000s, when China joined the World Trade Organization, in a slow reaction to a policy change in Beijing that had actually happened in the mid-1990s.

The move to hire foreign pilots received its big push when Hainan Airlines hired two foreigners in 2001 to fly on its first international route.

Then, as now, pressure from Chinese airlines in need of pilots led to the policy change. But in the 1990s there was still a lack of official enthusiasm, partly because most of China's airspace was—and still is—'owned' by the military. Thus allowing foreign pilots to fly to many of the dual-use military/civilian airports could be a threat to national security. So virtually nothing happened in spite of repeated requests from Hainan Airlines and China Southern Airlines, both in southern China, until Hainan hired two foreigners in 2001 to fly on its first international route.

Change and irony

Some conditions have changed: The military has ceded some control of airspace connecting major commercial aviation centers, and exposure to foreign tourists over greater areas of the mainland has served to reduce some of the outright xenophobia that was prevalent in much of China. But with jobs for pilots at that time being plentiful outside China, living and working in an alien culture had limited attraction for many pilots until about four or five years ago, when financial rewards and living conditions for foreigners began to improve significantly.

Now, the jobs being offered by several recruiting agencies involve excellent salaries, help with housing, and encouragement to bring families, with international schools available. It has taken a while for conditions of service to reach international levels, but this has happened to a large extent. Nothing is perfect, of course (and there are still allegations about shoddy agencies and poor treatment), but the other side of the coin is that conditions for many pilots outside China have unquestionably worsened.

The resulting situation is extremely ironic: The economic slowdown in the U.S. and Europe has combined with increased retirement ages among flight crew, slowing promotion prospects for copilots in both places. Voting with their feet is therefore a logical reaction to a less-than-optimistic career outlook, at least in the short term.

But now add to that the FAA's intention of mandating that by next year new copilots in public transport operations must have the same number of flying hours as new captains—at least 1,500—and both must have the Air Transport Pilot (ATP) certificate. That is the result of congressional moves to raise experience levels among pilots at regional airlines—the outcome of public concern after a turboprop crash near Buffalo killed 50 people in 2010. (Both pilots in that crash had the certificates then required—the captain had an ATP and the copilot a Commercial Pilot certificate—and both had more than 1,500 hours; the accident report seemed more concerned with training quality and fatigue than with certificates. But that is another story.)

In short, the effect of U.S. pilots moving to China will raid the very cohort of experience at home that the FAA wants to build up. Combined with Chinese pilots being trained abroad and a large number of Chinese students at foreign universities, it is also likely to wreak major changes in China and Chinese society by increasing self-assertiveness and importing foreign standards and styles of thinking.

Flight simulators will play a crucial part in getting this huge influx of pilots ready to get into the cockpit.

Quality of experience

The search not just for experience but for quality of experience among aircrew is nothing new anywhere. China has been training new pilots and technicians at home and at overseas colleges in, for instance, the U.S. and Australia. One rule is true for these new pilots and engineers, whether their college is at home or abroad: In addition to required technical subjects, if they are to be able to work on international routes, they must be trained in aviation English to the minimum Level 4 mandated by the International Civil Aviation Organization, the U.N.'s expert body for international flying.

There is a huge difference between the two environments: At home, students who study Level 4 English learn it very much as a second language while still immersed in their own culture. Overseas, they are immersed in English as well as in a foreign and far more self-assertive culture.

China's airlines expect increasing competition from foreign carriers, so they are eager to acquire and operate to foreign (meaning international) standards with regard to safety and efficiency. But while the goal is in itself obviously laudable, it is a moving target.

Most of China's carriers originated as state-owned or province-invested entities that effectively flew as government air-taxi services for VIPs. As the economy has grown and travel restrictions have eased, the airlines have themselves changed beyond all recognition, and in numerous respects are already comparable with many of their foreign counterparts in terms of passenger service levels and reliability.

China's aviation chiefs chose many years ago to adopt the regulatory path trodden by the FAA, as have most other Asian countries—the exceptions are nations or territories with aviation regulatory systems that are legacies of former British rule. For China it was an obvious choice. The U.S. is the world's biggest 'aviation nation.' It is home to one of the world's two largest airliner makers and is a huge source of innovation in aviation equipment, operating techniques, and knowledge. It is also a massive buyer of China-made products, even if many of these are made in U.S.-owned or invested factories.

While China's airlines and regulators have leapt headlong into the modern era so far as aircraft and aviation rules are concerned, training facilities cannot move so fast, and for good reason: A school takes a few weeks to put up, but building experience takes its own time, particularly experience at international levels. It takes about 10 years for a pilot in China to reach the copilot seat of a large airliner—hence the move to buy experience by seeking foreign pilots.

The training boom

So now there is a huge opportunity for the aviation training industry to offer its services to China. According to *China Business News*, the country's aviation industry is expected to need 18,000 more pilots in the next three years, or 6,000 a year. Giant U.S. plane maker Boeing's estimate is just over half that, or 72,700 pilots over the next 20 years, with around 40% of the total demand in the Asia-Pacific region. Even so, the domestic training industry can turn out only about 1,000 a year. Add in maintenance staff and the figures become massive: The Asia-Pacific region will require 220,000 new engineering staff, with China alone needing 96,400.

The trick is to use facilities outside China, so that standards are international, but with flying opportunities unharmed by erratic weather. Hence the attraction of Australia and the U.S. for basic training and for students to be 'immersed' in English to bring them up to ICAO Level 4 standard. For type training and recurrent proficiency checks, Boeing and Airbus have their own simulator centers in China, as well as simulators run by or in partnership with local airlines. FlightSafety International and Gulfstream in mid-February opened a brand new simulator in Hong Kong for G450 and G550 executive jets because of increasing numbers of those types flying within China.

Culture shock

Bringing in foreign pilots inevitably produces something of a culture shock on both sides of the cockpit. Chinese custom tends to favor a top-down hierarchy in which subordinates are not expected to correct their seniors—except possibly by the politest of subtle hints. This does not work too well in a foreign-run cockpit, where a copilot who realizes the captain has made a mistake is expected to say so clearly and rapidly. From a foreign perspective, it also does not work too well in a local environment, in that a copilot who does not speak up is no more than another passenger.

Chinese airlines hired nearly 100 U.S. pilots at the Pan Am International Flight Academy's All China Job Fair, held in February. Image courtesy Pan Am International Flight Academy.

The Cockpit Resource Management training system is supposed to overcome such problems with the 'power distance' or 'power gradient' on flight decks, but it still takes cultural sensitivity and adjustment on both sides to reach a good working understanding. There is nothing new in this—a much-cited Hong Kong University MBA thesis on cultural influences in cockpit communications was written by J. Graeme Ogilvie (overseen by Prof. S. Gordon Redding) in 1984. But whatever the concept's age, it still must be borne in mind.

Similarly to be remembered in cross-cultural working environments is the need to understand the subtleties of automatic systems, and the imperative of keeping an eye on the basics of flight—not to become 'children of the magenta line,' totally dependent on the flight path shown on the flight instruments. Again, there is nothing new in this need—but it keeps rearing its head with monotonous regularity.

For instance, from *Flight International* magazine in 1990, "…accident investigators have concluded that the aircraft was not at fault but that human error played a major part in the crash. What has not been resolved is whether that human error was attributable wholly to the crew or partially to those who trained the crew on the aircraft's systems…." Several accidents in the past few years merit the same doleful epitaph.

FlightSafety's proud motto is: "The best safety device in any aircraft is a well-trained pilot." Precisely—and that puts the emphasis back on training, where China seems to be avoiding the temptation to run its pilots' courses like high-speed sausage machines.

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The next major target for improvement could well be air traffic control—not air traffic management itself, which is upgrading its equipment and trying to cope with huge airline expansion, but airspace management, which largely remains at the military's whim. Delays, lack of explanations, and frustrated, angry passengers have become commonplace, whether or not they are the fault of weather or the military.

But getting airspace out of the military's hands will take major political willpower, and for the next few years this may be a bridge too far. A leadership change in Beijing toward the end of this year might bring clues. But then again, it might not.

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Patrick Ky

The SESAR [Single European Sky ATM Research] program, Europe's counterpart to the FAA's NextGen program, is an ambitious and expensive project. What are the most challenging technical targets, and how will you achieve them?

There are technical challenges and 'softer' challenges such as human factors, which we also regard as technical. Everything in SESAR is about a change of paradigm in air traffic management [ATM], and this change will come from the integration of the aircraft with systems on the ground.

The real technical challenge will be to have this integration done technically—typically with data link—and functionally, where the system on the ground can talk to the system on the aircraft. These systems were not built to do this. This I think is the real challenge—to integrate the world of the aircraft and the world of the ground.

Data link, which is the key to enabling this, has been around for a long time, yet its take-up has been relatively slow. Why is that?

The difficulty is the business side. If you want to succeed in data link you need aircraft operators to invest in new equipment to put on board the aircraft. But they are not the ones who directly benefit from this investment. Then there is the problem of synchronization. This technology can be really beneficial when there are a certain number of aircraft that are equipped, and where there is sufficient coverage of all the ground stations. It's a 'Catch-22' situation.

But aircraft operators must benefit from data link at some stage, because it will reduce pilot workload and improve the performance of the overall system.

They don't directly benefit. When we looked at the data-link services being planned in Europe, most of those services are being used to replace exchange of information taking place by voice. Basically it will replace a voice exchange with a kind of email. What are the real benefits to replacing a telephone call by email? It's hard to determine with precision. And our difficulty is that we have to start with this.

The sort of human factor changes this will bring, however, will allow us to go to a later step where the aircraft operators will really see the benefits when we move to trajectory-based operations, where there are real benefits in terms of reduced workloads and more efficient trajectories. But to get there you need intermediate steps, which are not necessarily the ones that will trigger the greatest benefits.

So how do we do it?

We are trying to link the technical change with operational improvements. This makes it more complex—you need to build new operating procedures, new functions, possibly, to use the new type of information exchange. But we believe this is the proper way to propose to the airlines the benefits they are looking for.

"This I think is the real challenge—to integrate the world of the aircraft and the world of the ground."

You've obviously talked to airlines about this—what is their reaction?

Let's say it's been mixed. They understand the concept. They agree that for their new aircraft they will have the new technologies on board, but the difficulty will be to retrofit older aircraft. What we are trying to do in Europe is have an ATM master plan, which is a roadmap of which technologies will be deployed by whom and by when. We are trying to define the roadmap for air traffic control service providers, aircraft operators, and the military. We want to build operational packages that make sense from the business perspective. It's not easy, but our expectations are that the new ATM master plan will be ready before the summer.

And it will include business and general aviation, too?

Yes, but taking into account that the business case for business and general aviation will be a little different from that of an airliner.

When you look at these roadmaps and when the benefits to aircraft operators might be realized, what sort of time-scale and investment are we talking about?

We have a mandate for data link which says that all airlines flying in Europe will have to be equipped with what we call ATN Baseline 1—the kind of email facility we have been talking about—by 2014. Airliners that are equipped with FANS [Future Air Navigation System] equipment—which is the case for most aircraft flying Atlantic routes—do not have to equip with ATN Baseline 1. A second step is to move toward the first trajectory-based operations, which will take place between 2018 and 2020. We think this is quite aggressive. In the U.S., current discussions are taking place on NextGen and are pushing this second step toward 2030.

The point is we have to minimize as much as we can the transition period. It is in the transition phase where it will be most costly—to maintain infrastructures, to provide voice services and new types of services.

The definition phase of SESAR finishes in 2013, and deployment starts in 2014. What will be the first new SESAR-standard technologies to be

Interview by Philip Butterworth-Hayes

deployed, and when will the first benefits flow into the ATM system in terms of improved safety, delay figures, cost efficiency, and environmental performance?

There are a certain number of tools needed for data link to be implemented. We are also working on tools independent of data-link applications. In terms of new ones for controllers, we are looking in particular at better planning tools, for both preflight—for a better integration of airline and ATC operations—and after the flight has taken off. This means the development of departure and extended arrivals managers and the coupling of these two systems.

We are also investing substantial amounts of money on tools that do not require aircraft integration in ATC, and those tools will start to be implemented from this year on.

"It sounds easy, but in a continent where we have 27 different air navigation service providers, with different companies and nationalities, it's not that easy."

Can you give some examples of these new tools? When are we going to start seeing measurable benefits?

We have developed new enhanced short-term conflict-alert algorithms that will be implemented, and we think they will have a very positive benefit on safety. We are working also on tools that will have short-term beneficial air traffic flow management measures, which will allow for better coordination between ATC centers and airports to provide maximum flexibility in the management of traffic flows. If there is an overload of a sector in a center, immediate actions on the upstream centers can be taken to slightly deviate the trajectories of the incoming aircraft, or vice versa. If we have a sector that is underloaded we can accelerate the flow of traffic into that sector.

It sounds easy, but in a continent where we have 27 different air navigation service providers [ANSPs], with different companies and nationalities, it's not that easy. We are also working on approach procedures with vertical guidance or P-RNAV [precision navigation], schemes that are already resulting in environmental benefits and cost savings, because we have smoother paths into the airport.

Patrick Ky was appointed executive director of the Single European Sky ATM Research (SESAR) Joint Undertaking in October 2007 and since then has driven the setup and execution of Europe's ambitious air traffic management modernization program.

Ky graduated from the Ecole Polytechnique in Paris and the Ecole Nationale de l'Aviation Civile in Toulouse, France, and holds degrees in economics. With over 22 years of work experience in civil aviation, he has held different managerial positions in the French Civil Aviation Authority, a private consulting company, and EUROCONTROL. Between 2001 and 2004 he was the ATM rapporteur for the ACARE (Advisory Council for Aeronautics Research in Europe). In 2004, he joined the European Commission to work on SESAR.

Could you give examples of concrete progress as a result of cooperation between Europe and the U.S.? There are some high-level agreements in place, but in terms of coordinating at a program level, how much real cooperation is there?

We have a high-level agreement to work with the FAA, and more specific areas of cooperation where we have set up teams to exchange information and agree on common plans. Typically, on the exchange of trajectory information, everything has to be defined so that we can have new standards. And we are working very closely with the FAA to define new standards on what this trajectory should look like.

On 'green approaches' we have common projects, such as the AIRE [Atlantic Interoperability Initiative to Reduce Emissions] project, where we have transatlantic flights that have a green departure in the USA and a green arrival in Europe (and vice versa), and we exchange best practices. We also have to recognize the U.S. system operates in a very different way from the European system, so there will always be differences between us. But we try to exchange as much information as possible, and we have been working closely in the framework of ICAO [International Civil Aviation Organization] to ensure its plans are compatible with NextGen and SESAR.

What are the differences between the U.S. and the European approaches—will data link be used in the same way, for example?

The data-link services are standardized, and I don't think we have divergence on the way data link is going to be used. Where we currently are having divergences is on how we deal with the transition periods. In Europe we want to keep the transition period as small as possible; in the U.S. the approach is to say: "We agree on the need for trajectory-based operations, but the transition will last 15 years." This is the difference.

In order to keep the transition period shorter in Europe, we need to provide the right incentives to accelerate the transition. Whereas in the U.S., the approach seems to be: "The transition period is very long, so we need to prepare to have mixed equipage, mixed operations, and mixed management." This is perhaps due to the higher proportion of general aviation operators in North America.

However, this has an impact on the business cases on both sides of the Atlantic.

A key component to the success of SESAR will be achieving buy-in from the ANSP and aircraft operator communities. They will have to invest billions of euros in reequipping to the new standards. Do we know what carrot-and-stick approaches may be used to encourage deployment?

The stick is the regulations. We have a mandate for data-link equipage in Europe—not really a stick but a common milestone which all the actors have to synchronize with. It is likely we will also have to have a common milestone for the second stage of data link. How aggressive this milestone will be is something that will have to be discussed with all the different actors.

We also want to make sure that the business case can be positive. We have invested in developing business assessment methodologies, a kind of tool box that is adapted to the specific operation of an air navigation service provider or aircraft operator. What we would like is that those stakeholders use our business tools to evaluate whether the business case is positive or not for their own operations.

"We also have to recognize the U.S. system operates in a very different way from the European system, so there will always be differences between us."

There are some kinds of stakeholders for which the business case may not be positive, and this we need to address. Typically this is the military, and possibly general aviation. How we can incentivize their investments is something we need to discuss with them and with the public authorities. Because this is one area where I think we will need some kind of public involvement to develop incentives for investing.

Will airports, too, have to invest in these tools? How do we integrate airports, especially 'nonaviation' areas of the airport, such as terminal operations, into the SESAR concept? In Europe each country seems to organize the management of its airports in a different way.

For us this is something that is essential. We believe in the need for an integrated process chain for passengers, comprising all the different elements, including the baggage system, which will have an impact on the overall performance of the system. We are working with the integration of airports in the overall plan, so we can identify everything that will have an impact on what time the aircraft will be ready for departure. It needs to be known by the controllers as soon as possible—and vice versa. If there are any events, such as a meteorological event, that will affect the performance of the flight or the time that the aircraft arrives or is ready to depart, it should be known by the airport operator.

In terms of airport operators, there are different business models in Europe. What we want is for all the different actors to understand each other. So we have worked on airport collaborative decision-making [CDM], which in Europe is mostly about airport information exchange between all the different actors.

As far as investments are concerned we foresee that airport operators will have to invest in the upgrade of their systems to connect with—and be integrated within—the next generations of CDM networks, which we call SWIM, or system-wide information management.

We do have airport CDM programs in Europe, but they tend to be only in the larger airports. And the speed with which smaller airports are embracing the concept seems to be quite slow, considering the importance they play in the overall network.

If you look at airport business models, it's true that most of their revenues are not strictly aviation related. I think most airport managers come from a nonaviation world, so to convince them to invest in something that has an operational benefit but not necessarily a financial one is something we are working. We are being increasingly heard in the airport community, but it is a challenge we have to face.

Who will be responsible for managing the implementation phase of SESAR?

There is a political process that was launched by the European Commission on this recently. The implementation will be done by the actors—aircraft operators, airports, air navigation service providers. The real question is, how do we make sure all this is coordinated? Take the example of data link: It doesn't make any sense if Lufthansa invests in data link but the German air navigation service provider does not. It doesn't make a lot of sense to have data link in just one country.

The commission has proposed a way forward in this aspect, using the carrot and stick approach. The carrot is the fact that the commission would like to use European Union funds to accelerate the implementation of new technology, and to incentivize the coordination and synchronization of the deployment.

Do we have a time scale for these regulations?

We are working on that. We mentioned the second stage of data-link implementation. My personal feeling is that we will need to regulate how we exchange regulation. If we build SWIM, the possibility to exchange all types of information across a kind of intranet for ATM, we need to be very clear on who has the right to access the different types of information and what you can do and cannot do with it. I think this will have to be framed as part of a legal framework.

Could you give us some idea of what will change in the controller and pilot's roles after the implementation of new SESAR concepts? What tasks will be automated, and how will this impact the performance of the overall system?

If we take as an example the 4D flights that were operated on February 10, for those flights we used the arrival into the airport for the most constraining factor for the trajectory of the flight. Therefore the arrival airport—in this case Stockholm—provided a constraint in that they wanted the aircraft to be at a given position at a given time—with a plus-or-minus of two or three seconds. Today it is the controllers who give instructions to the aircraft to meet that target. We were trialling an operation where the aircraft was to automatically adapt its trajectory to meet the target.

The real change will come from that. We still have the controller responsible for traffic flows, for safety; but instead of being the one who manages the trajectory of the aircraft to meet a given rendezvous point, this will be the responsibility of the aircraft itself. It will not be the pilots who will be turning the aircraft or changing the speed to meet the target; they simply will enter into the FMS [flight management system] the trajectory the aircraft will fly.

It may seem an easy concept, but we need to look at what this means in terms of safety: If there's a problem, how do we recover? How do we ensure all the aircraft will be able to fly with the right degree of precision?

How long will it take to perfect this operation, to go from the initial steps to implementing it throughout the continent?

We are starting the tests now, and we think we can make progress on it in the next three to four years. We know the technology will be ready on the aircraft side by 2018. New generations of FMS will be able to deploy this type of functionality. But I don't believe it will be deployed overnight on the continent. We will start to do it in low-density airports first and eventually deploy it at busier airports like London Heathrow, which is the only airport in Europe where there is still airborne holding. This operation will get rid of that.

How have the recent economic troubles in Europe impacted the SESAR program? Has there been any pressure to speed up the process of moving from research into operation, or has a lack of funds slowed things down?

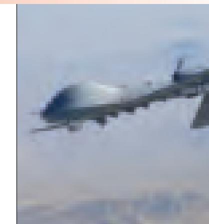
Both. For the current phase of the problem we are lucky not to have been impacted by public funding issues, because the public funding was secured. What we do see are issues around the availability of resources from our partners, especially industry partners.

But we think the real issues will emerge at the deployment phase. Airlines and ANSPs are saying that if they do not have a return on investment in five years, they won't do it. This is going to be very challenging. We will have a lot of discussions about the availability, or not, of EU public funds for help in the deployment of new technologies. We are working on ideas such as the creation of an airline investment fund to help airlines get access to cash and reimburse the loan when the benefits kick in.

"I think most airport managers come from a nonaviation world, so to convince them to invest in something that has an operational benefit but not necessarily a financial one is something we are working."

We are also looking at incentives to aircraft operators to equip, perhaps saying to them: 'If you have this technology on board then you may have a higher quality of service, or be able to fly a different trajectory.'

But we don't want to create inequities in the system—we are working in the framework of a policy that will be sustainable and intend to go to ICAO to have the principle discussed and agreed there.



UAV sector faces sweeping changes

The market environment for unmanned aerial systems (UAS) promises to shift dramatically in the next few years, with UAV companies being forced to reinvent themselves to remain competitive.

Driving these sweeping changes are pressures on defense spending worldwide, combined with prospects for the long-awaited development of a commercial market for UAS.

Companies in this sector are accustomed to an environment of plenty: DOD spending for UAS rose explosively during the past decade, from $545 million in FY02 to $4.8 billion in FY11—nearly a tenfold increase. In the new austere fiscal environment, such growth is a thing of the past.

FY13 cuts

The proposed FY13 military budget calls for reductions across major UAS programs. The Army requested $26 million for the purchase of 234 AeroVironment RQ-11 Raven mini-UAVs, a 74% decline from the $86 million for 900 vehicles approved in the FY12 budget. Army funding for the Textron AAI RQ-7 Shadow has dropped precipitously, from $549 million in FY11 to $161 million in FY12. In the latest budget, funding fell to $104 million.

It was not just the Army that took a hit. With concerns about the affordability of the Northrop Grumman RQ-4 Global Hawk, the Air Force proposed ending the aircraft's Block 30 program in favor of continued use of the U-2 airplane. Still, funding was retained for the Global Hawk Block 40 and the Navy's Broad Area Maritime Surveillance System. The continuation of those efforts provided some cushion for the program, meaning that the request for Global Hawk fell from a total of $1.46 billion in FY12 to a proposed $1.25 billion in FY13.

Global Hawk

Raven

The Air Force cut the planned purchases of MQ-9 Reapers to 24 from 48 the previous year. The Army revised its plans for buying the MQ-1C Gray Eagle, cutting the number from 43 in FY12 to 19 in FY13. Yet even with the reduction, General Atomics Aeronautical Systems, manufacturer of the Predator/Reaper family, fared relatively well as funding was added in areas aimed at making UAVs more effective, such as training and ground stations. Total funding for the Predator/Reaper family fell from $2.07 billion in 2012 to $1.91 billion in 2013.

In short, reductions in the proposed FY13 budget have hit virtually all of the biggest UAS programs, putting revenue pressure on four of the nation's largest UAS companies: General Atomics Aeronautical Systems, Northrop Grumman, Textron AAI, and AeroVironment.

Ripple effects

Budgetary pressures promise to have repercussions beyond the immediate programs being cut, and will fall particularly hard on small companies. These firms have been an important source of innovation in the industry.

With U.S. involvement in Iraq and Afghanistan receding, the decline in emergency wartime spending means that a source of funding for innovation—one that has helped smaller companies in particular—will disappear. Moreover, small firms that still have not secured any position on key military programs will be in an especially bad situation. With few new programs likely to move ahead in the current environment, such companies will face serious pressure. In addition, this lack of positioning will make larger players uninterested in purchasing them.

Major U.S. companies are shifting their strategies to respond to these new conditions. Affordability initiatives will be critical in ensuring that programs stay funded in a more austere environment. Contractors are working to provide UAS with more autonomy and persistence to reduce the number of personnel needed to operate them. Several companies, including Northrop Grumman, Aurora Flight Systems, and L-3 Communications, are now offering innovative concepts such as optionally manned systems. These vehicles improve affordability by enabling a pilot to take them through closed airspace and operate them even in areas with very limited infrastructure.

Predator

International interest

International sales are recognized as a key element of efforts to find continued growth. Adoption of UAVs has lagged significantly overseas—typically, considerably less than 10% of UAV sales for U.S. companies come from abroad. For the Predator A/B, only 5% of sales are international. For the Shadow 200, the figure is only 6%. AeroVironment, which leads the market in mini-UAVs, derives 7% of its revenues from overseas even though its UAVs are easier to export than the Predator A/B.

Recognizing this strong growth potential in overseas markets, major U.S. defense companies are pushing ahead with efforts to bolster international sales. General Atomics Aeronautical Systems, which must deal with serious U.S. hindrances due to concerns about possible violations of the Missile Technology Control Regime, has developed an export version of the Predator that is tamper proof.

Textron's AAI, manufacturer of the Shadow 200 tactical UAS, has been pushing hard for exports, achieving a string of victories. Faced with the end of production of Shadow 200 for the Army as its backlogs declined, the company invigorated its export drive, reaping handsome benefits. In July 2010, Italy awarded AAI $64 million for four Shadow systems.

Shadow 200

That triumph came just two months after a similar sale in Sweden. AAI has contracted to provide two Shadow 200 systems and associated services under a $31.4-million Swedish award. AAI also won a competition conducted by Saab on behalf of the Swedish Ministry of Defense. In May 2010, the Defense Security Cooperation Agency notified Congress of a possible foreign military sale of two RQ-7B Shadow 200 UAS to Australia, with associated equipment, parts, and logistical support, for an estimated cost of $218 million. Now AAI is looking beyond Europe and Australia into possible exports in the Middle East and Asia.

Other strategies

Beyond the drive to bolster exports, major U.S. companies are working to invest their own R&D funds in new products they hope will attract military interest. General Atomics Aeronautical Systems' investment in the Predator C, or Avenger, a jet-powered stealthy UAV, paid off in December 2011 when the Air Force purchased one at $15 million for testing. GAAS is targeting Avenger as a possible interim replacement pending the advent of the long-delayed Air Force plans for introduction of a next-generation UAV.

Avenger

Boeing has been willing to invest in flight testing of the Phantom Ray to better position itself in any future competition for unmanned combat aerial vehicles (UCAVs). AAI unveiled the Shadow M2 last year in an effort to continue dominating the Army tactical market. The M2, a possible successor to the Shadow 200, uses a new Textron Lycoming heavy-fuel engine and can carry two separate payloads instead of only a single electrooptical/infrared load.

KMAX

Companies are also working to ensure that their products are seen as families whose systems complement each other and use the same infrastructure. AeroVironment is presenting the Raven, the larger Puma, and the smaller Wasp as part of the same family of mini-UAVs, using a common ground control station. Similarly, the Shadow M2 would save money by using the existing infrastructure of the Shadow 200.

Despite the pressures on military UAV sales, some newly emerging requirements could help reshape the competitive environment. Unmanned cargo systems are getting a push with the deployment by the Marines of two unmanned K-Max helicopters to Afghanistan. Naval unmanned combat aircraft will get a push from UCLASS, a carrier-operated unmanned combat aircraft program expected to be operational by 2018. The Army has shown an interest in optionally manned helicopters, including a Blackhawk in this category.

Shifting alliances

The budgetary pressures that are beginning to hit in the U.S. are already doing so in Europe, which is still significantly behind the U.S. in research and procurement of UAS. European companies recognize there will be a need for multinational programs and are jockeying to be in position for any that move forward.

Those pressures have resulted in rapidly shifting alliances. BAE Systems

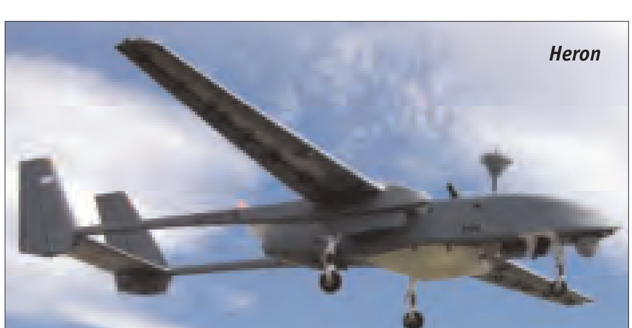
Mantis

ScanEagle

and Dassault Aviation seized the initiative by teaming to offer BAE's Mantis for a planned €1 billion-€1.5 billion French/British medium-altitude, long-endurance (MALE) aircraft program. A joint effort involving the two largest defense spending countries in Europe is a must-win for any European firm with aspirations to offer a MALE UAV.

EADS, the largest aerospace company in Europe, aspires to become a major player in UAVs and has now counterattacked to avoid being left out. It has been at the forefront of an effort to build alliances in Germany and Italy, hoping to position itself for future UAS programs. Finmeccanica and EADS announced in December 2011 that they would create an alliance based upon a next-generation MALE UAS such as EADS' Talarion. In view of Italian government austerity, Finmeccanica was particularly concerned about being left out of the French-U.K. program.

Then in January came the creation of a joint UAS venture by Rheinmetall and EADS' Cassidian unit. Under the agreement, Cassidian will have a 51% stake and Rheinmetall 49%. This effort, which will have about 160 employees, effectively means that Cassidian will absorb Rheinmetall's UAS work. The joint venture will continue to manufacture the KZO unmanned reconnaissance systems for the German armed forces. It will also continue to work on providing the Heron UAS on a leased basis, with its partner Israel Aerospace Industries, for the German armed forces.



Heron

For EADS' Cassidian unit, the move is important in solidifying its position as the leading UAS company in Germany. With the wavering French backing for EADS' UAS aspirations, building up its position in Germany becomes all the more critical.

KZO

Opening airspace

U.S. and European companies also face the prospect of the gradual opening of national airspace for UAV operations. Congress approved an FAA reauthorization bill that would require the agency to integrate UAVs into the national airspace by September 30, 2015. Small UAVs, under 55 lb, are to be allowed to fly within 27 months. If the U.S. measures move ahead and are successful, Europe can be expected to follow suit.

The possible opening of the commercial UAS market promises to be a landmark in reshaping the market in coming years. Provisions that would quickly open airspace for small UAVs would be particularly beneficial to AeroVironment's family of systems and Boeing's ScanEagle. Other very small, low-cost UAV manufacturers are also likely to benefit.

Competitive priorities will be reordered as cost replaces top-grade military performance requirements. Fee-for-service contracts also will become increasingly important as customers in law enforcement, agriculture, and other sectors require the use of UAVs for just a small part of the year.

To be competitive, companies will need to address that market through services that can be purchased without buying the UAV itself. Boeing and AAI already offer fee-for-service contracts for the military. Such contracts may prove difficult for smaller companies because of the need to keep considerable assets on the books.

In short, it is a brave new world ahead for UAV manufacturers. Life will not be as easy as in times of plenty, but new opportunities are emerging that promise to transform the market.

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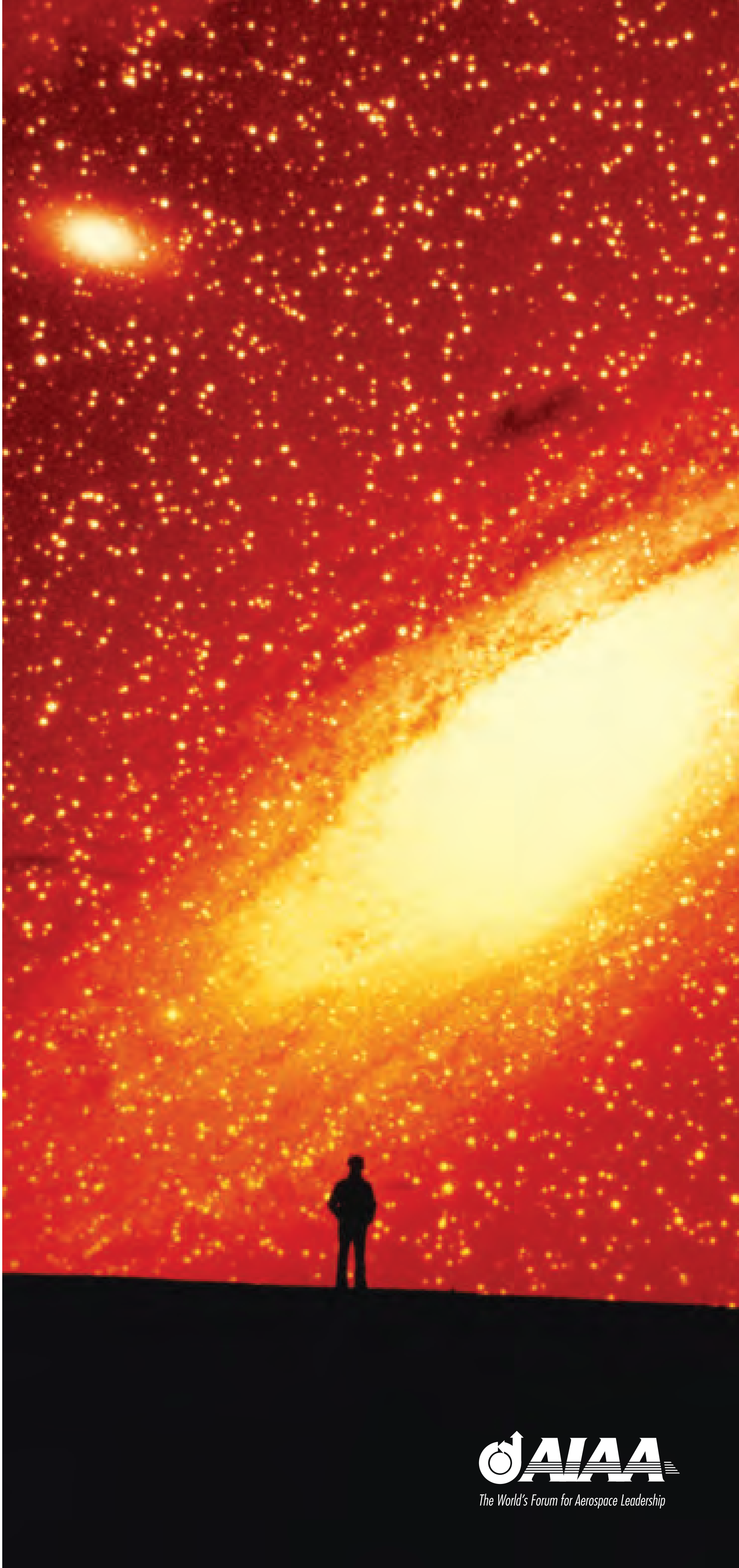

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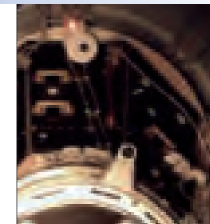


STORRM watch: Improving space navigation

ENGINEERS FROM NASA, BALL AEROspace, and Lockheed Martin are using results from an experiment called STORRM (sensor test for Orion relative navigation risk mitigation) to make significant tweaks in the navigation system and operational simulations they are preparing for the Orion multipurpose crew vehicle.

NASA is also providing details on a technical glitch that prevented engineers from collecting as much video as they had wanted during the May 2011 mission of the space shuttle Endeavour. The problem could have had a far worse impact were it not for a rush workaround.

The experiment

The goal of STORRM was to test a high-definition video camera and a new type of laser range finder for Orion. The experimental instruments were installed on the orbiter's docking truss, and they fed their video and laser readings to STORRM's avionics box, which contained two data recorders, one for each instrument.

The centerpiece of the experiment was Ball Aerospace's laser range finding and imaging instrument, called the vision navigation sensor (VNS). Less technically challenging was the high-definition docking camera. Its role on Orion would be to provide situational awareness to the crew and reassurance that the VNS was accurately reporting the relative positions of Orion and the space station.

The plan was to operate the docking camera and VNS simultaneously with the shuttle's laser-based trajectory control system and cameras. For safety's sake, the VNS would shadow the trajectory control system, but its readings would not be used by the shuttle's navigation system.

Still, Ball engineers were anxious to prove the advantages of the VNS over the trajectory control system. "It's much lower power and mass than the current system, and it actually has no internal moving parts, which is also an improvement over the current system. That helps with reliability, of course," says Ball's Jeanette Domber, a systems engineer and the STORRM lead.

The trajectory control system consists of three mechanically scanning laser range finders, or lidars, that move back and forth over the field of view. VNS, by contrast, is a unitary sensor that sends pulses of light at the docking target 30 times a second. By measuring time of return from a set of reflectors installed on the target, the range and bearing can be determined.

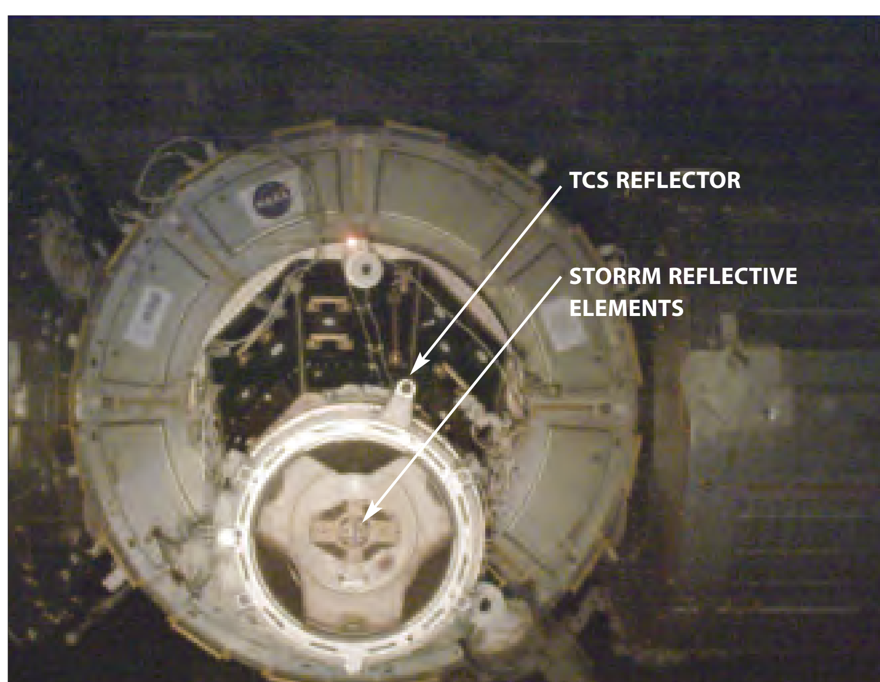
Only a space experiment could tell Ball engineers exactly what the complex surface of the ISS would look like in the particular wavelengths they had chosen for VNS. They needed to be sure their algorithms could find the docking targets from among those readings. The team would use the results to improve simulations at the Orion test chamber, built by Lockheed at its Waterton, Colorado, facility and unveiled last March.

Aboard Endeavour, the astronauts would view snippets of STORRM's video and laser range readings on a laptop computer. But for the most part, the data would be stored for processing and analysis after the mission.

Working around the clock

The STORRM equipment worked well on flight day three when Endeavour approached the ISS and docked with it. However, things would turn interesting on flight day 13, when astronaut Drew Feustel reported that the data recorder for STORRM's high-definition docking camera had failed to initialize properly.

In jeopardy was the plan to conduct a more elaborate STORRM test on flight day 15, the start of the orbiter's



STORRM's high definition docking camera captured the docking target as Endeavour approached the ISS in May 2011. As the shuttle neared, the individual reflectors on the docking target were resolved by the VNS and can be seen as five bright spots in the middle of the docking ring in the VNS intensity image.

trip home. After undocking, Commander Mark Kelly was to maneuver Endeavour away and reapproach the station to within 305 m on a trajectory mimicking the approach of an Orion crew vehicle. It would be an important test of VNS's ability to sense the relative positions of the spacecraft accurately during a docking approach.

The glitch never posed a safety issue for Endeavour, because STORRM's avionics box and sensors were separate from the shuttle's control system. But losing the day-15 data would have been a major blow for the engineers.

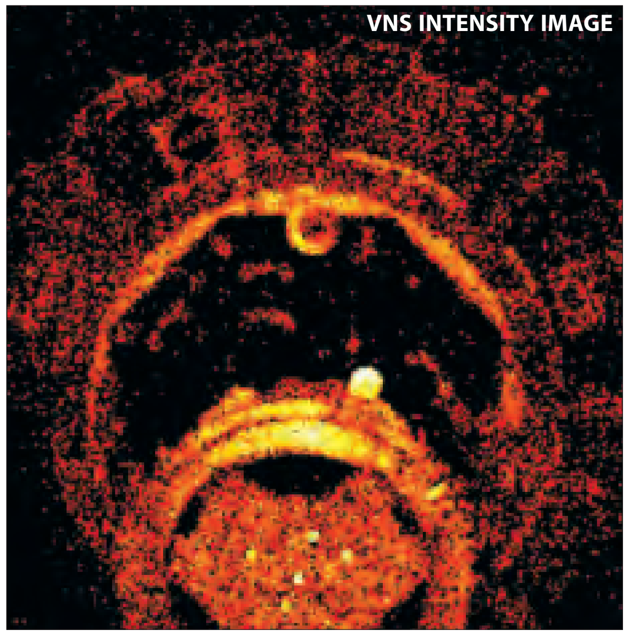
They spent the time between days 13 and 15 working "pretty much around the clock writing new procedures for Drew [Feustel]," says NASA engineer Heather Hinkel, the principal investigator for STORRM.

The fix would not be easy. Engineers had planned STORRM so that the docking camera and VNS would operate in tandem. A problem with either instrument would sound an alert. Feustel would have to load new procedures into the STORRM computer to quell the alerts. The docking camera could then be turned off and the VNS operated separately.

Running the docking camera without recording its images was not an option, because the recorder was also the command pathway to the camera.

"With that data recorder unit failing to initialize, there was no way to get commands from or to the docking camera anymore," says Hinkel.

The engineers managed to figure out how to shut off the docking camera without sounding alerts, and the VNS system operated as planned on flight day 15.



Surprising results

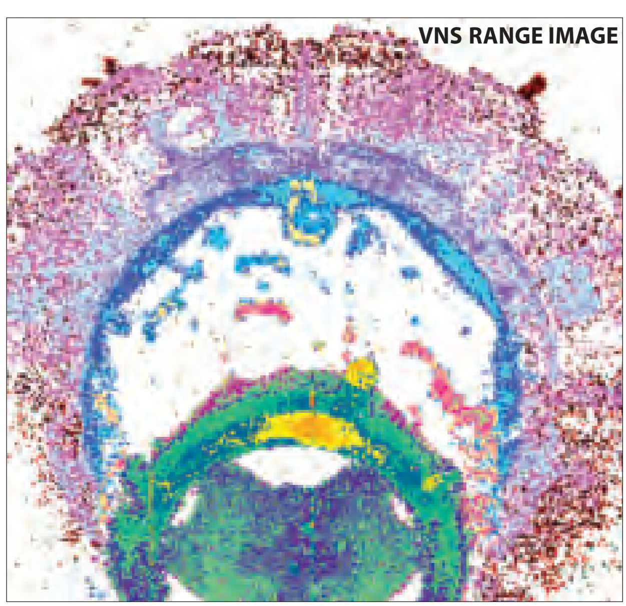
Thirty times a second, the VNS sent pulses of light at the ISS. These pulses bounced off the surface of the station and the five 1-in.-diam. reflectors that astronauts had installed on its docking target in 2010. If the VNS worked as hoped, it would acquire and start tracking the station from about three times farther away than the shuttle's trajectory control system could.

The two systems had radically different designs, starting with how they handled the varying light intensities. During docking, a laser system must be able to detect dim laser reflections at long ranges, as well as bright reflections at closer ranges, without becoming saturated by the light. The shuttle's trajectory control system consisted of three laser sensors for long, medium, and close-range sensing. The STORRM engineers wanted to prove they could accomplish the same thing with one sensor by toggling among different modes of gain, or sensitivity. If the strategy worked, it would reduce the mass and power of future navigation systems.

Ball engineers worked on the electronics in conjunction with Raytheon Vision Systems in Goleta, California, formerly Santa Barbara Research.

"In order to get that full range, we had three different modes built into the detector, which required two different electrical circuits on the back side. That was the innovation," explains Lisa Hardaway, lead engineer for Orion projects at Ball.

During the mission, engineers received some hints that the VNS was working well. Kelly had requested that the STORRM engineers display range estimates. The VNS was recording reflections 30 times a second, but without a powerful processing computer on board, range estimates could only be displayed once every 30 sec. Engineers were worried that bad luck might deliver 'noisy' range readings.



But, says Hinkel, Kelly "would look at that, and look at the other range information that was available, and it was matching up quite well."

After Endeavour landed, Ball engineers processed the VNS data and were happy with what they found. Before the mission, they had not been

(Continued on page 45)

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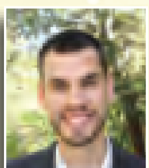

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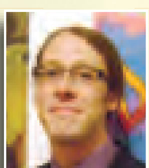

Kyle A. Godin (Astronautics)
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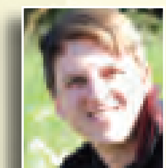

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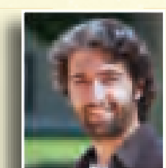
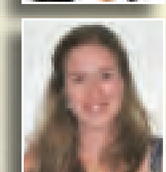
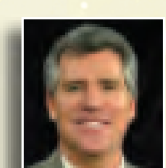


Sertac Karaman
Massachusetts Institute of Technology
Cambridge, Massachusetts

Chandrashekhar Tiwari
The Pennsylvania State University
University Park, Pennsylvania



Jill Tombasco
University of Colorado
Boulder, Colorado



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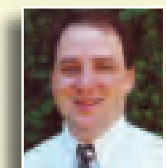

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Professor of Aerospace Engineering and Engineering Mechanics
University of Texas at Austin
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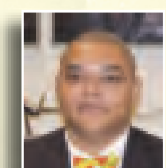

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Daniel Guggenheim School of Aerospace Engineering and H. Milton Stewart School of Industrial and Systems Engineering
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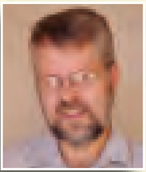

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Instituto Nacional de Técnica Aeroespacial (INTA)
Madrid, Spain

AIAA Pendray Aerospace Literature Award
Robert F. Stengel
Professor of Mechanical and Aerospace Engineering
Princeton University
Princeton, New Jersey

AIAA Van Allen Space Environments Award
Mary Hudson
Professor, Department of Physics and Astronomy
Dartmouth College
Hanover, New Hampshire

AIAA von Kámán Lectureship in Astronautics
William H. Gerstenmaier
Associate Administrator for Human Exploration and Operations
NASA
Washington, D.C.

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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Getting from gate to gate

When growing congestion at airports forces flights to queue up for takeoffs and landings, the resulting delays can have ripple effects throughout the air traffic system. NASA has been developing technology and software aimed at streamlining aircraft departures and arrivals, including ground movements, while still maintaining safe distances between planes. 2012 will be a busy year for testing these new air traffic management tools.

by Jim Banke
Public Affairs writer, NASA Headquarters; President, MILA Solutions, a NASA contractor

Cruising more than seven miles high, most airline passengers are occupied with an in-flight movie, a good book, or a nap. They do not give much thought to the ongoing collaboration of pilots, operations centers, and air traffic controllers who guide the aircraft on its journey.

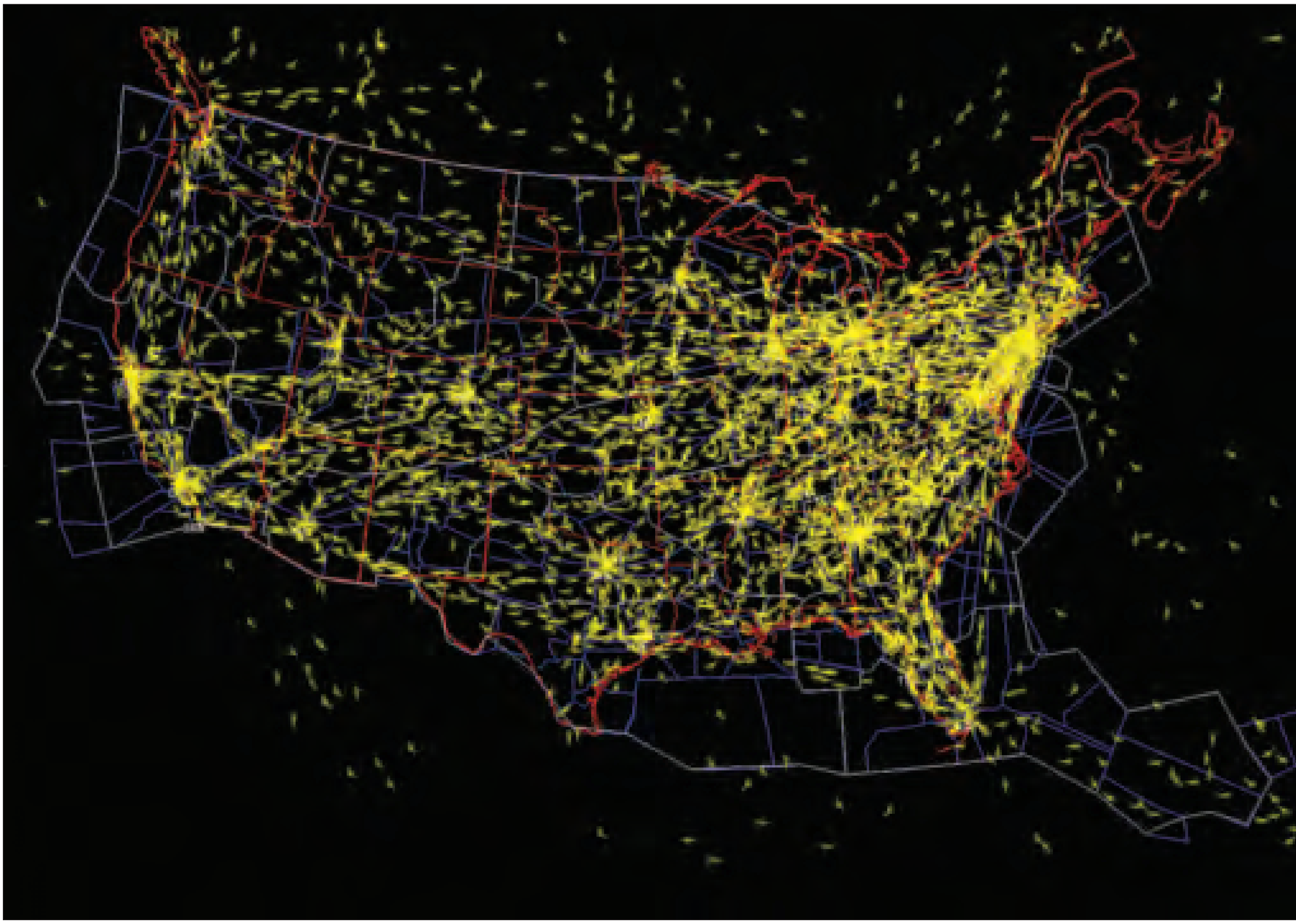
Every movement of an airplane—from the terminal gate to the runway at the departure airport, through takeoff and climb to altitude, onward to descent and landing, and the final taxi to an arrival gate—involves a complex set of tools and procedures, all of which must be managed precisely to ensure a safe voyage.

With air traffic growth spawning dire predictions of traffic jams in the sky in the not-so-distant future, NASA researchers are collaborating with the FAA and its partners to develop more efficient ways to manage airliners moving from gate to gate.

Today's air traffic control system is safe but antiquated. It relies on radio and radar-based technology developed in the 1940s. Satellite-based technology, advanced avionics, and pioneering software algorithms are among the many tools being advanced by innovators from NASA's Aeronautics Research Mission Directorate to modernize the system and help create what is being called the Next Generation Air Transportation System, or NextGen.

"Our goals are to expand capacity, enable fuel-efficient flight planning, reduce the overall environmental footprint of airplanes today and in the future, reduce delays on the ground and in the sky, and improve the ability to operate in all weather conditions while maintaining the current high safety standards we demand," explains Jaiwon Shin, NASA's associate administrator for aeronautics research.

NASA and FAA facilitate the evolution of these innovations through research transition teams. Made up of experts from government, industry, and academia, the teams are responsible for ensuring that the relevant new technology needed for NextGen



Future air traffic management concepts evaluation tool (FACET) uses live air traffic feeds and real-time weather information to process thousands of aircraft trajectories across the U.S. Air dispatchers use FACET to select more efficient routes based on capacity and weather conditions.

is identified, developed, tested, and then turned over to FAA for eventual use.

"We're partnering with some of the best innovators both inside and outside of government, and together we'll lead this global change in airspace operations to meet the demands of air mobility both now and in the future," says John Cavolowsky, director of the Airspace Systems Program at NASA Headquarters. In that vein, successful research is taking place in aeronautical laboratories at NASA facilities and industry sites around the nation.

Airport surface operations

On a trip from one airport to another, sometimes the longest delay is the journey from the terminal gate to the runway as dozens of aircraft vie for their turn to take off. "We need to minimize the potential for getting stuck in 20-minute, 30-minute, or even 60-minute conga lines, which can lead to missing your connecting flights, waste fuel, and create additional emissions and noise for the neighborhoods around airports," says Cavolowsky.

In an effort to dramatically reduce departure disruptions, NASA is working on a pair of software tools aimed at better managing the flow of air traffic on the ground: the Spot and Runway Departure Advisor (SARDA) and System Oriented Runway Management (SORM).

SARDA helps determine which planes should head for the runway, when they should depart the gate, and what routes they should use so that everyone gets to leave at the right time. Tests of SARDA software in 2010 demonstrated that the amount of fuel burned and emissions released on the ground could be cut by up to 38%.

"While SARDA promises to increase the capacity and efficiency of airport surface operations, its full benefits can't be realized unless we improve how we decide which of an airport's runways to make active at any given time of day and how aircraft will be assigned to these runways. That is the role of SORM," says Parimal Kopardekar, manager of the concepts and technology development project at NASA Ames.

SORM assists controllers with runway selection. Currently they select active runways by reacting to variables such as wind direction, weather forecasts, aircraft trajectories, and requirements for maintaining safe separations as aircraft arrive or depart. SORM considers these variables and produces a proactive forecast of the best runway and aircraft assignments throughout the day, which helps prevent traffic delays.

Simulations using data from Memphis International Airport in 2010 showed that using SORM could cut traffic delays in half. Another analysis of 79 flights to and from JFK International Airport one afternoon in 2009 indicated delays could have been slashed by two hours using SORM rather than what controllers actually selected on their own that day.

So far, SORM has been tested only at individual airports, but NASA researchers envision expanding its capabilities to consider simultaneous runway use at several airports in the same metropolitan area in order to improve overall air traffic efficiency. Moreover, future versions of both the SORM and SARDA software will consider maximizing fuel efficiency and minimizing pollution from emissions and noise.

Departure

After determining the best timing for taxiing from the gate to the runway, the next step is to join the departing aircraft with those flying overhead. This is the job of a new tool called Precision Departure Release Capability (PDRC).

"Imagine trying to get into the busiest restaurant in town. You definitely will want a reservation, and once you have your reservation you want to make sure you don't miss it. PDRC is reducing the chances of missing that 'reservation,' which is called a slot, by determining when is the ideal time to have your flight take off so it doesn't miss its slot," says Leighton Quon, manager of the NextGen systems analysis, integration, and evaluation project at Ames.

There are specific tools for managing airport surface movements and the flow of departing aircraft, but they could not be used together for more effective air traffic control until recently. In field tests near Dallas in July 2011, NASA researchers used PDRC software to integrate existing surface traffic procedures and automate the process for timing departure releases.

Test participants offered positive feedback on the system's performance and potential benefits, which include less frequent delayed or missed departures, more departures within a given timeframe, quicker identification of departures that may be affected by changing surface traffic conditions, and reduced controller workload. Additional field evaluations are planned before the technology is transferred to the FAA later in the year.

Enroute cruising

Just as the nation is divided into states and then further into counties or parishes, the airspace is structured into sectors and areas to help air traffic controllers organize and manage the flow of airliners. Sectors are managed by radar controllers; supervisors monitor the traffic within an area encompassing six to eight sectors; and traffic managers watch over several areas, monitoring activity and coordinating information between the airlines and controllers.

Radar controllers and traffic managers operate in two different time frames: Controllers focus on a 20-min period during which aircraft are crossing their sector, while traffic managers think an hour or longer into the future as they contemplate the flow of aircraft across their areas.

Along with its partners, NASA researchers have introduced Flow-Based Trajectory Management (FBTM), a set of new tools and procedures that help flight controllers identify and deal with potential traffic issues that might occur in the 20-60-min

NASA researcher David Wing works in the Air Traffic Operations Laboratory, which supports human-piloted simulators and finding ways to improve aircraft separation and resolve potential aircraft conflicts in the NextGen.

time frame. This capability is especially handy when aircraft are trying to avoid unpredictable bad weather.

"One of the key benefits of the FBTM tool is that it allows problems to be solved as late as possible, which reduces the risk of either making corrections too early and delaying more flights than necessary, or not making any corrections at all and causing severe bottlenecks in the flow of traffic," says Cavolowsky.

Simulations between 2006 and 2010 showed the tool was effective and could be employed without adding another controller position, as initially proposed. Tests also indicated the tool would be most efficient if all aircraft were fully equipped with a suite of digital communication avionics that would allow controller instructions to be delivered to the cockpit electronically instead of vocally.

All FBTM research results were delivered to the FAA in July 2011. The FAA will perform additional testing, certification, and, eventually, operational use in the field.

Descent

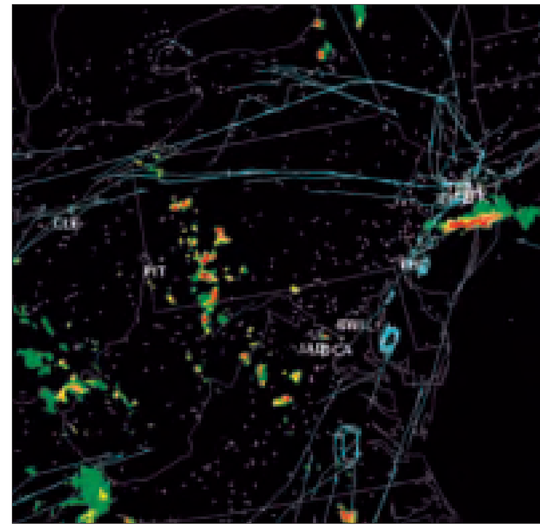
As airliners descend toward the nation's busiest airports, the view below may resemble a crowd of football fans heading to a stadium for the big game. Driving in vehicles of all sizes, from stretch limousines to subcompacts, they inevitably experience traffic jams as they vie for parking spaces in hopes of being seated before kickoff.

An aircraft approaching an airport from a high cruising altitude usually has to descend in steps and occasionally fly a wide circle above the airport while waiting its turn to touch down, following verbal commands from air traffic controllers all the way. This allows controllers to keep everything from jumbo jets to light commuter aircraft a safe distance apart. However, this dive-and-drive approach wastes fuel, increases unwanted emissions, creates more noise for areas surrounding the airport, and places a heavy workload on controllers.

NASA offers a potential solution to the problem in Efficient Descent Advisor (EDA) software, which helps controllers make sure aircraft of all sizes can perform continuous descents from cruising altitudes at quieter, less fuel-thirsty power levels and remain safely separated. EDA alerts controllers to potential conflicts all along an aircraft's planned approach path, which improves flight management efficiency and reduces controller workload.

"Think of EDA this way: Imagine being in your car, cruising down your street on your way home, and being able to take your foot off the gas at the perfect time to roll to a stop in your driveway without having to use the gas and brake—smooth, efficient, and quiet," says Quon.

EDA works by considering variables such as the size, speed, and trajectories of neighboring aircraft; the time required for descending to the runway; and input from other information sources. Using the flight data that airplanes are already transmitting to each other and to the ground, EDA computes how a particular aircraft can maintain safe separation from others in the sky while flying a continuous descent, and recommends any adjustments to avoid conflicts.



NASA is developing sophisticated computer algorithms to reduce delays and reroutes caused by bad weather, especially approaching busy airports like those near New York City.

EDA shows the solution to controllers, who radio the pilot with voice approval of the proposed new flight path. If EDA is deployed as envisioned, controllers could approve the continuous descent solution electronically. This would enable the aircraft's flight management system to effectively fly the efficient approach on autopilot.

Tests in 2005 at the Air Route Traffic Control Center (ARTCC) in Fort Worth demonstrated the benefits of EDA. Another set of simulations in 2009 at the Denver ARTCC validated results of the earlier exercises and showed that while the tool was specifically designed for high-density traffic situations, other, less busy airports could benefit as well. Based on simulations, NASA estimates $300 million in fuel savings during descents if EDA is implemented fleet-wide at the nation's busiest airports.

In January results of the research were turned over to the FAA, which is responsible for certifying and implementing the technology.

Approach and arrival

With the flight nearly complete, the final leg of the journey from gate to gate presents its own challenges, as every airport has its own runway configuration and unique weather characteristics. This is especially true in San Francisco.

The city's storied summertime fog conjures up thoughts of romance and mystery for some, but for air traffic controllers, it

The NextGen system will be able to take on the 'green' aircraft of the future, regardless of their configuration.

means only chaos. Low, thick stratus clouds roll in off the Pacific Ocean almost daily from May through October, blanketing runways and approach lanes at San Francisco International Airport. They reach the ground as fog, delaying local air traffic for hours at a stretch and triggering other flight delays across the U.S.

Compounding this problem are the airport's parallel runways, built before the jet age and situated very close together. When the stratus layer is in place pilots cannot see each other, so the FAA is forced to limit the number of aircraft landing or taking off. This effectively cuts arrival capacity from 60 planes per hour to 30. The aircraft are held on the ground at their departure points and again in the air if the stratus does not clear as forecast.

"The key to improving this situation is to know more precisely when the stratus will dissipate and then communicate that information to the controllers—who are not meteorologists—in a way that is useful to them," says Kopardekar.

A new forecasting procedure developed under a NASA research contract does just that. It uses an improved weather model for forecasting when fog will lift and conveys data to traffic managers in a way that helps them minimize the number of holds around the country for flights heading to San Francisco. NASA and its research partner Mosaic ATM put the tool to a successful test in summer 2011.

"Without the tool, they may send too many planes too early or perhaps might hold planes back all over the country, unnecessarily causing delays to you and me during our travels," says Kopardekar.

Controllers in San Francisco and FAA's System Command Center in Warrenton, Va., received the data as they decided when to release commercial aircraft from distant cities on flights to San Francisco, timing the departures so that when the planes arrived at the West Coast hub their pilots would have clear approaches to the runway.

The shadow evaluation, so called because the new procedure merely backs up decision tools already in place, affirmed early benefit assessments indicating that unnecessary ground delays for San Francisco International arrivals could be reduced by 29%, saving more than $5 million a year in airline operating costs.

The procedure will undergo an operational evaluation this summer. If the upcoming test is successful, the technology will be transferred to the FAA.

Putting it all together

As NASA works with the FAA and other partners to devise better ways of managing the national airspace system, many air traffic control tools and procedures currently in use will be upgraded or replaced for use in NextGen. This will enable the system to benefit from satellite navigation, digital communications, increased airport throughput, and reduced controller workload. "All of these technologies working together will help make air travel from gate to gate more dependable and efficient," says Quon.

To this end, NASA will begin planning this year for an Air Traffic Management Technology Demonstration (ATD-1) that will evaluate how well these emerging tools will work together in managing arrivals of aircraft at major airports with heavy traffic while enabling fuel-efficient, environmentally friendly approaches and landings.

"We need to bring together the multiple ground-based and airborne control tools needed to efficiently achieve and maintain safe spacing and reduce delay. The critical challenge will be to achieve these operational and environmental benefits simultaneously," says Cavolowsky.

When demonstrated together in ATD-1, software and procedures should allow arriving aircraft to maintain safe separation in heavy traffic and enable controllers to react better to changing conditions. The demonstration also will address terminal area congestion and how well the air traffic management tools work when not all aircraft have the same avionics equipment.

NASA's hope is that, in addition to environmental benefits, ATD-1 will demonstrate significant potential fuel savings and provide airlines a business case for equip-

NASA innovations improve journey from gate to gate

- *Airport surface operations: Reducing delays while safely increasing the number of aircraft taxiing between the terminal gate and runway.*
- *Departure: Efficiently merging aircraft as they taxi, take off, and climb to join other traffic flying overhead.*
- *Cruise: Streamlining air traffic controller workload and procedures as aircraft fly at cruising altitude.*
- *Descent: Enabling aircraft to more efficiently descend and approach an airport, saving fuel and reducing emissions.*
- *Arrival: Engaging satellite navigation; digital communications with new software and procedures to increase airport capacity.*

ping more of their aircraft with the avionics needed to take full advantage of NextGen.

Many of the tools to be showcased with ATD-1 rely on whether a plane has advanced avionics such as ADS-B (Automatic Dependent Surveillance-Broadcast) available in the cockpit. ADS-B gives flight crews a greater awareness of other traffic in the area, allowing them to improve safety and efficiency. It will enable an aircraft to transmit its location and receive the locations of others. The FAA considers this capability the 'cornerstone' of NextGen and has mandated that most aircraft be outfitted with the transmission technology by 2020.

The ATD-1 effort will start with computer simulations this year and progress to simulations with pilots and flight controllers assessing the new tools and procedures. The activity will conclude with field demonstrations using aircraft operations at a major airport during 2015.

✈✈✈

ATD-1 and the other technology programs just detailed are just a handful of the many research programs NASA is conducting in an effort to increase the efficiency and safety of air travel, save fuels, shrink its environmental footprint, and improve the flight experience for passengers. These enhancements to air traffic management, along with work to design aircraft and engines that burn less fuel, emit fewer noxious fumes, fly more quietly, and make the whole air transportation system safer, comprise NASA's aeronautics research portfolio.

Says Jaiwon Shin, "These investments in cutting-edge aeronautics research were selected to meet the future needs of an aviation industry that plays such an important role in so many aspects of our daily lives and serves as a major engine for our nation's economy."

Editor's note: *This is the last feature in our series describing the challenges associated with trying to invent a truly 'green' airplane. The first feature (March 2011) covered research into reducing nuisance noise around airports. The second (May 2011) concerned efforts in lowering aircraft emissions and improving air quality. The third (July-August 2011) looked at efforts to reduce fuel consumption.* 𝔸

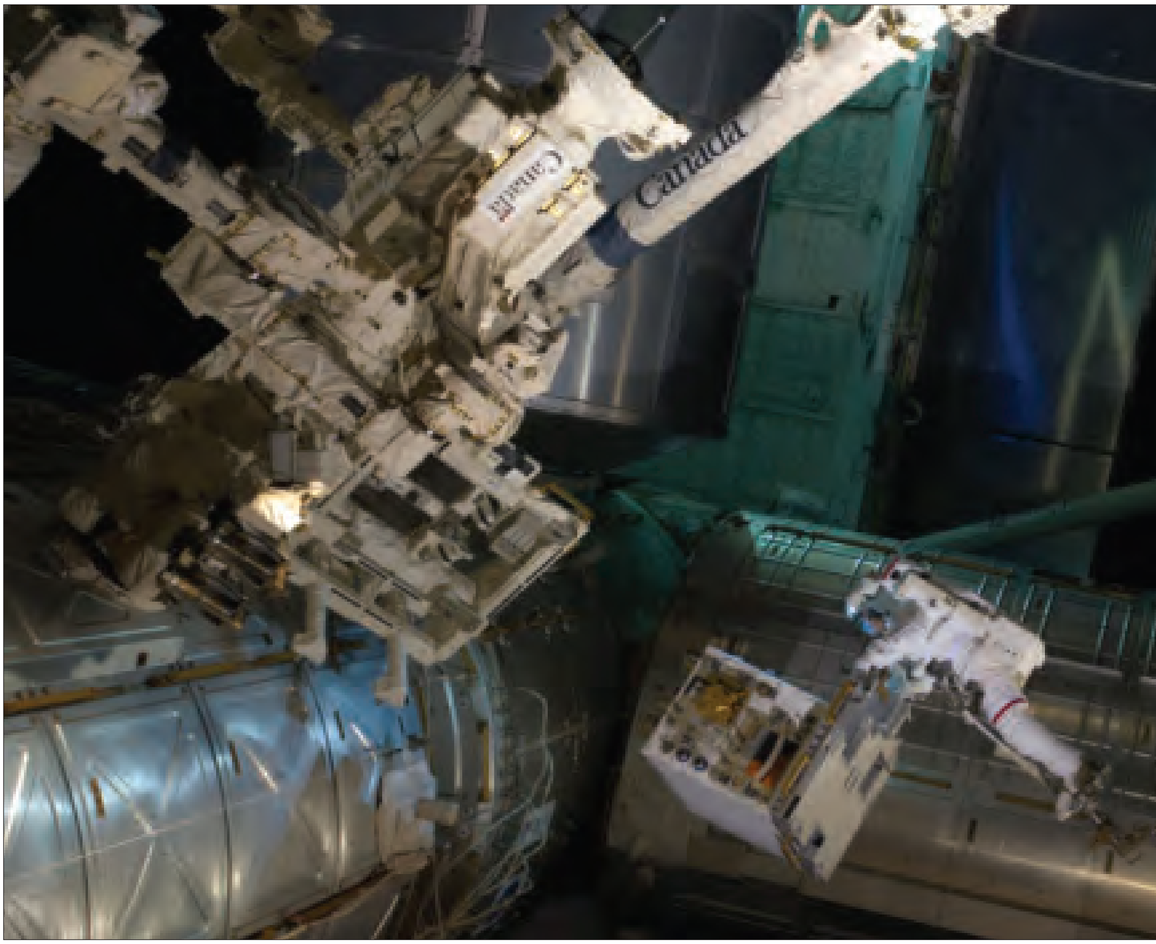
For more information, download the free ebook, NASA's Contributions to Aeronautics, Volume 2, *edited by Richard P. Hallion, at http://www.aeronautics.nasa.gov/ebooks/index.htm*

On-orbit servicing

From the moment the first operational satellite went into orbit, the user community began looking for ways to keep their initial investment viable beyond the life expectancy set by the manufacturer. Even more important, they wanted a way to recover a satellite that failed to reach its designated orbit, failed to deploy solar panels or antennas, or malfunctioned in other ways.

However, the concept of on-orbit satellite servicing—from refueling to component replacement—has faced serious obstacles, from the first platform design to the difficult tasks of locating, identifying, approaching, and 'snagging' a target satellite to actually performing on-orbit maintenance-level tasks never envisioned.

"We've been involved in satellite servicing since the late 1970s. In those days, some satellites were designed to take ad-



On July 12, 2011, spacewalking astronauts Mike Fossum and Ron Garan successfully transferred the RRM module from the Atlantis cargo bay to a temporary platform on the international space station's Dextre robot. Image credit: NASA.

The new focus

Concepts for on-orbit satellite repair and maintenance have been progressing, along with the tools and technologies for carrying them out. Despite the complexity and high costs, companies are moving forward to pursue these capabilities. Their development is potentially quite profitable, say proponents, and could bring significant savings for users, investors, and insurers.

vantage of two things: first, the space shuttle being able to grab onto the Solar Max, for example, with a robotic arm; and second, astronauts being able to then go out and change out modules to restore the health and full operational capability of the satellite," Frank J. Cepollina, associate director of the Satellite Servicing Capabilities Office (SSCO) at NASA Goddard, tells *Aerospace America*. "That was first done in 1984.

"We did it with a variety of other satellites in the following years, including an emergency repair of the Compton Gamma Ray Observatory before it was ever released from the shuttle. Those all required various forms of tools that we gave the astronauts. And all those tools evolved as a function of being able to tell the astronauts they did not have to expend as much energy and muscle, because they had microprocessors and power systems to do the work. Instead, they needed to expend intellectual insight into the operation of those tools."

Until the shuttle was retired in mid-2011, leaving the U.S. with no way to send astronauts to perform hands-on satellite repairs and maintenance in LEO, the tools used for such efforts continued to evolve.

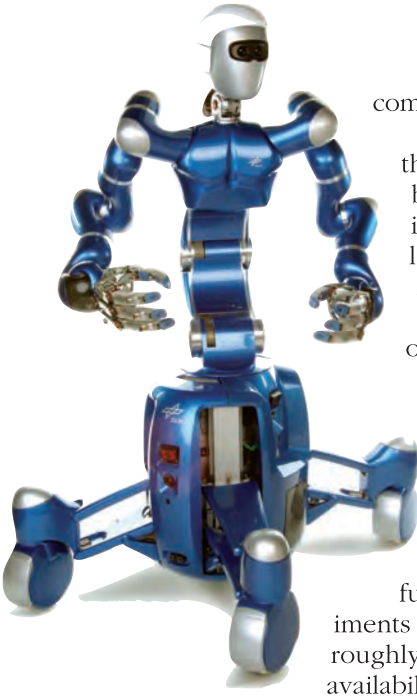
"That was especially true with the Hubble repair missions—five of them from 1993 through 2009. By the time we were doing the fifth mission, the tools had evolved to the point where they had become semi-autonomous. We did eight days' worth of work in five days on that final Hubble mission, thanks to ever-evolving robotic capability on the tools," Cepollina adds.

"And now that continues with the robotic refueling mission—RRM—where the tools basically have evolved from that last Hubble mission to our experiments aboard the ISS in 2011. And now ground control robotics operators at JSC [NASA Johnson] are watching their monitors here on Earth and operating these tools in space."

Remote experiments

The RRM uses robotic tools to work with a 1-m^3 module outfitted with typical satellite ports, interfaces, connectors, even thermal insulation blankets used to maintain the proper temperatures to protect sensitive

by J.R. Wilson
Contributing writer



Justin, the German Space Agency's humanoid robot, will be aiding development of DEOS, the Deutsche orbital servicing mission.

components for optimum performance.

"What we are doing is going through the exercises, in a telerobotic fashion, of refueling, changing gas ports, cutting MLI [multilayer insulation] blankets, and so forth. We've already started some of those...and will start another set of tasks from July through October [2012]," Cepollina says.

"The robotic operators will be on the ground, with vision systems on our individual tools, to validate that we can repair and refuel satellites that were never designed to be repaired or refueled in space. That series of experiments will last about 14 to 18 months, roughly through mid-2013, subject to ISS availability schedules."

NASA's RRM project also builds on Orbital Express, a 2007 joint effort by DARPA and NASA Marshall, using spacecraft specially built by Boeing Integrated Defense Systems and Ball Aerospace & Technologies. Boeing's ASTRO (autonomous space transport robotic operations) servicing satellite was launched into the same orbit as Ball's NEXTSat (next-generation satellite), a prototype modular spacecraft designed to dock with and be serviced by the ASTRO.

Other players, other concepts

NASA's is not the only satellite servicing concept in development. Some believe this area may become a major business opportunity for decades to come. Among the international players are the German Space Agency (DLR), with its government-sponsored Deutsche Orbital Servicing Mission (DEOS), and Canada's MDA (MacDonald, Dettwiler and Associates), which is taking a purely commercial approach for its Space Infrastructure Services unit.

ViviSat uses ATK's Mission Extension Vehicle to safely connect to an orbiting satellite to provide attitude and propulsion capabilities without disrupting the client satellite's operation.

MDA and its anchor customer, Intelsat General, the world's largest commercial satellite fleet operator, declined requests to be interviewed. But ViviSat, the leading U.S. commercial competitor, went into considerable detail about its plans for servicing satellites in geosynchronous Earth orbit.

A joint venture of Alliant Techsystems (ATK) and U.S. Space, ViviSat was created in 2011. The business plan promotes "satellite life extension ser-vices, [to] change the way satellite operators make decisions by giving them better performance, higher return, and more flexibility in deploying capital and timing of assets."

"The time is right for this," says retired Air Force Maj. Gen. Craig Weston, president and CEO of both ViviSat and U.S. Space. He is speaking of ViviSat's plan to provide on-orbit servicing to both commercial and government customers. ATK's role draws on its years of experience with robotics and precursor technologies, while U.S. Space provides management expertise and financing.

Gradual approach for ViviSat

While agreeing that the Hubble repairs provided both foundation and proof of need for on-orbit servicing, ViviSat and NASA have significant differences of opinion—and approach.

"ATK has been looking at satellite servicing since 2007 and trying to determine the best way to enter the market, what the technology risk is, and what the future is. We decided we needed to take a low-risk marketing entry position to establish the market in a sort of crawl-walk-run mentality," says Tom Wilson, vice president and general manager of ATK Spacecraft Systems and Services. "And that is the thinking that went into the design of our mission extension vehicle, which is based on proven technology that has been flown many times.

"That, we believe, will establish the marketplace, and the feedback we have gotten from both commercial and government markets is that it is a low-risk approach. We do have visions of doing refueling and robotic repair in the future, but we are perfectly happy to let the government take the risk on that now, which is what DARPA is doing in terms of robotic repair or morphing in space, and NASA's emphasis on refueling using robotic arms. Those have not been flown in orbit and are more complex, but we are partnering with them to see those developed for future insertion into our fleet. In the meantime, we can get going with systems that are proven."

NASA's robotic emphasis

ViviSat's approach is to dock with a target satellite, then use its own onboard fuel, rockets, and electronics to handle the problems of aging or improper deployment in GEO. NASA, after a similar rendezvous and dock, instead is looking to refuel the target satellite and replace or repair its original components. This process, says Cepollina, is not limited to GEO but can be performed on spacecraft in any orbit.

While not mentioning ViviSat specifically, Cepollina says a piggyback approach, taking over rather than fixing the target satellite, "does not fulfill all the objectives of repair and replacement, but we are looking at all possibilities. I can't go into it any more than that, because it is part of the RFI [request for information] currently on the streets. We're looking for all kinds of different commercial ideas and partners."

However, he adds, "if you are going to have a repair truck in orbit, a level of sophistication I'm thinking about, you must have a broad robotic capability across the board—relocation, fueling, repair, replacement. And the robotic part is just as important as approach, rendezvous, and grapple."

In November 2011, NASA issued a new RFI "to gather market research to assist NASA in developing strategies for supporting the development and dissemination of on-orbit robotic servicing capabilities for existing and future spacecraft, particularly including strategies involving collaboration with private domestic entities that leverage the government's existing intellectual property, technological resources, and expertise in this area. NASA does not intend to establish a government-operated on-orbit satellite servicing capacity, but rather to foster the creation of a domestic capability which may meet both future government and nongovernment needs."

That RFI is the latest in SSCO's congressional mandate to advance the use of robotics in space.

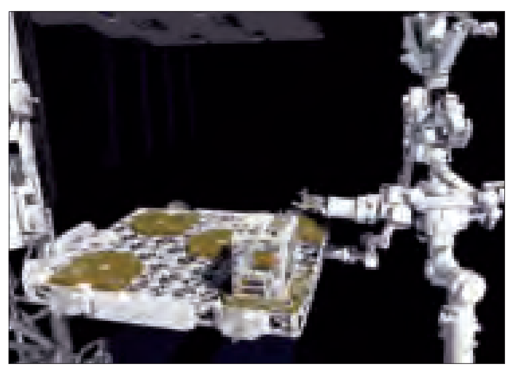
Current focus

NASA's near-term focus, building on Hubble repairs and the Orbital Express experiment, is on telerobotic and semiautonomous servicing of existing satellites.

"History taught us some very important, consequential lessons about the value of on-orbit servicing, such as that of the Hubble Space Telescope."

Frank J. Cepollina

"We broke that down into two areas: One is [to] approach, rendezvous with, and grapple systems never designed to be grappled (or even approached), and all the technologies to design meaningful experiments by which one could overcome" the lack of grapple fixtures on those satellites, Cepollina says. "Second is the ability to do the robotic manipulations on the spacecraft once it is captured—cut blankets and safety wires, remove ground-based installed fuel caps, connectors, and plugs.



In this artist's concept, the ISS's Canadian Dextre robot (right) approaches the RRM module (center, mounted to platform) with an RRM tool (above module). Image credit: NASA.

"So we're really evolving forward to a future where we will need to go to locations where humans currently are not present—such as GEO and L-1 orbits—and conduct repairs, in some cases adding new scientific instruments and capabilities. The objective is to push robotic maintenance technology forward as much and as fast as possible."

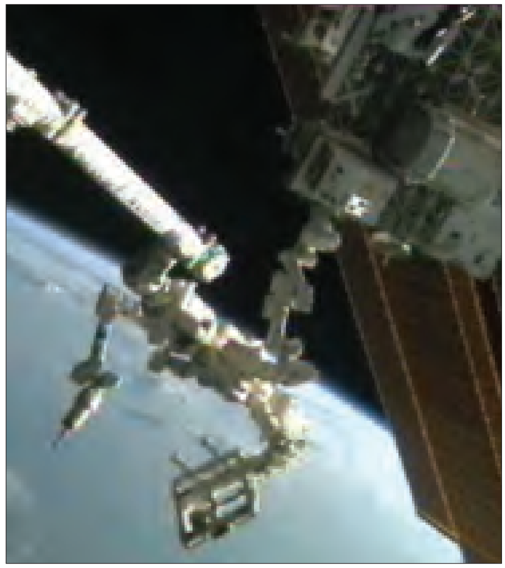
NASA's own statistics would seem to support ViviSat's focus on GEO, where Cepollina says nearly a quarter of the satellites have run out of fuel while still otherwise mission-viable, and another 20% or so were put into the wrong orbit or attitude.

"In the past decade, on average, 8.5 spacecraft a year have gotten into trouble because of contaminated fuel systems and were unable to fire their thrusters to maintain their orbits or orientations. And we have to be able to deal with these kinds of failures," he says.

Continuing evolution

Technological evolution is the key concept for NASA, which sees future developments

The Dextre robot transferred and installed the RRM module onto its permanent home on the international space station on September 2, 2011. RRM will remain on the station's ExPRESS Logistics Carrier-4 during its two-year window of operations. Image credit: NASA.



in satellite servicing as coming from a long history, moving from manned shuttle missions to a future in which robots do the job where astronauts cannot, or where humans and robots can work together.

"I see it as a natural evolution of space transportation, of humans operating in space, of our ability eventually to even do human/robotic surgery in space," Cepollina says. "Consider an astronaut who has been in space for six months and is still that far away from Earth, but needs an appendectomy. The astronaut could be operated on by an onboard robot, aided by a surgeon on Earth. Consider it part of our ability to take care of humans on long interplanetary trips."

ViviSat has no problem with NASA pursuing more advanced technologies—which even the agency acknowledges are years from operational use—but believes their own approach will more quickly respond to a current and immediate need.

"We believe there is a viable market today for life extension of satellites about to run out of propellant, and for a next generation of on-orbit servicing that will get into more complex operations, such as repair and removal of modules," Weston points out. "That's where the government taking the lead can buy down the risk much more rapidly than commercial industry can. So that's where DARPA and NASA can help commercial servicing take a leap forward, by accelerating the next phase of servicing."

As with most space programs, the same contractors often are on both 'teams.' MDA and the Canadian Space Agency, for example, are working closely with NASA on its ISS-based experiments, in which Canada's Dextre, a two-armed robotic telemanipulator, plays a crucial role. Elsewhere aboard the space station, DLR's humanoid robot Justin will be furthering the development of DEOS, which Germany hopes to have in operation in 2015.

"Both technically and financially, on-orbit servicing is disruptive; but being disruptive is not always bad, especially in space, if you can bring a new business concept to life."

Maj. Gen. Craig Weston (USAF, ret.)

A less optimistic view

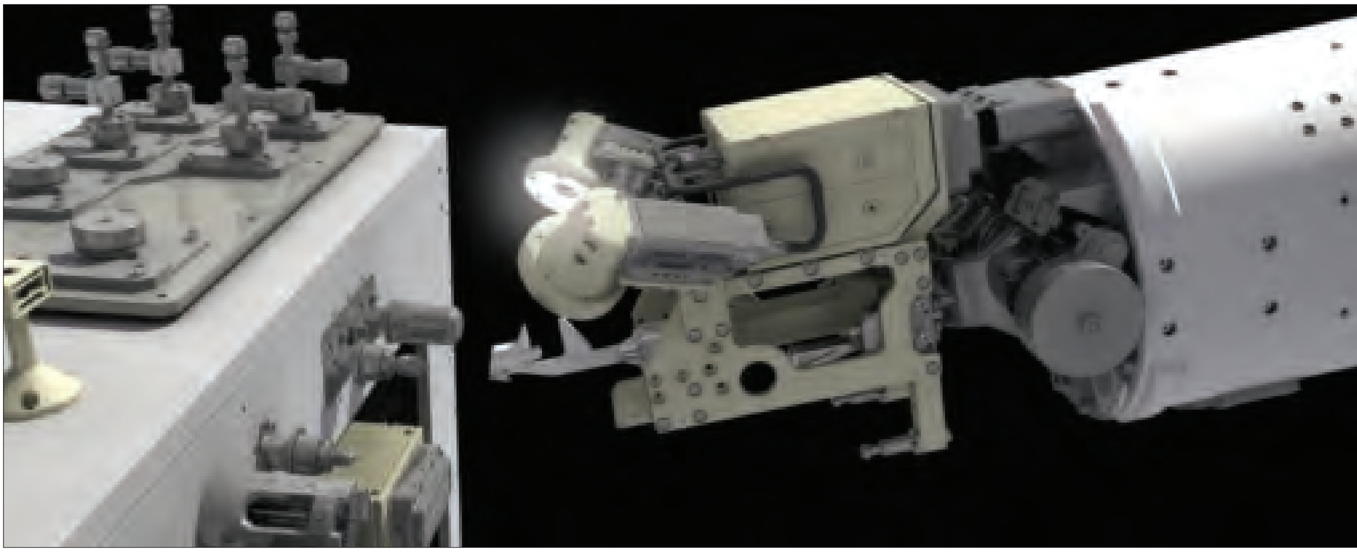
Even as those and other satellite servicing concepts move forward, however, not everyone believes they are practical, either as a commercial venture or as an option satellite manufacturers and launch service providers are likely to embrace.

The CEOs of Europe's Astrium Satellites and Thales Alenia Space and of the U.S.'s Orbital Sciences all have been quoted as saying the technology required is too complex and expensive for a commercial venture to be practical. Even if they can overcome those obstacles, MDA may face an unexpected problem with what previous comments by the company and Intelsat indicated would be a critical customer: the U.S. military.

DOD satellites are among the largest and most expensive in orbit, which made the possibility of extending their useful lives or recovering those lost or crippled by launch problems seem a certain proposition. However, at SATCON 2011 in November, Col. Michael Lakos, chief of the USAF Military Satellite Communications Systems Directorate, said the plan faces two major problems: Tight budgets and new satellite technologies.

Lakos told the conference it would be hard to convince DOD to support a new (and still experimental) program when existing programs are losing funding. That is especially true, he added, when the military's telecommunications satellites are being replaced by the new AEHF and Wideband Global Satcom system fleets, making servicing of existing satellites irrelevant.

Another threat to the commercial programs may be the NASA and DARPA efforts, which leave private industry hard pressed to compete. With a renewed emphasis on dealing with U.S. contractors, the Canadians could be shut out of future competitive bidding.



In this artist's concept, cameras light the way as an RRM tool approaches the RRM box to cut wire—one of the steps to accessing a satellite's triple-sealed fuel valve. Image credit: NASA.

Prospects for success

ViviSat officials, meanwhile, have said they will enter any competitions with a U.S.-based proposal that does not require extensive new R&D. But, they add, the success of their business will not depend on government contracts.

ViviSat also dismissed most of the other arguments against both the viability of a commercial venture and the approach the company is taking to on-orbit satellite servicing. Wilson, for example, says they have been working with GEO satellite manufacturers and operators, including the U.S. government, and have determined the designs of the spacecraft are such that "we can dock with about 80% of the more than 300 satellites up there now without difficulty. And that is more than enough to warrant this venture.

"We chose the backpack approach because the fill-and-drain valves and end caps were not designed to be taken off after 10 or 15 years in orbit," says Wilson. "And NASA is spending dollars to figure out that problem while we establish the marketplace with this docking-based system," he adds, responding to one of the major questions raised about the NASA approach.

All of the satellite servicing proponents also are working to gain the support of the insurance companies that serve the satellite industry. Saving a satellite that failed to achieve its proper orbit could save insurers billions of dollars in the next couple of decades. At the same time, industry officials have questioned the value of saving satellites with outdated technology.

"This is a tough financial investment market, so at this point a lot of satellite operators are trying to avoid new capital expenditures. One obvious way is to maintain existing satellites in orbit, even if they are technologically outdated," Weston replies. "There also is an emerging group of companies that acquire aging satellites and relocate them to serve underserved markets. In that case, a 70 or 80% solution, extended in its mission by a package such as ours, could be very valuable."

Looking ahead

Whether by 'grapple-and-repair' or 'dock-and-recover,' Cepollina believes on-orbit servicing is both an inevitable development—with future implications far beyond simply saving Earth-orbiting satellites—and one that ultimately will be up to private industry to advance and maintain.

"First and foremost, NASA is in the business of being the technology innovator to take us forward. But we're not in the commercial satellite business—nor should we be in the commercial satellite repair business. We're about demonstrating a technology to a point where it becomes extremely useful, and industry can step up and take over," he says.

"There are first-time things that are so risky and what I call venture-tech oriented that, in fact, somebody like NASA needs to take the lead. And that's what we're doing with RRM and other activities, whether human or robotic or a combination. And there are step-off points where there is important gain, and important commercialization potential, that would give the commercial community a belief that they can go up there, and do so in a way that will enable them to really profit from it."

Earth observations lead to healthier lives

Bloom of the toxicalga Karenia brevis is visible along the west coast of Florida. Image from Jacques Descloitres; NASA.

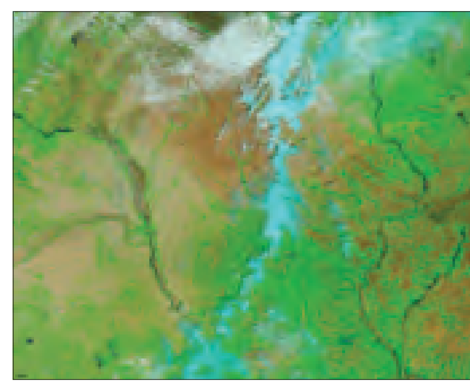
Factors such as air pollution, flooding, and changes in rainfall patterns can cause or aggravate conditions ranging from asthma to heart disease to malaria. Data from Earth observations aid public health decision-makers by alerting them to environmental changes, so they may plan more effectively for coping with health implications.

Earth observations enable us to monitor and anticipate key environmental phenomena that affect our health. The data they provide can be incorporated into models to help detect, monitor, or predict disease, giving policy-makers the opportunity to control an epidemic, respond more quickly to disease outbreak, and act to prevent or mitigate the occurrence of disease. Air quality, water quantity and quality, infectious disease, waterborne and insect disease vectors, and temperature are areas where Earth observations can most readily benefit public health.

For example, combined space- and ground-based measurements help local and national policy-makers reach better decisions on controlling emissions that can cause or exacerbate cardiovascular and respiratory diseases. Earth observation measurements of rainfall and remote sensing of oceans, lakes, reservoirs, and aquifers are critical to decision-makers for planning and adapting to changes in rainfall patterns that cause droughts, floods, and water contamination, posing significant health risks. Changes in land cover and habitat, for example, can help identify disease vectors and predict infectious diseases.

The public health benefits of such data have gained increasing recognition over the past decade. The Intergovernmental Group on Earth Observations, or GEO (comprising more than 85 nations and the European Commission) and the U.S. Group on Earth Observations (USGEO, with representatives from more than 15 federal agencies and the White House) have focused on the acquisition and use of Earth observation data to achieve societal benefits including improved health. These groups have taken actions to provide public health officials with such data, and the tools for using it, working with them to apply the knowledge to their objectives and needs.

Several U.S. government Earth observation and public health organizations are also working in this area and cooperating in science and operational coalitions. These groups include NASA, NOAA, the U.S. Geological Survey (USGS), the Centers for Disease Control and Prevention (CDC), the EPA, the National Institutes of Health (NIH), DOD Armed Forces Health Surveillance Center, and the U.S. Agency for International Development (USAID).



The summer of 2011 brought flooding along the Missouri River. Captured by the Moderate Resolution Imaging Spectroradiometer on NASA's Terra satellite, these images show the advance of flood waters on the river between May 30 and June 27, 2011. A combination of visible and infrared light increases contrast between water and land.

Earth observation provider activities

Over the past decade, the NASA Public Health program has been developing tools to support planning, management, and policy decision-making for the public health, medical, and environmental health sectors. NASA partners with national, state, and local public health agencies on a wide range of projects using Earth science research for public health. The projects address epidemiological surveillance in the areas of infectious disease, environmental health, and emergency response and preparedness.

For example, the NASA-funded Environmental Health Application System project has been working with the New Mexico

by Lyn D. Wigbels
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Western Lake Erie algae blooms can be seen with the naked eye.

Dept. of Health using remote sensing data and models to improve forecasts of atmospheric ozone, fine particulates, and other aerosols that trigger asthmatic responses or heart attacks. Daily dust forecasts now are available on the department's website and transmitted to local officials. Using these forecasts, hospitals can adjust staffing levels for episodic increases in patient numbers, schools can keep students indoors at recess, and parents can ensure that children use needed medications.

NASA also worked with public health officials in California using remote sensing data and models to determine risks of mosquito outbreaks. This improved the state's ability to align intervention and response strategies with risks, and to initiate mosquito population control methods when necessary. NASA requires the involvement of the public health community in its projects, seeking their input on topics for investigations that help shape the content of future project solicitations.

NOAA initiated an Oceans and Human Health Initiative to bring together relevant experts from across the agency, in partnership with academia, the private sector, and other federal, state, and local agencies. While this is a fairly new initiative, it has already elevated the importance of health within NOAA. Related agency efforts flow from its long-standing role in health as it relates to climate, oceans, and marine animals, and its role in weather and climate data acquisition, modeling, and forecasting.

For example, the National Weather Service provides forecasts for CDC researchers studying the effects of heat waves and also works with state and local officials to prevent heat-related morbidity and mortality. NOAA is funding forecasting tool studies, including one that involves incorporating a climate element for forecasting algae blooms in the Great Lakes. The agency is also funding development of a pathogen model as a tool for managers of drinking water treatment plants and beaches; a sea surface temperature tool for early warning of cholera and other bacteria; and tools for forecasting the impacts of coastal development on the ecosystem and public health.

USGS works with the health community to examine the connections between natural science and public health. The agency synthesizes scientific information on natural and living resources that influence human health and presents the material in a useful format. For example, USGS scientists used Landsat imagery in studying West Nile virus prevalence and land cover variation. The results suggested that preserving large wetland areas and, by extension, intact wetland bird communities, may be a valuable ecosystem-based approach for controlling West Nile virus outbreaks.

USGS also provides, at no charge, all of its archived Landsat scenes and has partnered with the private sector to create a new geospatial website, "Change Matters." This website enables scientists and the public to see more quickly how landscapes have changed over time as a result of forest harvesting, urban growth, wildfires, floods, pest outbreaks, and drought.

Public health community efforts

CDC has partnered with NASA since 2004 to investigate how NASA Earth science can help to determine the link between the environment and health. The two organizations are studying how remote sensing data can fill gaps in environmental data collected on the ground to understand the incidence of asthma and to link environmental and cardiovascular health data.

The CDC Climate Change Program is also working with NASA to develop decision-support tools. One project uses Earth observation data and models to improve

Harmful algal blooms are an accumulation of tiny organisms known as algae and can release harmful toxins into the environment. Binder Lake in Iowa is seen here covered in algal blooms. Among other effects, such blooms can cause fish kills in areas where oxygen is depleted or when algal blooms are producing toxins. Photo by Jennifer L. Graham, U.S. Geological Survey.

heat watch warning systems, incorporating meteorological, mortality, remotely sensed, and sociodemographic data. CDC is initiating a similar project using remote sensing to aid in identifying locations that are particularly vulnerable to flash flooding and to enable more effective mitigation of its health-related impacts.

In addition, CDC is working with NASA to develop a climate model that integrates observed ground weather station data with modeled data and also takes land surface data into consideration. Last December, CDC included the model in its Environmental Public Health Tracking Network, undertaken to identify and track environmentally caused health problems in the U.S. For the network, NASA is providing CDC with remotely sensed observations and products, and NOAA is working with CDC to support integration of ocean, climate, and public health information.

The EPA established its Advanced Monitoring Initiative (AMI) to bring environmental information to decision-makers and has provided seed money for more than 100 projects. AMI has integrated remotely sensed and in-situ data to form new models for air quality forecasting, nitrogen deposition, harmful algal blooms, and Lyme disease risk maps. For example, the AIRNow program partnered with NOAA, NASA, the National Park Service, and state and local environmental and health agencies to develop a website that provides daily air quality index conditions and forecasts.

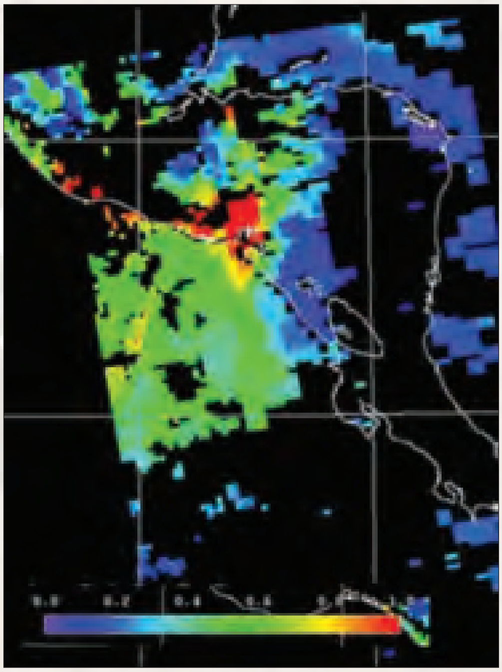
Another AMI project used remote sensing data to develop a tool for evaluating in-situ data on nitrogen emissions. The tool detected a discrepancy between the numbers recorded in the National Emission Inventory (NEI) and the predicted emissions based on the NO_2 column. EPA's investigation found that a transcription error had occurred when the numbers reported by the states were entered into the NEI, and the error was corrected. The agency is also applying this tool to quantify emissions that are difficult to measure, such as exhaust from automobiles located in regions that lack a monitoring infrastructure. In addition, AMI projects have advanced the technology for forecasting beach and coastal health hazards by developing detection and warning systems for harmful algal blooms, bacteria outbreaks, and coastal flooding. All AMI projects strive to involve the final stakeholders early in the project to ensure that the products are relevant and useful.

The NIH's National Institute of Environmental Health Sciences works with other federal agencies, international research and policy groups, academia, and nongovernmental organizations to identify gaps in knowledge about the links between climate change and adverse human health impacts. Together these groups are also developing a research plan to address these gaps, communicate findings, and incorporate them into health policy and actions.

Another NIH effort, the Human Health Impacts of Climate Change program, funds research in this area as well. Working with NASA, EPA, and other agencies, the program seeks to fill in data gaps, develop an inventory of relevant databases, and identify what is needed to enhance the agencies' capabilities. NIH recently launched a multiyear study to look at the potential health effects of the 2010 oil spill in the Gulf of Mexico region. In planning the study, it used remote sensing data for some of its exposure scenarios and exposure modeling. The researchers plan to make greater use of remote sensing data as they become available for this study.

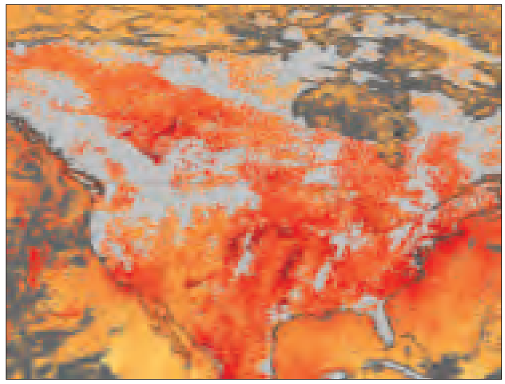
The Armed Forces Health Surveillance Center collects and interprets data that impact the health of U.S. military populations. In Southeast Asia where U.S. troops are deployed, it uses NASA Earth observation data for tracking malaria conditions to determine appropriate preventive measures. Among its key projects is the Global Emerging Infections Surveillance and Response System, which focuses on national and international preparedness for infectious disease outbreaks. A model using monthly reports and risk maps developed from satellite vegetation measurements and climate data provided by NASA successfully predicted an outbreak of Rift Valley fever in 2006-2007 and again in 2010. It provided warnings two to six weeks in advance, enabling health authorities to inform the public, control mosquitoes, and vaccinate livestock.

USAID has worked with NASA since 2003 in establishing centers that enable



An Aerosol Optical Depth image of fires in Nicaragua and Honduras was provided by the MODIS sensor on NASA's Aqua satellite on April 27, 2008. The red areas indicate that the satellite detected high concentrations of particles in the vertical column of air between the satellite and the ground, likely due to smoke from the fires.

More of the U.S. was in a drought in July 2011 than in any other month in the past 12 years, according to the National Climatic Data Center; 26% of the lower 48 states experienced severe to extreme drought. Credit: NASA Earth Observatory image created by Jesse Allen using data provided by the Dept. of Agriculture Foreign Agriculture Service and processed by Jennifer Small and Assaf Anyamba.



people in developing regions to use Earth observations for addressing challenges in agriculture, energy, health, biodiversity conservation, climate change, disaster response, and weather forecasting. The SERVIR initiative integrates satellite observations, ground-based data, and forecast models to monitor and predict environmental changes and improve decision-making in these areas. Regional SERVIR hubs are located in Panama, Kenya, and Nepal.

While these efforts are bringing about tangible benefits for public health, they are just a beginning. Funding in this area has remained very low for the past several years because of competing priorities. Far greater benefits also would result if a broader segment of the public health community could be engaged in developing the tools it will need to confront pressing health issues.

Future needs

Further benefits to public health would result from improvements in several areas. These include expansion and enhancement of remote sensing capabilities; continuity of Earth observation data and research; integration and interoperability of satellite, in-situ, health, and socioeconomic data; more funding for developing and applying models and decision-support tools to analyze and apply the data; and enhanced dialogue between the Earth observation and public health communities on the potential health applications of Earth observation data and decision-support tools.

A September 2011 CSIS report, *Using Earth Observation Data to Improve Health in the United States,* identified several steps that should be taken to achieve these improvements and fully deliver on the potential of Earth observations for public health:

- The U.S. should increase its investment and pursue opportunities for international cooperation to enhance and sustain Earth observations, both from space and in situ, that would benefit public health as outlined by the NRC and USGEO.
- Support should be increased for federal Earth observation health application activities that engage the public health community in developing and/or improving models and decision-support tools.
- Support should be provided and prioritized for consortia of Earth observation producers and public health agencies to issue collaborative solicitations for further maturing applications, making mature ones operational, and initiating new ones.
- Engagement of the public health community should be broadened by holding a series of workshops on specific health topics to engage Earth observation providers and the public health community in dialogue on what Earth observation data are available; how they can contribute to detecting, monitoring, and predicting disease; and the models and decision-support tools needed to translate the data into information useful to the public health community.
- U.S. government support of the Intergovernmental GEO and of federal agencies' participation in GEO health tasks should continue, and the GEO's efforts to engage the public health community should be strengthened.
- Participating GEO nations should be encouraged to share public health data.
- The private sector should be engaged as an active participant in applying Earth observations to public health.

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The continued availability of Earth observation data undergirds the success of current efforts to translate the data into societal benefits. These data are helping the public health community understand the connections between the environment and health and act to prevent disease and mitigate its impacts. However, there are no plans to sustain the specific Earth observation capabilities now in place, and uncertainty in the budget outlook for the next several years complicates prospects for addressing the problem.

The U.S., while confronting its fiscal challenges, would do well to place priority on its ability to gather environmental data continuously over the long term and apply it to public health and other societal needs. U.S. efforts to meet this objective should be global as well as national. People will be healthier for it—as will the economy.

(Continued from page 25)

completely confident that they could achieve tracking at a range of 5 km. They had tested the VNS by installing reflectors on a dorm at the University of Colorado in Boulder and at the National Center for Atmospheric Research. They made the reflectors a little larger than those on the ISS—2 in. in diameter compared to 1 in.—to compensate for atmospheric distortion. They then brought VNS to the roof of the Ball factory in Boulder and tested its ability to detect a reflection at 2.5 km and 5 km.

The engineers were anxious to have actual data from space because of the added complexities of the orbiter maneuvering relative to the station. The results were better than expected. "We acquired the space station at 5.7 km," says Hardaway. "Frankly, we were a little bit worried about acquisition at 5 km. That was the mode on the detector we were most worried about," she says. "We were so pleased."

The mission also provided unexpected challenges for VNS. "There was one time during the [day-3] rendezvous where the station actually had gone out of the field of view," says Hardaway. "You can see in the data exactly where that happens. And you can see the data come right back as soon as the station comes right back into view. The transition was perfect—[we] didn't expect that."

All the scurrying before day 15 paid off, too, because the engineers were able to push the sensitivity of the VNS's three modes.

"When we went in for the second dock, the 're-rendezvous,' we started off with long range. You could see station pretty far out; basically it was a dot. It turned out our midrange worked so well that when we switched to midrange, you could see the outline of the station," Hardaway says. "Now, it was noisier at the long ranges. Originally we thought it would be too noisy to use at 5 km, but it turned out we could see the station."

After the mission, the engineers gathered the data and tested the ability of STORRM's algorithms to process it rapidly and depict the relative positions of Endeavour and the station.

The mission also proved that the VNS's data can be turned into stunningly detailed images of a space object, because light from raised surfaces arrives back at the detector slightly earlier than light from the surrounding surfaces.

Ball engineers showed images of the space station to the astronauts after the mission. "You can see a handrail. You can see a NASA logo. It was just really amazing," says Hinkel. "If you don't have a camera, it's bringing you a three-dimensional picture. You can rotate it, you can look at it from the side, from above, from any direction you want, because it's got all that information right in the image. It's very powerful."

Hinkel says the technology could be valuable for asteroid rendezvous missions or satellite servicing.

Significant tweaks

The Orion team has installed the VNS and docking camera in the Space Operations Simulation Center at Waterton, the chamber that Lockheed built specifically for Orion.

"We'll try to duplicate the conditions we saw in orbit, and then see what the performance of the sensors on the ground looks like compared to flight. We'll see if we can't get them to match pretty closely," Hinkel says.

They've done just that for the station's docking ring. "When we first ran the VNS in the ground facility, the docking ring didn't look anything like the flight data," notes Hinkel. "We ended up taking some aluminum and scrubbing it with steel wool. That seemed to give us the type of reflective properties that we saw in the space station docking ring."

The STORRM data are "really helping to upgrade the fidelity of that facility," she says.

Already, the data have prompted engineers to change the algorithms that Orion would rely on to identify reflectors on the docking target. Before the mission, NASA Johnson and Ball each had written rival sets of algorithms for this purpose.

"Basically you take this bright-intensity pixel, or it might be a grouping of pixels that are very, very intense in your raw data, and you run it through a series of tests to see: Is this really a reflector, or is it just some spurious bright spot?" says Hinkel.

Engineers are pretty sure, for example, that one particularly bright spot in the data was the window of a Soyuz capsule rather than a reflector.

"Both of us [NASA Johnson and Ball] have had to make quite significant tweaks to our algorithms to make them work with what we actually saw," Hinkel explains. "When you get close in, there are all these different station structures that appear like reflectors. So we're having to do some things with algorithms to not identify those as reflectors. We've taken huge steps in the quality of those algorithms already."

Ben Iannotta
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25 Years Ago, April 1987

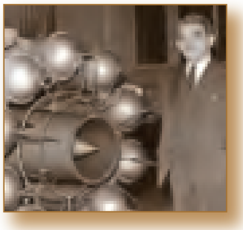
April 13 Soviet cosmonauts Yuri Romanenko and Aleksandr Laveykin successfully dock the Kvant to the Mir space station after several attempts. The Kvant is an unmanned astronomical observatory and the first experimental module to dock with Mir. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 108.

April 30 Martin Marietta forms Martin Marietta Titan Systems to sell versions of the Air Force Titan 3 to civil customers for launching commercial satellites. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 111.

50 Years Ago, April 1962

April 12 The USSR marks the first anniversary of the historic orbital flight of Soviet cosmonaut Yuri Gagarin, the first man in space. The occasion is celebrated throughout the country as Cosmonautics Day. *Flight International*, April 26, 1962, p. 667.

April 12 Special events in England mark the 25th anniversary of the first run of Frank Whittle's first jet engine. That prototype, made by his company Power Jets, was claimed to be the world's first turbojet engine. *Flight International*, April 12, 1962, p. 536, and April 19, 1962, p. 597.



April 12 Douglas Aircraft's Missiles and Space Systems Division rolls out a Thor vehicle, hailed as the company's 40,000th missile. Others made by Douglas over the years include the Roc 1 of the 1940s, the famous Nike-Ajax, Nike-Hercules, Nike-Zeus, Honest John, Genie, Thor, Skybolt, Delta, and Saturn S-4 and S-4B upper stages. *Flight International*, May 3, 1962, p. 714.

April 14 Britain's Bristol 188 stainless steel supersonic research aircraft, one of three built, flies for the first time. Powered by two de Havilland Gyron Junior PS.50 turbojet engines, the plane can reach Mach 2. *Flight International*, May 3, 1962, p. 693.

April 14 Army Capt. Boyce Buckner sets a new helicopter climb and altitude record of 19,685 ft in 5 min 51 sec. *Flight International*, May 3, 1962, p. 679.

April 15 The Vickers VC10, Britain's heaviest civil aircraft yet built and the biggest to be put into production in Europe, is rolled out at the Vickers plant at Weybridge, England. *Flight International*, April 26, 1962, p. 646.

April 20 NASA experimental research test pilot Neil Armstrong, later to become the first man on the Moon, achieves the longest duration flight in the history of the North American X-15 rocket research aircraft. He remains in flight for 12 min 18.7 sec piloting the X-15 No. 3, attaining Mach 3 (2,000 mph). Later in the year Armstrong transfers to NASA's astronaut corps. D. Jenkins, *X-15: Extending the Frontiers of Flight*, pp. 405, 621.

April 21 Sir Frederick Handley Page, one of England's great aviation pioneers, dies. Born in 1885, he founded one of the earliest British aircraft manufacturers, Handley Page, in 1909 and served as its chairman. The company produced several outstanding aircraft and in 1921 was responsible for the Handley Page slotted wing for preventing or minimizing stalling. During WW II the firm produced about 7,000 Halifax bombers, among many other aircraft. *Aviation Week*, April 30, 1962, p. 35; *Flight International*, May 3, 1962, p. 715.

April 22 Jacqueline Cochran claims some 49 records in one flight, principally the women's world record for distance in a straight line. Piloting a Lockheed JetStar from New Orleans to Gander, Newfoundland, she flies the 2,279 mi. at 479.8 mph. *Flight International*, May 3, 1962, p. 679.

April 23 The Ranger 4 lunar spacecraft is launched on an Atlas-Agena vehicle but later experiences a failure in its central computer. It therefore cannot complete a series of maneuvers and on April 26 is destroyed on impact with the Moon. *Flight International*, May 3, 1962, p. 682.

April 25 The second Saturn C-1, called the SA-2, is test launched from Complex 34 at Cape Canaveral, Fla. The huge vehicle for Project Apollo is deliberately destroyed 162 sec later and ejects about 85 tons of water from its dummy upper stage, generating the first man-made thunderstorm in space. The S-1 is to carry the

Past

An Aerospace Chronology

by **Frank H. Winter**
and **Robert van der Linden**

first Apollo three-man spacecraft boiler-plate models. *Aviation Week*, April 30, 1962, pp. 32-33.

April 26 Britain's first satellite, called Ariel or UK-1, is successfully launched into an elliptical 242x764-mi. orbit by a U.S. Delta vehicle from the Atlantic Missile Range at Cape Canaveral, Fla. The 132-lb satellite contains a number of ionospheric measuring instruments developed by British universities. *Flight International*, May 3, 1962, p. 712, and May 10, 1962, p. 749.

April 30 NASA test pilot Joseph A. Walker attains a new record altitude of 246,700 ft in an X-15 rocket research aircraft after it is released from its carrier B-52 at 45,000 ft. Flying north of Edwards AFB, Calif., the X-15 also achieves a top speed of 3,443 mph. The flight's objective is to obtain data on the use of reaction jet controls at extreme altitudes. D. Jenkins, *X-15: Extending the Frontiers of Flight*, p. 621.

75 Years Ago, April 1937

April 1 One of Italy's new Breda 88 all-metal twin-engined bomber-fighters, piloted by Furio Niclot, sets a world speed record for 100 km by flying at an average speed of 321.7 mph at Montecelio. The craft has two Isotta-Fraschini Gnome-Rhone engines of 1,500 total horsepower. *The Aeroplane*, April 14, 1937, p. 424; *Aircraft Year Book, 1938*, p. 408.

April 6 Two bombing attacks by airplanes of the Spanish Nationalist forces are mistakenly made on the British destroyer HMS Gallant off the coast of Spain, in the continuing Spanish Civil War. The Nationalist authorities express their regrets for this and similar incidents, and Lt. Col. Ramon Franco instructs his airmen to take more care in the future. *The Aeroplane*, April 14, 1937, p. 434.

April 9 Japanese aviator Masaaki Iinuma lands his Mitsubishi Karigane monoplane, named Kamikaze (Divine Wind), at Croydon Airport, London, smashing the Tokyo-London record set 10 years ago by French aviators Dieudonné Costes and Joseph Le Brix. Iinuma left Tokyo on April 6 and covered the approximately 9,900 mi. to England in an elapsed time of 94 hr 18 min, with a flying time of 51 hr 17 min 23 sec, beating the previous record by two days. *The Aeroplane*, April 14, 1937, p. 427.

April 12 British aeronautical engineer Frank Whittle successfully static tests the world's first gas-turbine engine, the U type, designed for aircraft propulsion. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 35.

April 13 The third mass flight of a squadron of Consolidated PBY-1 flying boats for the Navy is completed when 12 planes, carrying 78 men, land at Honolulu after a 2,553-mi. nonstop flight from San Diego. Heading the operation is Lt. Cmdr. L.A. Pope. *Aero Digest*, May 1937, p. 96.

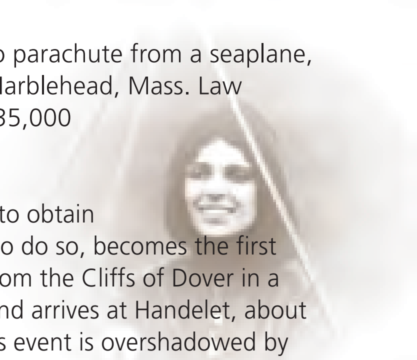
April 24 Flying a Caudron Typhon monoplane powered by two 220-hp Renault engines, the French pilot Capt. Maurice Rossi sets the world speed record for 5,000 km by flying at an average speed of 194 mph in 16 hr 4 min. The previous record was held by the U.S. with a Douglas DC-1 at 166 mph. *The Aeroplane*, April 28, 1937, p. 496; *Aircraft Year Book, 1938*, p. 409.

April 28 Pan American Airways' Sikorsky S-42 Hong Kong Clipper arrives in Hong Kong from Manila, marking the first complete crossing of the Pacific by a commercial aircraft. *The Aeroplane*, May 5, 1937, p. 545; E. Santos, *Trails in Philippine Skies*, p. 226.

100 Years Ago, April 1912

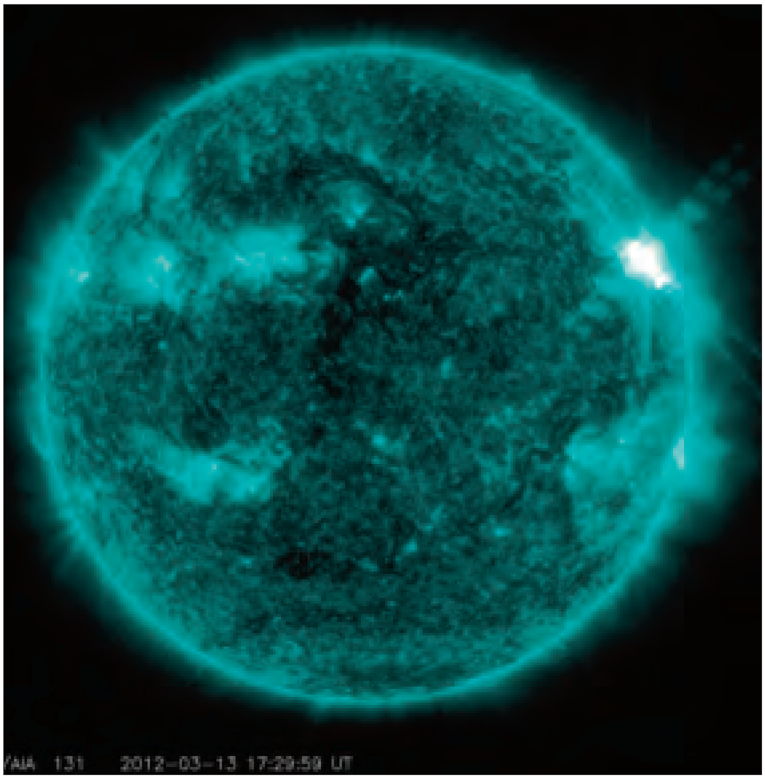
April 13 The Royal Flying Corps is formed, with activation taking place on May 13. C. Gibbs-Smith, *Aviation*, p. 247.

April 13 F. Rodman Law becomes the first person to parachute from a seaplane, a Burgess hydro-aeroplane piloted by P.W. Page at Marblehead, Mass. Law falls in the water and is rescued by a motor boat as 35,000 spectators look on. *Flight*, May 11, 1912, p. 427.



April 16 Harriet Quimby, the first woman in the U.S. to obtain a pilot's license, and the second woman in the world to do so, becomes the first woman to fly the English Channel. She departs solo from the Cliffs of Dover in a Blériot XI powered by a single 50-hp Gnome engine and arrives at Handelet, about 25 mi. south of Calais, where she wanted to land. This event is overshadowed by the sinking of the steamship Titanic, denying Quimby much of the acclaim she deserved for her flight. Quimby was also the first woman to fly at night, having done so on August 4, 1911. *Flight*, April 20, 1912, p. 345; *Fly*, June 1912, pp. 8-10.

AIAA Bulletin



On 13 March 2012, the sun erupted with an M7.9-class flare that peaked at 1:41 pm EDT. This flare was from the same active region, No. 1429, that has been producing flares and coronal mass ejections all week. That region has been moving across the face of the sun since 2 March, and will soon rotate out of Earth view. NASA's Solar Dynamics Observatory (SDO) captured this image of the M7.9 class flare at 1:29 pm EDT on 13 March. It is shown here in the 131 Angstrom wavelength, a wavelength particularly good for seeing solar flares and a wavelength that is typically colorized in teal. (*Image credit: NASA/SDO*)

APRIL 2012

AIAA Directory

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† U.S. only. International callers should use 703/264-7500.

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

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

Meeting Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
2012				
23–26 Apr	**53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** (Jan) **20th AIAA/ASME/AHS Adaptive Structures Conference** **14th AIAA Non-Deterministic Approaches Conference** **13th AIAA Gossamer Systems Forum** **8th AIAA Multidisciplinary Design Optimization Specialist Conference**	Honolulu, HI	*Apr 11*	**10 Aug 11**
14–18 May†	**12th Spacecraft Charging Technology Conference**	Kitakyushu, Japan Contact: Mengu Cho, +81 93 884 3228, cho@ele.kyutech.ac.jp, http://laseine.ele.kyutech.ac.jp/12thsctc.html		
22–24 May	**Global Space Exploration Conference (GLEX)** (Apr)	Washington, DC	*Oct 11*	**1 Dec 11**
22–25 May†	**5th International Conference on Research in Air Transportation (ICRAT 2012)**	Berkeley, CA Contact: Andres Zellweger, 301.330.5514, dres.z@comcast.net, www.icrat.org		
4–6 Jun	**18th AIAA/CEAS Aeroacoustics Conference (33rd AIAA Aeroacoustics Conference)**	Colorado Springs, CO	*Jun 11*	**9 Nov 11**
4–6 Jun†	**19th St Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia Contact: Prof. V. Peshekhonov, +7 812 238 8210, elprib@online.ru, www.elektropribor.spb.ru		
18–20 Jun†	**3rd International Air Transport and Operations Symposium (ATOS) and 6th International Meeting for Aviation Product Support Process (IMAPP)**	Delft, the Netherlands Contact: Adel Ghobbar, 31 15 27 85346, a.a.ghobbar@tudelft.nl, www.lr.tudelft.nl/atos		
19–21 Jun	**AIAA Infotech@Aerospace Conference** (Apr)	Garden Grove, CA	*Jun 11*	**6 Dec 11**
25–28 Jun	**28th Aerodynamics Measurement Technology, Ground Testing, and Flight Testing Conferences** (Mar) **including the Aerospace T&E Days Forum** **30th AIAA Applied Aerodynamics Conference** **4th AIAA Atmospheric Space Environments Conference** **6th AIAA Flow Control Conference** **42nd AIAA Fluid Dynamics Conference and Exhibit** **43rd AIAA Plasmadynamics and Lasers Conference** **43rd AIAA Thermophysics Conference**	New Orleans, LA	*Jun 11*	**17 Nov 11**
27–29 Jun†	**American Control Conference**	Montreal, Quebec, Canada Contact: Tariq Samad, 763.954.6349, tariq.samad@honeywell.com, http://a2c2.ort/conferences/acc2012		
11–14 Jul†	**ICNPAA 2012 – Mathematical Problems in Engineering, Aerospace and Sciences**	Vienna, Austria Contact: Prof. Seenith Sivasundaram, 386/761-9829, seenithi@aol.com, www.icnpaa.com		
14–22 Jul	**39th Scientific Assembly of the Committee on Space Research and Associated Events (COSPAR 2012)**	Mysore, India Contact: http://www.cospar-assembly.org		
15–19 Jul	**42nd International Conference on Environmental Systems (ICES)** (Apr)	San Diego, CA	*Jul/Aug 11*	**15 Nov 11**
30 Jul–1 Aug	**48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit Future Propulsion: Innovative, Affordable, Sustainable** (Apr)	Atlanta, GA	*Jul/Aug 11*	**21 Nov 11**
30 Jul–1 Aug	**10th International Energy Conversion Engineering Conference** (Apr)	Atlanta, GA	*Jul/Aug 11*	**21 Nov 11**
13–16 Aug	**AIAA Guidance, Navigation, and Control Conference** **AIAA Atmospheric Flight Mechanics Conference** **AIAA Modeling and Simulation Technologies Conference** **AIAA/AAS Astrodynamics Specialist Conference**	Minneapolis, MN	*Jul/Aug 11*	**19 Jan 12**
11–13 Sep	**AIAA SPACE 2012 Conference & Exposition**	Pasadena, CA	*Sep 11*	**26 Jan 12**
11–13 Sep	**AIAA Complex Aerospace Systems Exchange Event**	Pasadena, CA		
17–19 Sep	**12th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference** **14th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference**	Indianapolis, IN	*Oct 11*	**7 Feb 12**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
23–28 Sept†	**28th Congress of the International Council of the Aeronautical Sciences**	Brisbane, Australia Contact: http://www.icas2012.com		**15 Jul 11**
24–27 Sept†	**30th AIAA International Communications Satellite Systems Conference (ICSSC) and 18th Ka and Broadband Communications, Navigation and Earth Observation Conference**	Ottawa, Ontario, Canada Contact: Frank Gargione, frankgargione3@msn.com; www.kaconf.org	*Nov 11*	**31 Mar 12**
24–28 Sep	**18th AIAA International Space Planes and Hypersonic Systems and Technologies Conference**	Tours, France	*Mar 12*	**12 Apr 12**
24–28 Sep	**7th AIAA Biennial National Forum on Weapon System Effectiveness**	Ft. Walton Beach, FL	*Nov 11*	**15 Mar 12**
1–5 Oct	**63rd International Astronautical Congress**	Naples, Italy (Contact: www. iafastro.org)		
11–12 Oct†	**Aeroacoustic Installation Effects and Novel Aircraft Architectures**	Braunschweig, Germany (Contact: Cornelia Delfs, +49 531 295 2320, cornelia.delfs@dlr.de, www.win.tue.nl/ceas-asc)		
23–25 Oct†	**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, +31 527 248520, siggi.pokoern@dnw.aero, www.dnw.aero		
5–8 Nov†	**27th Space Simulation Conference**	Annapolis, MD Contact: Harold Fox, 847.981.0100, info@spacesimcon.org, www.spacesimcon.org		
6–8 Nov†	**7th International Conference Supply on the Wings**	Frankfurt, Germany (Contact: Richard Degenhardt, +49 531 295 2232, Richard.degenhardt@dlr.de, www.airtec.aero)		
2013				
7–10 Jan	**51st AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition**	Dallas/Ft. Worth, TX	*Jan 12*	**5 Jun 12**
21–25 Jan†	**Annual Reliability and Maintainability Symposium (RAMS)**	Orlando, FL Contact: Patrick M. Dallosta, 703.805.3119, Patrick.dallosta@dau.mil, www.rams.org		
2–9 Mar†	**2013 IEEE Aerospace Conference**	Big Sky, MT Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org		
8–11 Apr	**54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **21st AIAA/ASME/AHS Adaptive Structures Conference** **15th AIAA Non-Deterministic Approaches Conference** **14th AIAA Dynamic Specialist Conference** **14th AIAA Gossamer Systems Forum** **9th AIAA Multidisciplinary Design Optimization Conference**	Boston, MA	*Apr 12*	**5 Sep 12**
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		
14–18 Jul	**43rd International Conference on Environmental Systems (ICES)**	Vail, CO		
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		
10–12 Sep	**AIAA SPACE 2013 Conference & Exposition**	San Diego, CA		

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 http://www.aiaa.org/content.cfm?pageid=292.

AIAA Courses and Training Program

DATE	COURSE	VENUE	LOCATION
2012			
21–22 Apr	**Fundamentals of Composite Structure Design**	SDM Conferences	Honolulu, HI
21–22 Apr	**Introduction to Bio-Inspired Engineering**	SDM Conferences	Honolulu, HI
21–22 Apr	**Aeroelasticity: State-of-the-Art Practices**	SDM Conferences	Honolulu, HI
21–22 Apr	**Introduction to Non-Deterministic Approaches**	SDM Conferences	Honolulu, HI
2–3 Jun	**Phased Array Beamforming for Aeroacoustics**	Aeroacoustics Conference	Colorado Springs, CO
14–15 Jun	**The Space Environment—Implications for Spacecraft Design**	National Institute of Aerospace	Hampton, VA
23–24 Jun	**Perturbation Methods in Science and Engineering**	Fluids Conferences	New Orleans, LA
23–24 Jun	**Space Environment and Its Effects on Space Systems**	Fluids Conferences	New Orleans, LA
23–24 Jun	**Turbine Engine Ground Test and Evaluation**	Fluids Conferences	New Orleans, LA
23–24 Jun	**Stability and Transition: Theory, Experiment and Modeling**	Fluids Conferences	New Orleans, LA
23–24 Jun	**Computational Heat Transfer and Thermal Modeling**	Fluids Conferences	New Orleans, LA
1 Jul–31 Dec	**Intro to Computational Fluid Dynamics**	Home Study Course	n/a
1 Jul–31 Dec	**Advanced Computational Fluid Dynamics**	Home Study Course	n/a
1 Jul–31 Dec	**Computational Fluid Turbulence**	Home Study Course	n/a
1 Jul–31 Dec	**Introduction to Space Flight**	Home Study Course	n/a
1 Jul–31 Dec	**Fundamentals of Aircraft Performance and Design**	Home Study Course	n/a
9–10 Jul	**Optimal Design in Multidisciplinary Systems**	Ohio Aerospace Institute	Cleveland, OH
14–15 Jul	**Spacecraft Design and Systems Engineering**	ICES Conference	San Diego, CA
2–3 Aug	**Hybrid Rocket Propulsion**	Joint Propulsion Conference	Atlanta, GA
2–3 Aug	**Advanced Solid Rockets**	Joint Propulsion Conference	Atlanta, GA
2–3 Aug	**Hydrogen Safety**	Joint Propulsion Conference	Atlanta, GA
2–3 Aug	**NPSS: A Practical Introduction**	Joint Propulsion Conference	Atlanta, GA
2–3 Aug	**Missile Design and System Engineering**	Joint Propulsion Conference	Atlanta, GA
6–7 Aug	**Systems Requirements Engineering**	Ohio Aerospace Institute	Cleveland, OH
11–12 Aug	**Flight Vehicle System Identification in Time Domain**	GNC Conferences	Minneapolis, MN
11–12 Aug	**Atmospheric Flight Dynamics and Control**	GNC Conferences	Minneapolis, MN
11–12 Aug	**Recent Advances in Adaptive Control: Theory and Applications**	GNC Conferences	Minneapolis, MN
11–12 Aug	**Fundamentals of Tactical and Strategic Missile Guidance**	GNC Conferences	Minneapolis, MN
11–12 Aug	**Optimal State Estimation**	GNC Conferences	Minneapolis, MN
11–12 Aug	**Six Degrees of Freedom Modeling of MIssile and Aircraft Simulations**	GNC Conferences	Minneapolis, MN
13–14 Aug	**Computational Aeroacoustics: Methods and Applications**	National Institute of Aerospace	Hampton, VA
27–29 Aug	**Space Environment and its Effects on Space Systems**	Ohio Aerospace Institute	Cleveland, OH
11–12 Sep	**Robust Aeroservoelastic Stability Analysis**	National Institute of Aerospace	Hampton, VA

**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.

From the Corner Office

AIAA AND COMMERCIAL SPACE

Michael Griffin, AIAA President-Elect

In my last visit to this forum, I commented upon the long-term trend of dwindling membership in our society, and invited reader feedback concerning how we might reverse that trend. I received a number of thoughtful comments; the most common theme was that AIAA membership reflects trends in the aerospace profession at large, and that we really cannot expect young engineers to get excited about aerospace when the nation is not pursuing the bold endeavors that we seniors recall so well. A number of you suggested to me that we in AIAA should be advocating for bold national goals such as a lunar base, a Mars mission, the restoration of our now-defunct nuclear rocket program, hypersonic vehicles, etc.

Given my track record, I strongly suspect that most readers will realize that suggesting such things to me is truly "preaching to the choir". I'd like nothing more than to see the United States seek and attain leadership on the frontiers of aviation and space, and in the technologies that enable such leadership. And, no question, if such national initiatives were to be pursued once again, AIAA membership concerns would take care of themselves.

But while I may hope for such an about-face in national space policy, and more broadly in national science and technology policy, I don't expect it. Thus, it seems to me that if we are concerned about the health of our Institute, the most fruitful path will be to expand our base among today's aerospace professionals.

One of the most pronounced upward trends in today's aerospace profession is that of "commercial space". I've put quotes around this term because it has come to mean many things to many different interest groups, and not all of these are necessarily very similar to what is meant by "commercial" in other market segments. The common understanding of a "commercial" enterprise is one that raises its own money to create a new product or service, which it then offers on the open market. That's not, or at least not yet, what we're seeing with "commercial space". What we're seeing is more in the nature of a "private-public initiative", with the rules of the road still largely unsettled, and thus the road so far has offered more than a few bumps to those who are traveling on it.

But be that as it may, it is obvious that the influx of NASA funding in this area has energized a whole new group of aerospace professionals. Many of them are younger professionals who have very limited experience, or none at all, with traditional government-directed aerospace development programs carried out by teams of prime and subcontractors. By and large, these aerospace professionals are not involved with AIAA. They are not steeped in a tradition of membership and participation in the Institute and its activities, and those activities and conferences in which they do participate are not usually "core" AIAA events.

This has to change. Without regard to the details of how it might or will happen, I think we can all agree that "space" has progressed beyond its "all government, all the time" roots. In my view, this is an absolutely essential evolution of our profession. I believe that there are myriad ways in which space development has failed to benefit from the vigor and energy that characterizes the marketplace, and that our profession and our nation can benefit greatly from properly structured government policies to encourage the growth of a vibrant commercial space sector. I also believe that we in AIAA have a role to play in this evolution, and that if we play that role properly we will also benefit. Indeed, I believe the health of our Institute ultimately depends upon how we play that role.

Let's step back for a moment and look at the broader landscape. Whatever potholes we see in the road today, who in aerospace would doubt that in, say, fifty years, reasonably reliable and efficient commercial cargo and crew transportation systems will exist for transportation to low Earth orbit? And if that is so, who can doubt that such systems will likely be more cost-effective than comparable government systems? I suspect that most readers of *Aerospace America* would expect to see such systems in operation. Now then, who among our readers believes that we will have such enterprises operating successfully within five years? I will hazard a guess that most aerospace professionals today would say, "not too likely". Thus, via this thought experiment, I would conclude that sometime with the next couple of generations we will see the successful development of viable commercial space transportation enterprises. If so, do we in AIAA, as an Institute, want to play a significant role? Or do we just want to sit on the sidelines and watch?

Some may disagree, but I think we want to play. If so, how can we engage with the emerging commercial space sector in a productive, strategically meaningful way?

It seems to me that there are numerous possibilities, and I am sure that once we start down that path, others will think of many more. But to start, where are the sessions at our conferences that address topics such as the appropriate certification standards for commercial cargo and crew vehicles? If commercial companies are not required or disposed to apply blindly the MIL and NASA Standards with which most of us have grown up, how do we best set and promulgate appropriate engineering standards in this new sector? Will AIAA standards assume a more prominent role, and if not, then what? Where are the AIAA-sponsored forums through which we can lead public-policy discussions concerning the appropriate balance of funding, direction, and regulation in the new public-private partnerships that are characteristic of today's "commercial space" endeavors? What will be the criteria that the space insurance sector will use to set premiums for direct and consequential damages following the failures that must inevitably occur in the course of developing new flight systems? How will the FAA—the appropriate regulatory agency—come to understand and apply what NASA—emphatically not a regulatory agency—has learned about the man-rating of space vehicles? What will be the role, if any, of government in indemnifying commercial providers when such damages exceed insurance policy limits?

There are dozens of such topics to be addressed over the next generation or two as the commercial space sector evolves. We can watch it evolve or we can be a part of it. I know which course I favor, but it isn't up to me. It will be up to the many early and mid-career professionals who will guide our Institute into the future to determine if (and I hope "how") AIAA will not only adapt to but help lead the development of this exciting new part of the aerospace profession. AIAA has a growing group exploring these issues, both technical and business oriented. If you'd like to be a part of setting these directions, contact the Commercial Space Group through Eleanor Aldrich at eleanora@aiaa.org and get involved!

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.

AIAA ASSOCIATE FELLOW INDUCTED INTO OREGON HALL OF FAME

Congratulations to AIAA Associate Fellow **Jerry Florey** who was recognized as a 2012 College of Engineering Oregon Stater honoree! Each year, Oregon State University's College of Engineering recognizes outstanding alumni who have used their education to excel professionally and provide inspirational leadership to others. Mr. Florey and this year's other honorees were recognized at a dinner on 24 February.

Mr. Florey graduated from Oregon State University with a B.S. in Chemical Engineering in 1955. His career touched on all aspects of space systems—rocket engines, launch vehicles, and satellites and their payloads. His experience included business development, strategic planning, technical marketing, and extensive program engineering and technology contract management. He is most proud of his involvement with the Apollo space program. Florey also served as director and chief engineer for the Rockwell International Space and Satellite Systems Division, where he managed the engineers in all technical disciplines. He retired as senior staff manager, Space Transportation Division, McDonnell Douglas.

Mr. Florey has been a member of AIAA for over 40 years. He is a past member of the AIAA Board of Directors, and former director of the AIAA Space and Missile Group from 1989 to 1996. Mr. Florey was elected to the Oregon Aviation Museum Hall of Honor at the Evergreen Air and Space Museum, Evergreen, WA in 2010 in recognition of his contributions to aviation and airpower in all parts of the aerospace community.

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, 10 May 2012, at 12:00 PM.

Klaus Dannenberg, AIAA Corporate Secretary

CALL FOR NOMINATIONS

Recognize the achievements of your colleagues by nominating them for an award! Nominations are now being accepted for the following awards.

Nomination Deadline 1 June 2012

AIAA-ASC James H. Starnes, Jr. Award is presented In honor of James H. Starnes, Jr., a leader in structures and materials, to recognize continued significant contribution to, and demonstrated promotion of, the field of structural mechanics over an extended period of time emphasizing practical solutions, to acknowledge high professionalism, and to acknowledge the strong mentoring of and influence on colleagues, especially younger colleagues.

Nominations due to AIAA by **1 June 2012**. To obtain the nomination form or further information, contact AIAA Honors and Awards at 703.264.7623 or at carols@aiaa.org.

Nomination Deadline 1 July 2012

AIAA Ashley Award for Aeroelasticity recognizes outstanding contributions to the understanding and application of aeroelastic phenomena. It commemorates the accomplishments of Prof. Holt Ashley, who dedicated his professional life to the advancement of aerospace sciences and engineering and had a profound impact on the fields of aeroelasticity, unsteady aerodynamics, aeroservoelasticity, and multidisciplinary optimization. (Presented quadrennially, next presentation 2013)

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 is presented to recognize 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 is presented to recognize 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.

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 **31 December** of the year preceding the presentation.

Losey Atmospheric Sciences Award is presented for recognition of outstanding contributions to the atmospheric sciences as applied to the advancement of aeronautics and astronautics.

Missile Systems Award

The award is presented in two categories. The ***Technical Award*** is presented for a significant accomplishment in developing or using technology that is required for missile systems. The ***Management Award*** is presented for a significant accomplishment in the management of missile systems programs.

Pendray Aerospace Literature Award is presented for an outstanding contribution or contributions to aeronautical and astronautical literature in the relatively recent past. The emphasis should be on the high quality or major influence of the piece rather than, for example, the importance of the underlying technological contribution. The award is an incentive for aerospace professionals to write eloquently and persuasively about their field and should encompass editorials as well as papers or books.

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

Summerfield Book Award is named in honor of Dr. Martin Summerfield, founder and initial editor of the Progress in Astronautics and Aeronautics Series of books published by AIAA. The 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, approved by the Board of Directors in 1999, recognizes sustained, significant service, and contributions to AIAA by members of the Institute. A maximum of 20 awards are presented each year.

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

Nominations due to AIAA by **1 July 2012**, unless otherwise stated. Any AIAA member in good standing may be 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.

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

OBITUARIES

Associate Fellow Ross Died in January

Franklin J. Ross, an aeronautical engineer and an AIAA member for over 60 years, died on 13 January at age 90.

He attended St. John's University, receiving a Bachelor of Aeronautical Engineering in 1946 and he received an MS degree from the University of Minnesota in 1947. He served as an aircraft maintenance officer and B29 flight engineer instructor from 1942–1946 in the U.S. Army Air Corps.

During 1947–1951 and 1953–1955, he was a member of the research staff and later administrative scientist of the Rosemont Aeronautical Laboratories at the University of Minnesota, Department of Aeronautical Engineering. Recalled to active duty with the Minnesota Air National Guard from 1951 to 1953, he served as radar maintenance officer and research project officer. He was appointed as Chief of the Technical Facilities Division and later as Technical Director, Directorate of Flight Test of the Air Force Flight Test Center at Edwards AFB from 1955 to 1958.

From 1958 to 1959, Mr. Ross attended MIT as a Sloan Fellow and was awarded an MS degree in industrial management in 1959. He then served as Deputy for Requirements in the Office of the Assistant Secretary of the Air Force (R&D) (1959–1967). In 1967 he was appointed as the Director of Advisory Group for Aeronautical R&D (AGARD), NATO, in Paris, France, and served in that post until 1970. He returned to Secretary Air Force R&D (SAFRD) as the Deputy for Requirements in 1970, retiring from the federal government in 1978. Then he joined Thiokol Corporation as its Washington DC, representative for their space and congressional interests.

AIAA Fellow Pinson Died in February

Larry D. Pinson passed away on 12 February. He was 71 years old.

Originally from Pike County, KY, he began his education in a two-room schoolhouse. He received Bachelor's and Master's degrees in Civil Engineering from the University of Kentucky, and a Ph.D. in Engineering Science & Mechanics from Virginia Tech. After a short time with the Kentucky Highway Department, he began a career with NASA spanning three decades, consulting in the aerospace industry for several years after his retirement. He authored many technical papers, earned the Lifetime Achievement Award from the University of Kentucky. He was an AIAA Fellow, who served on the AIAA Board of Directors from 1997 to 2000 and was involved with AIAA's Technical Activity Committee and the Structures Technical Committee.

Associate Fellow Shuster Died in February

Malcolm D. Shuster died on 23 February. With his passing, the astronautics community lost a unique voice, an esteemed colleague, and a cherished mentor.

Dr. Shuster received the S.B. degree in physics in 1965 from the Massachusetts Institute of Technology and the Ph.D. in physics in 1971 from the University of Maryland. He then embarked on a brief but productive career in physics, holding positions with the Center for Nuclear Studies (Saclay, France), the University of Karlsruhe (Karlsruhe, West Germany), Tel-Aviv University (Tel-Aviv, Israel), and Carnegie-Mellon University (Pittsburgh, Pennsylvania). He taught physics courses at all levels and carried out research on the interaction of elementary particles with nuclei. Many of his physics articles continue to be cited.

Dr. Shuster changed his career path to aerospace in 1977, joining the Attitude Systems Operation of the Computer Sciences Corporation (CSC) in Silver Spring, MD. At CSC, he developed the QUEST (QUaternion ESTimator) algorithm for attitude estimation. This algorithm is a key component of many space and robotics applications, and is an accomplishment for which Dr. Shuster will always be remembered. In 1981, he moved to Business and Technological Systems, Inc. (BTS), Seabrook and Laurel, MD, working mostly on problems of submarine-launched ballistic missile systems and estimation for geophysical systems. While at BTS, he earned a master's degree in Electrical Engineering at The Johns Hopkins University, and coauthored a widely cited paper on Kalman filtering for spacecraft attitude estimation, work that he had begun at CSC.

During the 1980s, Dr. Shuster frequently served as an adjunct graduate professor of Mechanical Engineering at Howard University, and gave his course on Spacecraft Attitude Estimation at The Johns Hopkins University Applied Physics Laboratory (APL). In summer 1989, he presented the course Restitution d'attitude des véhicules spatiaux at CNES, the French Space Agency in Toulouse, and learned to speak Occitan, the language of the troubadours. This complemented his fluency in German, French, Hebrew, and Portuguese, which he used to present academic courses and seminars.

Dr. Shuster began working with greater intensity on problems of spacecraft attitude estimation after joining the Space Department of APL in 1987. In 1993, he and John L. Junkins were guest editors of a special issue of *The Journal of the Astronautical Sciences*, for which Malcolm provided an invaluable 79-page survey of attitude representations. From 1994 until 1999, he was professor of Aerospace Engineering, Mechanics and Engineering Science at the University of Florida, Gainesville.

Dr. Shuster was with the Orbital Sciences Corporation in Germantown, MD, from 1999 to 2001, until he stopped working because of medical issues. His subsequent publications appeared under the fictitious banner of the Acme Spacecraft Company, of which he styled himself Director of Research. Two of his last papers, "The Arts and Engineering" and "Advice to Young Researchers," published in the *IEEE Control Systems Magazine*, reflected his strong pedagogical interests.

Dr. Shuster was the author or coauthor of more than 60 journal articles—many of which have become key papers—and a comparable number of conference papers. He was a fellow of the American Astronautical Society (AAS) and of the British Interplanetary Society, an associate fellow of AIAA, and a senior member of the Institute of Electrical and Electronics Engineers (IEEE). He was also a member of the American Physical Society and the Society for Industrial and Applied Mathematics. He served as general co-chairman or technical co-chairman of several IEEE, AIAA, and AAS conferences and symposia. In 2000, the AAS presented its Dirk Brouwer Award to him, and in June 2005 held a special three-day astronautics symposium in his honor.

Global Space Exploration Conference (GLEX)

22–24 May 2012
L'Enfant Plaza Hotel
Washington, DC

Welcome!

Just over 60 years ago, the IAF was founded in response to concerns about an increasingly polarized world. Since then, the key word in space exploration has been "cooperation". Now, with many developing and newly industrialized countries joining the space community in recent years, we believe that international cooperation is more important than ever. That's why the IAF is proud to be jointly organizing with the AIAA the Global Space Exploration Conference (GLEX). With stimulating visions for exploration coming from both leading and emerging space nations, GLEX promises to be an exciting and interesting event.

Berndt Feuerbacher
President, International Astronautical Federation

As the "world's forum for aerospace leadership," AIAA is pleased to co-organize the Global Space Exploration Conference (GLEX), bringing leaders in space exploration from all over the globe to this important meeting in Washington, DC. AIAA shares the IAF's commitment to building and maintaining the international relationships that will support human exploration of outer space. We are excited for the collaboration and discussion on space exploration policy, science, and technology that will take place at this year's event. Springtime is the most anticipated and beautiful season in Washington, DC. There is no better time to visit this nation's capital and we look forward to your visit and participation in GLEX.

Brian D. Dailey
President, American Institute of Aeronautics and Astronautics

The IAF/AIAA Global Space Exploration Conference program is designed to stimulate dialog and exchange of ideas on topical issues related to human and robotic space exploration. Space exploration brings significant benefits to people on Earth and today's global economic challenges highlight the importance of continuing to explore. We must continue to be innovative in advancing technologies, developing new capabilities and planning missions. The GLEX technical program is designed to bring together leaders in the science and human exploration community - engineers, scientists, entrepreneurs, educators, agency leaders, and policy makers - and host a constructive dialog aimed at looking for innovative solutions to the challenges ahead. The ISECG Global Exploration Roadmap provides a backdrop for increasing synergies between human and robotic science exploration. We hope to see you in May.

International Program Committee Co-Chairs

Christian Sallaberger
MDA Corporation
Chair, IAF Space Exploration Committee

Hitoshi Kuninaka
JAXA, Chair, ISECG

Kathy Laurini
NASA, Past Chair, ISECG

Special Events

Young Professional Reception
Co-sponsored by The Boeing Company and United Launch Alliance
Monday, 21 May 2012, 1730–1930 hrs

All Young Professionals, please join us! Meet senior agency and industry executives as well as other early career space professionals at this networking reception. We've also designed a special program for you. Don't miss this event on the evening before GLEX begins!

Welcome Reception and Poster Session
Sponsored by The Boeing Company
Tuesday, 22 May 2012, 1900–2030 hrs

Join conference speakers and attendees at this gathering to welcome you to Washington, DC! Tickets are required and are included in the conference registration fee where indicated. Extra tickets may be purchased online or onsite at the conference.

Off-Site Reception at the Smithsonian National Air and Space Museum
Sponsored by Lockheed Martin Corporation
Wednesday, 23 May 2012, 1930–2100 hrs

Enjoy a light hors d'oeuvres reception while viewing the history of aviation and space at the Smithsonian National Air and Space Museum. The museum is located walking distance from the hotel. Tickets are required and are included in the conference registration fee where indicated. Extra tickets may be purchased online or onsite at the conference.

Dinner Cruise
Thursday, 24 May 2012

Buses will depart from the hotel at 1730 hrs; boarding of the boat will begin at 1800 hrs; cruise will begin at 1830 hrs

Board the Nina's *Dandy* from the dock in Old Town Alexandria for a Potomac River cruise under the dramatic low arched bridges of Washington, DC. Dine while viewing the famous monuments. Ticket includes three course dinner, two drink tickets, bus transportation, and musical entertainment. Tickets for this event are not included in the conference registration fee (separate ticket required).

Networking Coffee Breaks
Tuesday Networking Coffee Breaks Sponsored by Battelle Memorial Institute

Coffee and tea will be served in the morning and afternoon. Times will be listed in the final program brochure.

Conference Program

For complete program information, including list of speakers and presentations, go to **www.glex2012.org**.

Tuesday, 22 May 2012

0800–0830 hrs
Opening Ceremony

0830–0930 hrs
Plenary 1: Heads of Space Agencies—Global Space Exploration Dialog

A roundtable dialog on global space exploration with the heads of agencies responding to questions related to timely exploration topics.

0930–1000 hrs
Networking Coffee Break

1000–1300 hrs
Technical Sessions
ISS as the Foundation for Exploration
Goals and Status of Future Lunar Missions
Exploration Capabilities
Human Exploration of NEAs
The Human Space Exploration Value Proposition
Technology Roadmaps for Exploration
Specific Legal Issues of Space Exploration and Exploitation

1300–1400 hrs
Lunch Break

1400–1500 hrs
Plenary 2: Perspectives on Exploration

Speakers will give their perspectives on the current state of affairs related to space exploration including capabilities, destinations, timing, and the ISECG exploration pathways.

1500–1530 hrs
Networking Coffee Break

1530–1830 hrs
Technical Sessions
Concepts for Robotic and Human Missions to the Moon
Cis-Lunar Outposts and Other Exploration Missions
Robotic Mars Exploration
Advancing Propulsion Technologies
Space Resources Fundamentals and Asteroid Mining
Engaging Citizens: Results and Future Concepts
Interdependency

1830–2000 hrs
Opening Reception and Poster Session

Wednesday, 23 May 2012

0800–0900 hrs
Lecture 1: Mars Exploration

Organized by
American Institute of Aeronautics and Astronautics (AIAA)
International Astronautical Federation (IAF)

With the Participation of
Canadian Space Agency (CSA)
China National Space Administration (CNSA)
European Space Agency (ESA)
Indian Space Research Organization (ISRO)
Japanese Aerospace Exploration Agency (JAXA)
National Aeronautics and Space Administration (NASA)
Russian Federal Space Agency (ROSCOSMOS)

Partner Organizations
Committee on Space Research (COSPAR)
International Academy of Astronautics (IAA)
International Institute of Space Law (IISL)
International Lunar Exploration Working Group (ILEWG)
International Space Exploration Coordination Group (ISECG)

Platinum Sponsor
Lockheed Martin Corporation

Gold Sponsor
The Boeing Company

Bronze Sponsor
United Launch Alliance
Battelle Memorial Institute

Media Sponsor
Space News

0900–1000 hrs
Plenary 3: Capabilities for Human Exploration

This session will provide insight into the current thinking with regard to architectural elements and technical capabilities necessary to move beyond LEO. Representatives from international government agencies, industrial partners, and commercial providers will share their current ideas for future missions, partnerships and the technology advancements necessary to develop future capabilities.

1000–1030 hrs
Networking Coffee Break

1030–1300 hrs
Technical and Panel Sessions
Technical Sessions
Scientific Highlights and Lessons from Recent Lunar Missions
Robotic Precursors to the Mars System
Human Reach via Robotic Presence
Exploration Research and Technologies
Life Support Technologies and Systems

Panel Sessions
NASA's Space Launch System
Utilization of Off-Earth Resources: The Challenges Ahead

1300–1400 hrs
Lunch Break

1400–1500 hrs
Plenary 4: Human and Robotic Exploration: A Scientific Perspective

This panel will provide a perspective on human and robotic space exploration from the point of view of prominent planetary scientists. What are the priorities? What are the roles? How can we strengthen the partnership between human and robotic exploration in order to address the major science questions?

1500–1530
Networking Coffee Break

1530–1830 hrs
Technical and Panel Sessions
Technical Sessions
Lunar Surface Outposts and Enabling Technologies
Mars Sample Return and Human Exploration
Technology Development Concepts
Educating the Next Generation
New Business Models for Space Exploration

Panel Sessions
The ISECG Global Exploration Roadmap: Why is it important?
Human Health and Performance Risks

Thursday, 24 May 2012

0800–0900 hrs
Lecture 2: Exploring the Moon and the Asteroids: A Synergistic Approach

0900–1000 hrs
Plenary 5: Enabling a Political Concensus
Panelists will share their perspectives on how and when we might achieve and maintain the necessary political consensus to pursue global exploration initiatives that are becoming more and more complex over time.

1000–1030 hrs
Networking Coffee Break

1030–1300 hrs
Technical and Panel Sessions
Technical Sessions
Lunar Robotic Precursor Missions
Asteroid Robotic Precursor Missions
Human Robotic Exploration Partnership
Planetary Defense
Supporting Crews for Exploration Missions
Present and Future Regulation of Space Exploration and Exploitation: General Issues

Panel Session
The ISECG Global Exploration Roadmap: Advancing Toward Mars

1300–1400 hrs
Lunch Break

1400–1700 hrs
Technical and Panel Sessions
Technical Sessions
Exploration Technology Demonstrations Using ISS
Habitation for Exploration Missions
International Plans and Concepts
Precursor Missions to NEAs
Enabling Technologies for Exploration

Panel Session
The ISECG Global Exploration Roadmap: Destinations and Commercial Markets

1700–1730 hrs
Closing Ceremony

Technical Tours

NASA Goddard Space Flight Center
Friday, 25 May 2012
www.nasa.gov/centers/goddard

This tour of NASA Goddard Space Flight Center consists of Building 7, the Spacecraft Testing and Integration Facility, as well as Building 29, the Spacecraft Systems Development and Integration Facility. Buses will depart from the L'Enfant Plaza Hotel at 0830 hrs and return at 1300 hrs. A ticket for the tour is $20 per person and is listed as an extra ticket on the registration form. Space is limited to the first 40 participants who purchase tickets. Preregistration is required. *Foreign nationals must purchase their ticket no later than two weeks before the tour date, and must provide their full name (as on their passport), date of birth, passport number, and country of citizenship in an email to Sandra Turner, conference registrar, at sandrat@aiaa.org.*

National Oceanic and Atmospheric Administration (NOAA)
Friday, 25 May 2012
www.noaa.gov

This tour of the National Oceanic and Atmospheric Administration (NOAA) includes an overview of NOAA satellite programs, followed by a tour of the satellite operations control center and launch control room. Buses will depart from the L'Enfant Plaza Hotel at 0830 hrs and return at 1300 hrs. A ticket for the tour is $20 per person and is listed as an extra ticket on the registration form. Space is limited to the first 40 participants who purchase tickets. Preregistration is required. *Foreign nationals must purchase their ticket no later than two weeks before the tour date, and must provide their full name (as on their passport), date of birth, passport number, and country of citizenship in an email to Sandra Turner, conference registrar, at sandrat@aiaa.org.*

Lockheed Martin Space Experience Center
Friday, 25 May 2012
http://www.lockheedmartin.com

The Lockheed Martin Space Systems Company is pleased to provide a tour of its Space Experience Center for participants in the Global Space Exploration Conference. Your visit will include an overview presentation in the VectorStar Theater, a guided tour of the visitor center, and ample time to operate our hands-on simulators, demonstrators, and other exhibits. Buses will depart from the L'Enfant Plaza Hotel at 0830 hrs and return at 1300 hrs. A ticket for the tour is $20 per person and is listed as an extra ticket on the registration form. Space is limited to the first 40 participants who purchase tickets. Preregistration is required. *Foreign nationals must purchase their ticket no later than two weeks before the tour date, and must provide their full name (as on their passport), date of birth, passport number, and country of citizenship in an email to Sandra Turner, conference registrar, at sandrat@aiaa.org*.

Registration

We are committed to sponsoring a world-class conference in a safe and secure environment. As such, all delegates will be required to provide proper identification prior to receiving a conference badge and associated materials. All delegates must provide a valid photo ID (passport, national ID card, driver's license or government/military I.D.) when they check in.

All participants are urged to register online at **www.aiaa.org/glex2012**. A check made payable to AIAA or credit card information must be included with your registration form. The PDF registration form is available at the AIAA website. Print, complete, and mail or fax the form with payment to AIAA. Address information is provided. For questions, contact Sandra Turner, AIAA conference registrar, at +1.703.264.7508 or sandrat@aiaa.org.

Registration fees are as follows:

	Early Bird By 12 March	Standard 12 Mar–20 May	On Site
Member*	$850	$950	$1050
Non-Member*	$950	$1050	$1150
Full-time Students*	$170	$170	$170
Young Professionals*	$380	$380	$380
Full-time Retired*	$510	$510	$510

*Registration includes sessions, welcome reception, and off-site reception at the National Air and Space Museum.

Preregistrants may pick up their materials at the advance registration desk at the conference. All those not registered by **20 May 2012** may do so at the on-site registration desk.

Extra Tickets

Tuesday Welcome Reception	$75
Wednesday Off-Site Event	$75
Thursday Dinner Cruise*	$120
NASA Goddard Space Flight Center Tour*	$20
NOAA Tour*	$20
Lockheed Martin Space Experience Tour*	$20

**Not included in registration fee; tickets must be purchased separately for the cruise and tours.*

Discounted Group Rate

10% discount off AIAA/IAF 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. Includes sessions and all catered events. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be received by the preregistration deadline of **20 May 2012**. The group rate is $765 per person.

Media Accreditation

Media accreditation can only be granted to active members of the media and to photographers commissioned by a news agency, publication, TV, or radio station. All media representatives are to contact Duane Hyland at duaneh@aiaa.org in order to obtain accreditation.

On-Site Registration Hours

On-site registration hours will be held at the L'Enfant Plaza Hotel as follows:

Monday, 21 May 2012	1500–1900 hrs
Tuesday–Thursday, 22–24 May 2012	0700–1700 hrs

Cancellation Policy

Cancellations must be in writing and received no later than **7 May 2012**. There is a $100 cancellation fee. Registrants who cancel beyond this date or fail to attend the conference will forfeit the entire fee.

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. Claims of hours or applicability toward professional education requirements are the responsibility of the participant.

Hotel Accommodations

The L'Enfant Plaza Hotel (**www.lenfantplazahotel.com**) is both the conference venue and the recommended accommodation, conveniently located at the L'Enfant metro stop. Room rates are $239 for single or double occupancy plus 14.5% applicable tax. To make hotel reservations, please call the hotel directly at +1.800.635.5065 or fax at +1.202.646.5060. You can also visit **www.aiaa.org/glex2012** for a direct link to online reservations and the group discount code. A credit card or one night deposit is required to secure a room reservation within this block. Please identify yourself as an attendee of the Global Space Exploration Conference to receive the conference rate. Cancellations must be received 72 hours prior to arrival, or a one night room and tax will be assessed.

Meeting Site

The metropolitan Washington, DC, area provides an ideal backdrop for the 2012 GLEX event. Home to a distinctive combination of aerospace companies, government agencies, academic institutions, and nongovernmental organizations focused on aerospace, conference attendees will have unrivaled access to key partners and decision makers engaged in space exploration. In addition, the conference venue is located within walking distance of the world's largest collection of historic aircraft and space vehicles at the Smithsonian National Air & Space Museum, the White House, the U.S. Capitol, and the Washington Monument, and many other museums, attractions, and restaurants. Average temperatures in May are a low of 55° Fahrenheit/13° Celsius and a high of 77° Fahrenheit/25° Celsius. Currency accepted is the U.S. Dollar. Washington, DC, is on Eastern Standard Time Zone.

Visas

If you plan to attend this conference held in the United States and you require a visa for travel, it is incumbent upon you to apply for a visa with the U.S. embassy (consular division) or consulate with ample time for processing. To avoid bureaucratic problems, AIAA strongly suggests that you submit your formal application to U.S. authorities as early as possible in advance of the date of anticipated travel.

Prospective conference attendees requiring a visa to travel to the event should first contact AIAA to request an official letter of invitation to the event. This letter and a copy of the conference call for papers should be presented along with the required documentation to the U.S. consular officials as part of the formal application process. To request a letter of invitation, please contact Sandra Turner, AIAA conference registrar, at +1.703.264.7508 or sandrat@aiaa.org. AIAA cannot directly intervene with the U.S. Department of State, consular offices, or embassies on behalf of individuals applying for visas. More information and assistance can be found at **http://travel.state.gov/visa/**.

Transportation

When traveling to the nation's capital, experience the convenience of a choice of three major airports—Reagan National (DCA), Washington Dulles (IAD), and Baltimore Washington International (BWI). Convenient taxi service is available to DC from all airports. Reagan National (DCA) is also accessible by metro.

Reagan National Airport—Four Metro stops from the hotel
Washington Dulles International Airport (IAD)—27 miles
Baltimore Washington International Airport (BWI)—33 miles
Metro Subway System—Located below the hotel

Parking at the hotel is $42 for overnight (with in and out privileges), and $30 for daily parking (no in and out privileges).

Restrictions

Video or audio recording of sessions or technical exhibits, as well as the unauthorized sale of AIAA or IAF copyrighted material, is prohibited.

Messages and Information

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

Points of Contact

For questions related to the technical program, please contact Philippe Moreels at glex2012@iafastro.org.

For questions related to transportation, visa and/or accommodation, please contact custserv@aiaa.org.

International Astronautical Federation (IAF)

Founded in 1951, the International Astronautical Federation is the world's leading space advocacy body with more than 220 members on six continents including all leading agencies, space companies, societies, associations, and institutes worldwide. Following its theme "A space-faring world cooperating for the benefit of humanity," the Federation advances knowledge about space, fostering the development and application of space assets by advancing global cooperation.

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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.

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custserv@aiaa.org
www.aiaa.org

AIAA Infotech@Aerospace 2012 Conference
Intelligent Autonomy for Space and Unmanned Systems

19–21 June 2012
Hyatt Regency Orange County
Garden Grove, CA

Intelligent Autonomy for Space and Unmanned Systems

Autonomous systems are increasingly being deployed in many unmanned, space, and robotic platforms. Systems with high-level autonomy capabilities can greatly improve efficiency and reduce costs associated with the design and operation of many aerospace systems.

Space exploration robotic systems *are highly autonomous and are capable of high-level interactions with human operators to accomplish mission objectives. NASA's Mars Exploration Rovers (MER) have demonstrated the benefits of autonomy and intelligent systems in space exploration using machine vision, hazard avoidance, onboard re-tasking, intelligent data processing, and many other computational processes. Higher performance embedded computing resources utilizing advanced multi-core or graphics processors provide the raw performance needed to realize these increases in autonomy and computations.*

Spacecraft designs *are increasingly developed to include new, advanced capabilities for autonomy such as automated rendezvous and docking, intelligent adaptive control, adaptive mission operations, integrated system health management, plug and-play mechanisms, and other intelligent functions that enable complex operations to be performed in a space environment.*

Unmanned Aircraft Systems (UAS) *share many common autonomous capabilities with space systems by leveraging onboard computational resources to perform tasks such as intelligent terrain feature recognition and vision-based guidance. There are many significant technology and policy challenges to the integration of UAS into the National Airspace System (NAS) that are currently being addressed.*

Ground-based unmanned systems *have begun to appear and are being developed with autonomous guidance and navigation capabilities. These systems are capable of sensing and feature detection in terrain and urban settings, collision avoidance, and self-guidance and navigation.*

The technologies that enable autonomy in unmanned and space systems are being developed at a rapid pace. They integrate many foundational disciplines to achieve integrated solutions that utilize new and existing capabilities in intelligent systems, Integrated System Health Management (ISHM), sensor systems, software and computers, communications, digital avionics, and information and command and control.

Infotech@Aerospace 2012 will explore many of the core technologies and integration considerations that will enable "Intelligent Autonomy for Space and Unmanned Systems."

Nhan Nguyen
I@A 2012 General Chair

Synopsis

Infotech@Aerospace (I@A) is AIAA's premier forum for modern aerospace applications focusing on information-enabled systems, algorithms, hardware, and software, and provides a unique opportunity for fostering advances and interactions across these disciplines. Attendees and authors span military, scientific, commercial, and academic communities that are driven by the communication of information via computers and software. These communities will shape the 21st-century development of aerospace systems. I@A 2012 will cover scientific and engineering issues related to architecting, designing, developing, operating, and maintaining modern aerospace and defense systems, including aircraft, spacecraft, ground systems, robots, avionics, and sensors, as well as systems of systems. Of particular interest are autonomous, cooperative, space, and unmanned systems, communication and networked systems, robotic systems, and human-machine interactions. Select technical papers will be considered for publication in AIAA's *Journal of Aerospace Computing, Information, and Communication* (*JACIC*).

General Chair
Nhan Nguyen
NASA Ames Research Center

Technical Program Chair
Timothy Howard
EOSESS LLC

Deputy Technical Program Chair
Fernando Figueroa
NASA Stennis Space Center

Technical Events Chairs
Brian Argrow
University of Colorado, Boulder

Mitch Ingham
NASA Jet Propulsion Laboratory

Marketing Chair
Susan Frost, NASA Ames Research Center

Event at a Glance

	Monday 18 June 2012	Tuesday 19 June 2012	Wednesday 20 June 2012	Thursday 21 June 2012	
0700 hrs		Speaker's Breakfast	Speaker's Breakfast	Speaker's Breakfast	0700 hrs
0800 hrs		Keynote	Keynote	Technical Sessions	0800 hrs
0900 hrs		Break	Break	Break	0900 hrs
1000 hrs		Plenary Panel	Technical Sessions	Technical Sessions	1000 hrs
1100 hrs					1100 hrs
1200 hrs	JPL Tour	Lunch	Awards Luncheon	Keynote	1200 hrs
1300 hrs				Lunch	1300 hrs
1400 hrs		Technical Sessions	Technical Sessions	Technical Sessions	1400 hrs
1500 hrs		Break	Break	Break	1500 hrs
1600 hrs		Technical Sessions	Technical Sessions	Technical Sessions	1600 hrs
1700 hrs					1700 hrs
1800 hrs					1800 hrs
1900 hrs		Reception			1900 hrs
2000 hrs					2000 hrs

For more detailed program information,
visit the detailed agenda on the website at
www.aiaa.org/I@A2012

Benefits of Attendance

Why Attend?
Nowhere else will you get the depth and breadth of sessions offered at I@A. The conference will cover scientific and engineering issues related to architecting, designing, developing, operating, and maintaining modern aerospace and defense systems, including aircraft, spacecraft, ground systems, robots, avionics, and sensors, as well as systems of systems.

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

Who Should Attend?
- Engineering managers and industry executives
- Engineers, researchers, and scientists
- Young aerospace professionals
- Educators and students

What to Expect?
Discussion with distinguished speakers, including:
- Keynote speaker **Rob Manning**, Project Chief Engineer, Mars Science Laboratory
- **Kevin Korchersberger**, Director, Unmanned Systems Lab, Virginia Tech
- **David Brady**, Director, Office of Export and Secure Research Compliance, Virginia Tech
- **Brian Argrow**, Director, Research and Engineering Center for Unmanned Vehicles, University of Colorado
- **Col Eric "Scam" Mathewson**, U.S. Air Force (Ret.), Director, UAS Strategy, The Boeing Company
- **Lt Gen Michael A. Hamel**, U.S. Air Force (Ret.), Senior Vice President of Corporate Strategy and Development, Orbital Sciences Corporation
- **Steve Chien**, Senior Research Scientist & Technical Group Supervisor of the Artificial Intelligence Group, Jet Propulsion Laboratory

Networking and interaction with your peers during:
- JPL Tour
- Tuesday Evening Reception
- Coffee Breaks
- Awards Luncheon

Technical Areas of Focus

Infotech@Aerospace covers a broad range of topics related to aerospace information systems, such as:

- Space Autonomous Systems and Robotics
- Unmanned Systems Applications
- Human-Machine Interface
- Intelligent Systems
- System Integrity, Verification, and Validation
- Adaptive Systems
- Integrated System Health Management (ISHM)
- Sensor Systems
- Data/Information Fusion
- Computer Systems
- Software Systems
- Plug-and-Play Mechanisms
- Real-Time Embedded Computing Technologies

Special Events

Monday, 18 June 2012

1330–1600 hrs
JPL Tour
Pasadena is the home of the Jet Propulsion Laboratory, the lead U.S. center for robotic exploration of the solar system. The tour highlights include the JPL Visitor Center space museum, the Spacecraft Assembly Facility (where JPL's robotic spacecraft are integrated and tested), the Space Flight Operations Facility (which houses the mission control center for JPL's deep space missions), and other robotic testbeds and facilities used by JPL deep space and planetary missions. Bus transportation will leave the hotel at approximately 1200 hrs and return to the hotel at approximately 1800 hrs.

Tuesday, 19 June 2012

0800–0900 hrs
Keynote Address: "Engineering Truly Resilient Robotic Spacecraft: Can We Break Out of the Complexity Corner We Have Painted Ourselves Into?"—Rob Manning, Project Chief Engineer, Mars Science Laboratory

0930–1130 hrs
Plenary Panel UAS
Moderator: Brian Argrow, Director, Research and Engineering Center for Unmanned Vehicles, University of Colorado
Panelists: Kevin Korchersberger, Director, Unmanned Systems Lab, Virginia Tech; David Brady, Director, Office of Export and Secure Research Compliance, Virginia Tech

1800–2000 hrs
Welcome Reception

Wednesday, 20 June 2012

0800–0900 hrs
Keynote Speaker
Col Eric "Scam" Mathewson, U.S. Air Force (Ret.), Director, UAS Strategy, The Boeing Company

AIAA Programs

	Registration Type	Member Before 21 May	Nonmember Before 21 May	Conference Sessions	Awards Luncheon	Tuesday Reception	JPL Tour	Online Proceedings
Option 1	**Full Conference with Online Proceedings**	**$760**	**$915**	●	●	●	●	●
Option 2	**Full-Time Undergraduate Student**	**$20**	**$50**	●			●	
Option 3	**Full-Time Undergraduate Student plus Networking**	**$135**	**$165**	●	●	●	●	
Option 4	**Full-Time Graduate or Ph.D. Student**	**$60**	**$90**	●			●	
Option 5	**Full-Time Graduate or Ph.D. Student plus Networking**	**$175**	**$205**	●	●	●	●	
Option 6	**AIAA Retired Member**	**$40**	**n/a**	●	●	●	●	
Option 7	**Group Rate***	**$680**	**n/a**	●	●	●	●	●
	Extra Tickets				$55	$60		$170

Pricing subject to change.

*Advance only. 10% discount off early-bird member rate for 10 or more individuals from the same organization who register and pay at the same time with a single form of payment. Includes all catered events and online proceedings. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be submitted by the preregistration deadline of 17 June 2012. No substitutions.

1200–1330 hrs
Awards Luncheon with Keynote Speaker
Lt Gen Michael A. Hamel, U.S. Air Force (Ret.), Senior Vice President of Corporate Strategy and Development, Orbital Sciences Corporation

Thursday, 21 June 2012

1130–1230 hrs
Keynote Address: " Integrating Space, Air, In Situ, and Marine Assets into Autonomous Sensor Webs for Environmental Monitoring"—Steve Chien, Senior Research Scientist & Technical Group Supervisor, Artificial Intelligence Group, Jet Propulsion Laboratory

Student Paper Competition

The AIAA Intelligent Systems Technical Committee is hosting the 4th Intelligent Systems Student Paper Competition at I@A 2012, sponsored by the Computer Sciences Corporation and the Intelligent Systems Technical Committee. Up to four finalists will present their papers during a special student paper competition session, from which the Best Paper/Presentation will be selected, with the winner receiving a $1,000 prize at the Awards Luncheon.

Registration Information

All participants are urged to register on the AIAA website at **www.aiaa.org/I@A2012**. 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 available on the AIAA website. Print, complete, and mail or fax with payment to AIAA. Address information is provided.

Early-bird registration forms must be received by **21 May 2012**. Preregistrants may pick up their materials at the advance registration desk. All those not registered by **17 June 2012** may do so at the on-site registration desk. All nonmember registration prices include a one-year AIAA membership. If you require more information, please call 703.264.7504 or e-mail chrisb@aiaa.org.

Extra Tickets

Tuesday Evening Reception	$60
Wednesday Awards Luncheon	$55
Online Proceedings	$170

Registration Hours

Monday, 18 June	1500–1900 hrs
Tuesday, 19 June	0700–1700 hrs
Wednesday, 20 June	0700–1700 hrs
Thursday, 21 June	0700–1600 hrs

Hotel Reservations

AIAA has made arrangements for a block of rooms at the Hyatt Regency Orange County, 11999 Harbor Blvd., Garden Grove, CA 92840. Room rates are $125 for single or double occupancy. To make a reservation online, visit **https://resweb.passkey.com/go/sleepreserve**, or call 888.421.1442 and refer to the AIAA Infotech@Aerospace Conference. These rooms will be held for AIAA until **21 May 2012** while availability lasts. After 21 May, any unused rooms will be released to the general public. You are encouraged to book your hotel room early.

Wireless Internet Access

Wireless Internet access will be provided in all meeting spaces from Tuesday, 19 June at 0600 hrs through Thursday, 21 June at 1800 hrs.

42nd International Conference on Environmental Systems

15–19 July 2012
Hilton San Diego Resort and Spa
San Diego, CA

Synopsis

The 42nd International Conference on Environmental Systems (ICES) is organized by AIAA, and supported by the American Institute of Chemical Engineers (AIChE), the American Society of Mechanical Engineers (ASME), and the ICES International Committee (INT). The conference will cover the following topics related to humans living and working in hostile environments with applications inside or outside of terrestrial or outer space habitats or vehicles: aerospace human factors; environmental control and life-support system technology; environmental monitoring and controls; planetary protection; EVA system technology; life sciences; planetary habitats and systems; and thermal control systems technology for both manned and unmanned vehicles. The conference is open to participants from any nation, from academic, government, or industry organizations. There will be four days of technical presentations, with approximately 45 sessions.

Organized by American Institute of Aeronautics and Astronautics (AIAA)

Supported by
AIAA Life Sciences and Systems Technical Committee
AIAA Space Environmental Systems Program Committee
American Institute of Chemical Engineers (AIChE) Environmental Systems Committee
American Society of Mechanical Engineers (ASME) Crew Systems Technical Committee
ICES International Committee (INT)

After-Banquet Dessert Reception Sponsored by Paragon Space Development Corporation

General Chair
David Williams
NASA Johnson Space Center

Vice Chair
W. Andrew Jackson
Texas Tech University

Steering Committee

Grant Anderson
Paragon Space Development Corporation

Wes Ousley
Genesis Engineering Solutions LLC

Jeffery Farmer
NASA Marshall Space Flight Center

Amy Ross
NASA Johnson Space Center

Markus Huchler
EADS Astrium GmbH

Chang H. Son
The Boeing Company

Wolfgang Supper
European Space Agency

Special Events

Welcome Reception

A welcome cocktail reception will be held Sunday, 15 July, 1730–1900 hrs, at the Hilton San Diego Resort and Spa. A ticket for the reception is included in the conference registration fee where indicated. Additional tickets for guests may be purchased upon registration or on site.

Opening Plenary Session

The conference will open with a plenary session on Monday, 16 July, 0830–0930 hrs. The keynote speaker will be George Nield, Associate Administrator for Commercial Space Transportation, Federal Aviation Administration (FAA), Washington, DC.

Accompanying Persons Meet and Greet

Accompanying persons are invited to meet on Monday, 16 July, 0900 hrs, at the Hilton San Diego Resort and Spa. Information about San Diego tourist attractions will be available. Coffee and tea will be served. Room location will be announced in the final program.

AIAA Programs

Networking Reception and Student Poster Competition

A networking "happy hour" and student poster competition will be held on Monday, 16 July,1830–2000 hrs, at the Hilton San Diego Resort and Spa. All attendees are welcome to attend. The ICES student poster competition session is targeted to stimulate the participation of students, and will provide an excellent forum for students to present their work in an informal and interactive setting. Posters are ideal for presenting speculative or late-breaking results, or for giving an introduction to interesting, innovative work. Posters are intended to provide students and ICES participants with the ability to connect with one another and discuss the work presented. Each poster will be judged and cash prizes will be awarded.

Reception and Banquet

The reception and banquet will be held Wednesday, 18 July 1830–2200 hrs, at the Hilton San Diego Resort and Spa. A reception will be followed by dinner, then the awards presentation and a keynote speech by Keith A. Reiley, Deputy Program Manager, Commercial Crew Development, The Boeing Company, Houston, TX. A ticket for the reception and banquet is included in the conference registration fee where indicated. Additional tickets for guests may be purchased upon registration or on site.

After-Banquet Dessert Reception

Immediately following the banquet, there will be a dessert reception, sponsored by Paragon Space Development Corporation. All banquet attendees are welcome to attend.

Cyber Café

Computers with complimentary Internet access for conference attendees will be available at the AIAA Cyber Café. Hours of operation are as follows:

Sunday, 15 July 2012	1500–2000 hrs
Monday, 16 July 2012	0700–2000 hrs
Tuesday, 17 July 2012	0700–2000 hrs
Wednesday, 18 July 2012	0700–2000 hrs
Thursday, 19 July 2012	0700–1200 hrs

Conference Proceedings

Proceedings for this conference will be available in one format: online proceedings. The cost is included in the registration fee where indicated. The online proceedings will be available on **9 July 2012**. Attendees who register in advance for the online proceedings will be provided with instructions on how to access them. Those registering on site will be provided with instructions at that time.

Registration Information

AIAA is committed to sponsoring world-class conferences on current technical issues in a safe and secure environment. As such, all delegates will be required to provide proper identification prior to receiving a conference badge and associated materials. All delegates must provide a valid photo ID (driver's license or passport) when they check in. For student registrations, a valid student ID is also required. We thank you for your cooperation.

All participants are urged to register online at **www.aiaa.org/ICES2012**. 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.

Early-bird registration forms must be received by **18 June 2012**, and standard registration forms will be accepted until **14 July 2012**. Preregistrants may pick up their materials at the advance registration desk at the conference. All those not registered by **14 July 2012** may do so at the on-site registration desk.

Cancellations must be received no later than **2 July 2012**. There is a $100 cancellation fee. Registrants who cancel beyond this date or fail to attend the conference will forfeit the entire fee.

Attention AIChE/ASME/INT Members: Current members in good standing of AIChE, ASME, and INT are eligible to register at the same rate as AIAA members. This fee does not include AIAA membership. To become an AIAA member or renew AIAA membership, AIChE, ASME, and INT members should register at the nonmember registration rate.

For questions, please contact Sandra Turner, conference registrar, at +1 703.264.7508 or sandrat@aiaa.org.

Registration fees are as follows:

	Early Bird By 18 Jun	**Standard** 19 Jun–14 Jul	**On Site** 15–19 Jul
Option 1: Full Conference with Online Proceedings			
Conference	$930	$1030	$1130
Member Discount	$775	$875	$975

Includes sessions, Sunday welcome reception, Monday student poster competition reception, Wednesday reception and banquet, and single-user access to online proceedings.

	Early Bird	**Standard**	**On Site**
Option 2: Full-Time Undergraduate Student			
Conference	$50	$60	$70
Member Discount	$20	$30	$40

Includes sessions and Monday student poster competition reception only.

	Early Bird	**Standard**	**On Site**
Option 3: Full-Time Undergraduate Student Plus Networking			
Conference	$245	$255	$265
Member Discount	$215	$225	$235

Includes sessions, Sunday welcome reception, Monday student poster competition reception, and Wednesday reception and banquet.

	Early Bird	**Standard**	**On Site**
Option 4: Full-Time Graduate or Ph.D. Student			
Conference	$90	$100	$110
Member Discount	$60	$70	$80

Includes sessions and Monday student poster competition reception only.

	Early Bird	**Standard**	**On Site**
Option 5: Full-Time Graduate or Ph.D. Student Plus Networking			
Conference	$285	$295	$305
Member Discount	$255	$265	$275

Includes sessions, Sunday welcome reception, Monday student poster competition reception, and Wednesday reception and banquet.

	Early Bird	**Standard**	**On Site**
Option 6: Full-Time Retired Member (AIAA Member Only)			
AIAA Member	$40	$50	$60

Includes sessions, Sunday welcome reception, Monday student poster competition reception, and Wednesday awards reception and banquet.

	Early Bird	**Standard**	**On Site**
Option 7: Discounted Group Rate			
	$698 per person	$698 per person	N/A

10% discount off AIAA 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. Includes sessions, all catered events, and single-user access to online proceedings for each registrant. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be received by the preregistration deadline of **14 July 2012**.

Option 8: Continuing Education Course: Spacecraft Design and Systems Engineering

	Early Bird By 18 Jun	Standard 19 Jun–13 Jul	On Site 14–15 July
Course	$1365	$1465	$1565
Member Discount	$1288	$1388	$1488

Registration fee includes full conference participation: access to technical and plenary sessions, receptions, banquet, and online proceedings.

Extra Tickets

Sunday Welcome Reception	$85
Wednesday Reception and Banquet	$110
Extra Online Proceedings	$170

On-Site Registration Hours

On-site registration will be held at the Hilton San Diego Resort and Spa as follows:

Saturday, 14 July 2012	0715–0815 hrs (course only)
Sunday, 15 July 2012	1500–1900 hrs
Monday, 16 July 2012	0700–1700 hrs
Tuesday, 17 July 2012	0700–1700 hrs
Wednesday, 18 July 2012	0700–1700 hrs
Thursday, 19 July 2012	0700–1200 hrs

Hotel Reservations

AIAA has made arrangements for a block of rooms at the Hilton San Diego Resort and Spa, 1775 East Mission Bay Drive, San Diego, CA 92109. Room rates are $199 for single or double occupancy, and a limited number of room nights are available at the prevailing U.S. government per diem rate at the time of the conference for those who qualify. To make a reservation, call +1.877.313.6645 and refer to the AIAA 42nd International Conference on Environmental Systems (ICES), or make reservations online by following the links provided on the conference website at the government per diem rate or AIAA conference rate. Please note that when booking the government rate, the hotel will require government ID at check in. Rooms will be held for AIAA until **14 June 2012** while availability lasts. After 14 June, any unused rooms will be released to the general public. You are encouraged to book your hotel room early.

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 Event Preview 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!

Meeting Site

California's second largest city and the eighth largest in the United States, San Diego boasts a citywide population of nearly 1.3 million residents and more than 3 million residents countywide. Within its 4,200 square miles, San Diego County encompasses 18 incorporated cities and numerous other charming neighborhoods and communities.

San Diego is renowned for its idyllic climate, 70 miles of pristine beaches, and a dazzling array of world-class family attractions. Popular attractions include the world-famous San Diego Zoo and San Diego Zoo Safari Park, SeaWorld San Diego, and LEGOLAND California. San Diego offers an expansive variety of things to see and do, appealing to guests of all ages from around the world. For more information, visit **www.sandiego.org**.

Continuing Education Course

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.

On 14–15 July at the Hilton San Diego Resort and Spa, AIAA will offer a Continuing Education course in conjunction with the 42nd International Conference on Environment Systems (ICES). Please check the conference website for up-to-date information regarding the course.

Spacecraft Design and Systems Engineering

This course presents an overview of factors that affect spacecraft design and operation. It begins with a 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 effect 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.

Car Rental

Hertz Car Rental Company saves AIAA members up to 15% on car rentals. Discounts are available at all participating Hertz locations in the United States, Canada, and where possible, internationally. For worldwide reservations, call your travel agent or Hertz directly at 800.654.2200 (U.S.) or 800.263.0600 (Canada). Mention the AIAA members savings CDP #066135 or visit www.hertz.com. Don't forget to include the CDP number.

International Traffic in Arms Regulations (ITAR)

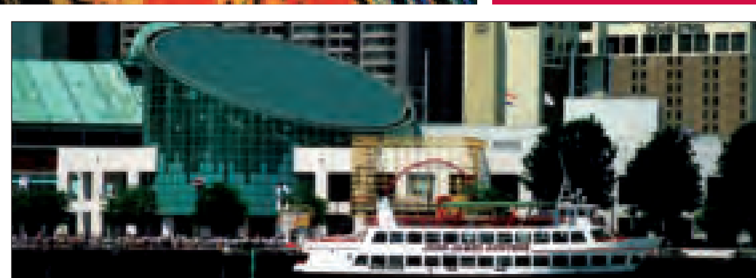
AIAA speakers and attendees are reminded that some topics discussed in the conference could be controlled by the International Traffic in Arms Regulations (ITAR). U.S. nationals (U.S. citizens and permanent residents) are responsible for ensuring that technical data they present in open sessions to non-U.S.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

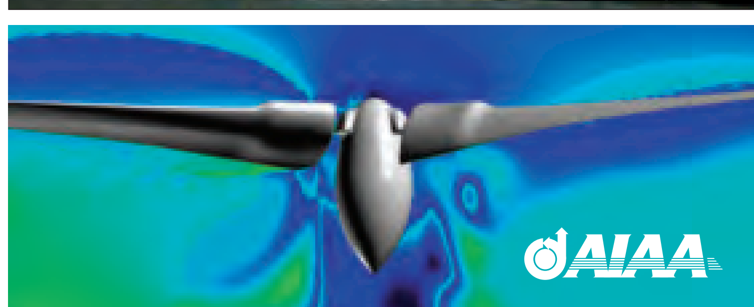
Visit **www.aiaa.org/ICES2012** for the full conference program, papers, and speakers.

AIAA Programs

Sessions-At-A-Glance

ICES101	Spacecraft and Instrument Thermal Design, Testing, and Technology
ICES102	Thermal Control for Planetary Surface Missions and Systems
ICES103	Thermal and Environmental Control of Exploration Vehicles and Surface Transport Subsystems
ICES104	On-Orbit Operations and Logistics of Thermal and Environmental Control Subsystems
ICES106	Space Station and Manned Orbiting Infrastructures Thermal Control
ICES107	Thermal and Environmental Control Engineering Analysis and Software
ICES108	Advances in Thermal Control Technology
ICES110	Thermal and Environmental Control of Commercial Spacecraft
ICES113	Spacecraft Propulsion Systems Thermal Control
ICES115	James Webb Space Telescope Thermal Control
ICES200	Physio-Chemical Processes: Air and Water
ICES201	Two-Phase Thermal Control Technology
ICES202	Satellite, Payload, and Instrument Thermal Control
ICES203	Thermal Testing
ICES204	Bioregenerative Life Support
ICES205	Advanced Life Support Sensor and Control Technology
ICES300	ECLSS and Thermal Modeling and Test
ICES301	Advanced Life Support Systems Control
ICES302	Physio-Chemical Life Support Process Development
ICES305	In-Situ Resource Utilization
ICES307	Orion Multi-Purpose Crew Vehicle Environmental Control and Life Support Systems
ICES308	Education and Outreach
ICES400	Extravehicular Activity: Space Suits
ICES401	Extravehicular Activity: Systems
ICES402	Extravehicular Activity: PLSS Systems
ICES403	Extravehicular Activity: Operations
ICES404	International Space Station ECLS: Systems
ICES405	International Space Station ECLS: Air and Water Systems
ICES406	Human/Robotics System Integration
ICES407	Spacecraft Water/Air Quality: Maintenance and Monitoring
ICES408	Regenerable Life Support Processes and Systems
ICES409	Airliner Cabin Air: Monitoring, Control, and Environmental Health Issues
ICES500	Life Science/Life Support Research Technologies
ICES501	Life Support Systems Engineering and Analysis
ICES511	Mission Assurance and Reliability Techniques for Environmental Systems
ICES502	Space Architecture
ICES503	Radiation Issues for Space Flight
ICES504	Management of Air Quality in Sealed Environments
ICES505	Microbial Factors Applied to Design
ICES506	Human Exploration Beyond Low Earth Orbit: Missions and Technologies
ICES508	Mars and Beyond
ICES509	Fire Safety in Spacecraft and Enclosed Habitats
ICES510	Lunar and Martian Dust Properties and Mitigation Technologies
ICES512	Human Rating for Space Systems
ICES513	Computational Modeling for Human Health and Performance Analysis





48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit

Future Propulsion: Innovative, Affordable, Sustainable

and

10th International Energy Conversion Engineering Conference (IECEC)

Aerospace Capabilities Applied to Solving Terrestrial Energy Problems—A Game Changer

30 July–1 August 2012
Hyatt Regency Atlanta Convention Center
Atlanta, GA

Joint Propulsion Conference Synopsis

AIAA, ASME, SAE, ASEE, and their industry partners proudly invite you to Atlanta, Georgia, for the 48th Joint Propulsion Conference (JPC) The design of our next-generation flight and space systems will be dependent more than ever on innovative technologies providing high performance, increasingly efficient, sustainable, reliable, and affordable propulsion systems. Our ability to design, test, and fly new aircraft and spacecraft propulsion technologies will have far-reaching impacts on the revolutionary roles these complex systems play in our everyday lives.

Come to Atlanta and be part of the exciting future of the aerospace propulsion industry. The objective of JPC 2012 is to identify and highlight how innovative aerospace propulsion technologies powering both new and evolving systems are being designed, tested, and flown. Flight applications include next-generation commercial aircraft, regional, and business jets, military applications, supersonic/hypersonic high-speed propulsion applications, commercial and government-sponsored launch systems, and orbital insertion, satellite, and interstellar propulsion. Special panel sessions to be announced will focus on advanced system applications that can be used to showcase propulsion systems and components, and the technologies that enable them.

Executive Chair (Government)
Robert Lightfood
Center Director
NASA Marshall Space Flight Center

Executive Chair (Industry)
Bart Olson
Vice President, Business Development
ATK Missile Products Group

General Chair (Government)
Frank Bauer
Chief Engineer, Exploration Mission Systems Directorate
NASA Headquarters

General Chair (Industry)
Gary Flinchbaugh
VP Programs
ATK Propulsion and Controls

Technical Chair
David McGrath
ATK Propulsion and Controls

Deputy Technical Chair
Gerard E. Welch
NASA Glenn Research Center

Academic Chair
Vigor Yang
Georgia Institute of Technology

Exhibits Chair
Geraldine Kimball
Pratt & Whitney Rocketdyne

ASME
John W. Robinson
The Boeing Company (Retired)

SAE
Ramon Chase
ANSER

ASEE
Robert A. Frederick Jr.
University of Alabama in Huntsville

10th International Energy Conversion Engineering Conference (IECEC)

The 10th International Energy Conversion Engineering Conference (IECEC) provides a forum to present and discuss engineering aspects of energy conversion technology, advanced energy and power systems, devices for terrestrial energy systems and aerospace applications, and the policies, programs, and environmental impacts associated with the development and utilization of this technology.

The IECEC is hosted by AIAA, which is joined this year by four Participating Organizations. These organizations are:

- The Heat Transfer Society of Japan (HTSJ)
- The IEEE Aerospace & Electronic Systems Society (AESS)
- The Egyptian Society of Mechanical Engineers (ESME)
- The Japan Society of Mechanical Engineers (JSME)

General Chair
Ramon Lugo
Director, NASA Glenn Research Center

Deputy General Chair
Robert "Joe" Shaw
NASA Glenn Research Center

Technical Program Chair
Michael Choi
NASA Goddard Space Flight Center

Deputy Technical Program Chair
Kenneth "Mark" Bryden
Iowa State University

Special Events

Opening Reception

The opening reception will be held Sunday, 29 July, 1830–2000 hrs, in the exhibit hall. 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.

Young Professional Networking Reception

The AIAA Young Professional Committee is hosting a networking reception for early career professionals on Monday, 30 July, at the Hyatt Regency Atlanta. This is a great opportunity for young professionals age 35 and under to meet and make new contacts. Join the AIAA Young Professional Committee for food, drinks, and relaxed socializing.

Accompanying Persons Program

Accompanying persons are invited to meet on Monday, 30 July, at 1000 hrs, at the Hyatt Regency Atlanta. Information about local attractions, activities, tours, shows, and restaurants will be available. Coffee and tea will be served.

Delta Accompanying Persons Tour

Tuesday 31 July (Busses will depart at 0830)

The museum's collections and facilities include: The Spirit of Delta, Delta's first 767, "Ship 41" (the first DC-3 to carry Delta passengers, a 1928 Waco 125 biplane, a 1931 Travel Air, and a 1936 Stinson Reliant SE. Also included are professionally managed archives of artifacts related to Delta and its ancestor airlines, an aviation reference library, and a replica of the first Delta station in Monroe, LA. Tickets are $15, including transportation, and available on a first-come, first-serve basis. Limit 50.

Networking Coffee Breaks

Networking coffee breaks for all attendees will take place in the exhibit hall. Times are designated in the program. Coffee and other beverages will be served.

Tuesday IECEC Awards Luncheon and Wednesday JPC Awards Luncheon

For those registration types that include the Award Luncheon tickets, those registrants that selected IECEC as their primary conference receive the Tuesday IECEC Awards Luncheon ticket and those that 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 pur-

Benefits of Attendance

Why Attend?

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

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

Who Should Attend?

- Engineering mangers and industry executives
- Engineers, researchers, and scientists
- Young aerospace professionals
- Educators and students

What to Expect?

Discussions with distinguished government and industry speakers.

- **Robert Lightfoot**, Center Director, NASA Marshall Space Flight Center
- **David Thompson**, CEO, Orbital Sciences Corp.
- **David Garrison**, Managing Director, Engine and Component Maintenance for Delta Tech Ops
- **Wes Harris**, Charles Stark Draper Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology
- **David Parekh**, Vice President of Research, Director, United Technologies Research Center
- **Ronald Sega**, Vice President of Energy and Environment, Institute of Energy and Environment, The Ohio State University

Networking and interaction with your peers during:

- Exhibits
- Continuing Education (two-day short courses)
- Sunday Evening Reception
- Coffee Breaks
- Awards Luncheon

	Sunday July 29, 2012	Monday July 30, 2012		
		IECEC	JPC Space & High Speed Systems	
700		Speaker's Briefing		
0800		Intro & Keynote Speaker Robert Lightfoot - Center Director, NASA MSFC		
0900		Coffee Break		Exhibits Hall Open
10:00		Panel Shuttle Space Transportation Replacement Options and Progress & IECEC Parallel Technical Sessions	Panel NASA MSFC National Institute for Rocket Propulsion Systems & JPC Parallel Technical Sessions	
Noon		Exhibit Hall Break/Lunch Reception Tickets Required		
1230				
1300		Keynote Speaker David Thompson, CEO Orbital Sciences Corp.		
1330				
1400		Panel Micro/Nano Thermal Management Technology for Aerospace, Energy and Environment & IECEC Parallel Technical Sessions	Panel Commercial Space Development & JPC Parallel Technical Sessions	
1430				
1500	Registration Open			
1530				
1600				
1630		Panel Combustion Characteristics of High Hydrogen Content Fuels & IECEC Parallel Technical Sessions	Panel Next Steps in Hypersonics —Turning Research into Reality JPC Parallel Technical Sessions	
1700				
1800				
1830				
1900 - 2100	Exhibit Hall Reception Tickets Required			

Tuesday July 31, 2012

IECEC	JPC Military and Commercial Aircraft Systems	
Speaker's Briefing	Speaker's Briefing	
IECEC Keynote Aerospace Capabilities Applied To Solving Terrestrial Energy Problems...A University View Ron Sega, The Ohio State University	**Keynote Speaker** **David Garrison, Managing Director - Engine and Component Maintenance for Delta Tech Ops**	
Break	Break	Exhibits Hall Open
Panel **Solar Absorption and Desiccant Cooling Technologies for Air Conditioning in Sunny Countries** **& IECEC Parallel Technical Sessions**	**Panel** Challenges for Future Commercial Aircraft Propulsion & JPC Parallel Technical Sessions	Exhibits Hall Open
IECEC Awards Luncheon Speaker: William Harrison III, Technical Advisor for Fuels and Energy, Air Force Research Laboratory Tickets Required	Exhibit Hall Break	Exhibits Hall Open
IECEC Awards Luncheon (continued)	**Panel** Interagency Propulsion Technology Development & JPC Parallel Technical Sessions	Exhibits Hall Open
IECEC Technical Sessions	**Panel** Interagency Propulsion Technology Development & JPC Parallel Technical Sessions	Exhibits Hall Open
IECEC Technical Sessions	Break	Exhibits Hall Open
Break	**Panel** Challenges for future rotorcraft propulsion & JPC Parallel Technical Sessions	
Panels I. The Future of Smart Grid in the United States and Abroad. II. Robust and Resilient System Design Approaches for Next Generation Terrestrial Nuclear Energy Systems & IECEC Parallel Technical Sessions	**Panel** Challenges for future rotorcraft propulsion & JPC Parallel Technical Sessions	

Time	Wednesday August 1, 2012				Thursday-Friday, 1-2 August 2012
	IECEC	**JPC** Commercial Aviation & Space Public Policy & Education			
700	**Speaker's Briefing**	**Speaker's Briefing**			**Continuing Education Courses**
0800	**IECEC Plenary** Aerospace Capabilities Applied to Solving Terrestrial Energy Problems...An Aerospace Industry View David Parekh	**Keynote Speaker** Wes Harris, Charles Stark Draper Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology	0830–1230 hrs **Lockheed Martin Tour** (Tickets Required)		
0900	Break (0830–9000); panels begin at 0930 hrs	Break (0830–9000); panels begin at 0930 hrs		Exhibits Open	
10:00	**Panel The Latest Advances in Radioisotope Power Systems – A Mission Perspective & IECEC Parallel Technical Sessions**	**Panel** Clipped Wings: Assessing U.S. Aeronautical Flight Research & JPC Parallel Technical Sessions			
Noon	Lunch Break				
1230		**JPC Awards Luncheon** Speaker: Wayne Roberts, LM Fellow, Chief of Test Pilots Tickets Required			
1300	**IECEC Technical Sessions**				
1330					
1400		NSTC Aeronautics S&T Subcommittee Public Outreach & JPC Parallel Technical Sessions			
1430					
1500					
1530					
1600					
1630					
1700					
1800					

For more detailed program information, visit the detailed agenda on the website at **www.aiaa.org/jpc2012** or **www.iecec.org** chased upon registration or at the on-site registration desk while supplies last.

Awards Presentation

The following AIAA awards are scheduled to be presented:

IECEC Awards Luncheon, Tuesday, 31 July
Aerospace Power Systems Award
Energy Systems Award

JPC Awards Luncheon, Wednesday, 1 August
Air Breathing Propulsion Award
Ground Testing Award
Engineer of the Year Award
Propellants and Combustion Award
Sustained Service Award
Wyld Propulsion Award

Lockheed Martin Marietta Tour

Wednesday 1 August, (Busses will depart at 0830 hrs)

The tour will be conducted at the Lockheed Martin Marietta facility, home of the C-130J Super Hercules advanced tactical aircraft production line and our C-5 Super Galaxy modernization production line. The visitors will get to see both production lines. Additionally, the visitors will get an overview of the site history and see the F35 JSF mid fuselage and P-3 wing production areas. Tickets are $15, include transportation, and available on a first-come, first-serve basis. Limit 50.

Exhibits

The 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit will feature an impressive exhibit showcasing leading industry products and services relating to air breathing, liquid, solid, nuclear, electric, and other forms of propulsion for aerospace.

Who Should Exhibit?

Companies involved in engine systems, environmental control systems, ground support equipment, software, testing, analysis, research and development, management, propellant tanks, thermal products, noise and vibration, and simulation components of propulsion technology are invited to bring their best and most innovative products to this conference and exhibit.

Why You Should Exhibit:

- Meet decision makers and network with your current customer base.
- Recruit conference attendees to a future career within your company.
- Answer questions about your products and services.
- Watch hands-on demos from partner organizations.
- Increase your visibility, branding, and name recognition.
- Attract prospective business.
- Meet and speak with conference VIPs as they tour the exhibit hall.

Exhibit Hall Hours:

Monday, 30 July	0900–1600 hrs
Tuesday, 31 July	0900–1600 hrs
Wednesday, 1 August	0700–1400 hrs

To reserve your exhibit space today, contact Fernanda Swan, AIAA Exhibit Business Manager, at 703.264.7622, 800.739.4422, or fernandas@aiaa.org.

Presentation Stage

AIAA is excited to provide this additional complimentary marketing opportunity for exhibitors within the exhibit hall. The presentation stage will give exhibitors the opportunity to showcase their company and products by giving a short presentation (15 minutes) in front of conference attendees during one of the show days. Seating and AV will be provided by AIAA. As space is limited the available slots will be confirmed on a first-come, first-served basis.

For more information, or to secure your spot, email Carmela Brittingham at carmelab@aiaa.org.

1st Propulsion Aerodynamics Workshop (PAW01)

Saturday, 29 July 2012

The workshop (PAW01), sponsored by the Air Breathing Propulsion Systems Integration Technical Committee, will focus on assessing the accuracy of CFD in obtaining multi-stream air breathing jet performance and flow structure. CFD studies will be performed as a blind trial and compared with the available experimental data. Example grids will be provided for unstructured and structured solvers as well as geometry and test conditions. Participants are encouraged to develop their own mesh also and may run one or more cases, on one or more grids. The workshop provides an impartial forum that will be utilized to present the findings, discuss the results, exchange ideas, and evaluate the effectiveness of existing computer codes and modeling techniques. The main objectives of the PAW01 are to:

- Assess the numerical prediction capability (e.g., mesh, numerics, turbulent modeling) of current-generation CFD technology/codes for air breathing propulsion related aerodynamic flows.
- Develop practical CFD guidelines for 2-D and 3-D CFD prediction of jet related flow fields.
- Enable development of more accurate prediction methods, processes, procedures, and tools.
- Provide an impartial forum for evaluating existing CFD codes and modeling techniques.

For more information, visit **http://aiaapaw.tecplot.com**.

Application forms can be downloaded from the website. A returned signed application with an abstract is required to initialize the process. **This one-day workshop has a separate registration fee and does not include conference attendance.** Participation in the studies is not required to attend the workshop. Scholarships are available for qualified academic and retired participants.

Workshop results will be summarized into a conference paper to be presented at the next JPC conference. Best work and presentation for each of the cases will be selected and awarded.

Cyber Café

Computers with complimentary Internet access for conference attendees will be available at the AIAA Cyber Café, located in the exhibit hall. Hours of operation are as follows:

Monday, 30 July	0700–1800 hrs
Tuesday, 31 July	0700–1800 hrs
Wednesday, 1 August	0700–1400 hrs

Conference Proceedings

Proceedings for these conferences will be available in an online format. The cost is included in the registration fee where indicated. The online proceedings will be available on **23 July 2012**. Attendees who register in advance for the online pro-

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.

On 2–3 August at the Hyatt Regency Atlanta, AIAA will be offering Continuing Education courses in conjunction with the AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit. Please check the conference website for up-to-date information regarding the courses. Register for any course and attend the conference for FREE! (The course registration fee includes full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.)

Please note that course materials will not be distributed on site. AIAA and your course instructor highly recommend that you bring your computer with the course notes already downloaded. Once you have registered for the course, the course notes will be available about two weeks prior to the course event, and remain available to you in perpetuity.

Hybrid Rocket Propulsion

The "Hybrid Rocket Propulsion" short course is quintessential for all professionals specializing in chemical propulsion. The mechanisms associated with hybrid combustion and propulsion are diverse and affect our abilities to advance and sustain the development of hybrid technology successfully. It is our penultimate goal to promote the science of hybrid rocketry, which is safe enough to be used in both academia and the private sector. A historical demonstration of hybrid rocket capability is the 2004 X-prize winner SpaceShipOne. This technology can also be used in outreach activities when used in conjunction with hands-on design projects and payload launches that involve student teams. Interest in hybrid rocketry can thus be translated into increased awareness in science and technology, helping to alleviate the persistent attrition in our technical workforce. This course reviews the fundamentals of hybrid rocket propulsion with special emphasis on application-based design and system integration, propellant selection, flow field and regression rate modeling, solid fuel pyrolysis, scaling effects, transient behavior, and combustion instability. Advantages and disadvantages of both conventional and unconventional vortex hybrid configurations are examined and discussed.

Advanced Solid Rockets

Instructors: David Poe, Gainesville, VA; Dr. Robert Frederick, Professor, University of Alabama at Huntsville Propulsion Research Center, Huntsville, AL

Solid propulsion is vital to tactical, space, strategic and launch vehicles. The course examines fundamental and advanced concepts related to solid rockets. Theoretical and practical aspects of the field are covered. This course is based on the "Advanced Solid Rocket Propulsion" graduate-level mechanical engineering course taught at the University of Alabama at Huntsville (UAH). All instructors are experienced solid rocket experts and many were involved with the UAH course. The individual presentations included in this short course include broad rocket motor and system design principles, internal ballistics modeling, propellant fundamentals, component design (motor case, nozzle, and igniters), component and motor manufacturing, combustion instability, and motor failures.

Hydrogen Safety

The Hydrogen Safety course is intended to provide the student with a working knowledge of safety issues associated with the use of hydrogen. Using the aerospace industry standard, "Guide to Safety of Hydrogen and Hydrogen Systems" (AIAA G-095-2004), this course presents basic safety philosophy and principles and reviews a practical set of guidelines for safe hydrogen use. The information presented in this course is intended as a reference to hydrogen systems design and operations and handling practices; users are encouraged to assess their individual programs and develop additional requirements as needed.

NPSS: A Practical Introduction

The objective of this course is to give attendees a working knowledge of NPSS software and allow them to create and/or modify system models using this tool. The course material will discuss the object-oriented architecture and how it is used in NPSS to develop flexible yet robust models. A detailed presentation of NPSS execution options, syntax, and interfaces with external codes will be addressed. Overviews of NPSS operation (i.e., Solver, etc.) will also be included.

The attendees will be interactively involved with the material by performing exercises on their personal hardware that demonstrates and further clarifies the material being discussed in the lecture. All attendees will be provided with a reduced capability version of NPSS for their use during the course and will be permitted to keep it after the course is completed.

Missile Design and System Engineering

This short course provides the fundamentals of missile design, development, and system engineering. A system-level, integrated method is provided for missile configuration design and analysis. It addresses the broad range of alternatives in satisfying missile performance, cost, and risk requirements. Methods are generally simple closed-form analytical expressions that are physics-based, to provide insight into the primary driving parameters. Configuration sizing examples are presented for rocket, turbojet, and ramjet-powered missiles. Systems engineering considerations include launch platform integration constraints. Typical values of missile parameters and the characteristics of current operational missiles are discussed as well as the enabling subsystems and technologies for missiles. Sixty six videos illustrate missile development activities and performance. Attendees will vote on the relative emphasis of types of targets, types of launch platforms, technical topics, and roundtable discussion.

For detailed information on these courses, visit the AIAA website at www.aiaa.org.

AIAA **Programs**

Option	Registration Type	Member Before 2-Jul-12	Nonmember Before 2-Jul-12	Conference Sessions	Exhibits	Sunday Reception	Monday Lunch Reception	IECEC Tuesday Awards Lunch **or** JPC Wed. Awards Lunch*	Online Proceedings
Option 1	**Full Conference**	**$730**	**$885**	●	●	●	●	●	●
Option 2	**AIAA Undergraduate Student**	**$20**	**$50**	●					
Option 3	**AIAA Undergraduate Student with Networking**	**$192**	**$222**	●	●	●	●	●	
Option 4	**AIAA Graduate or PH.D. Student**	**$60**	**$90**	●					
Option 5	**AIAA Graduate or PH.D. Student with Networking**	**$232**	**$262**	●	●	●	●	●	
Option 6	**AIAA Retired Member**	**$40**	**n/a**	●	●	●	●	●	
Option 7	**Group Rate****	**$657**	**n/a**	●	●	●	●	●	●
Option 8	**Continuing Education Courses**	**$1,256**	**$1,343**	●	●	●	●	●	●
	Extra Tickets					$65	$55	$52	$170
	Tuesday Delta Accompanying Persons Tour	**$15**							
	PAW Workshop	**$307**	**$307**						
	Lockheed Martin Tour	$15							

Pricing subject to change.

*IECEC registrants will receive a ticket to the Tuesday IECEC Awards Luncheon. JPC registrants will receive a ticket to the Wednesday JPC Awards Luncheon. All registrants are invited to purchase a ticket to the other awards luncheon at an additional charge.

**Advance only. 10% discount off AIAA 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. Includes sessions, all catered events, and single-user access to online proceedings. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be received by the preregistration deadline of 25 July 2012.

ceedings will be provided with instructions on how to access them. If registering on site, you will be provided with instructions then.

Registration Information

AIAA is committed to sponsoring world-class conferences on current technical issues in a safe and secure environment. Delegates will be required to provide proper identification prior to receiving a conference badge and associated materials. All delegates must provide a valid photo ID (driver's license or passport) when they check in. For student registrations, a valid student ID is also required. We thank you for your cooperation.

On-Site Registration Hours

On-site registration will be held at the Hyatt Regency Atlanta as follows:

Sunday, 29 July	1500–1900 hrs
Monday, 30 July	0700–1800 hrs
Tuesday, 31 July	0700–1800 hrs
Wednesday, 1 August	0700–1700 hrs

Meeting Site

Only in Atlanta, Georgia, can you…

…see the largest fish through the largest window in the largest aquarium in the world.

Head to the Georgia Aquarium, where you can see tens of thousands of animals in more than 8 million gallons of water. The world's largest aquarium houses whale sharks, the largest fish in the sea and the only whale sharks in an aquarium in North America.

…stroll through the collections of art from around the world without leaving Atlanta.

The High Museum of Art, the premier art museum in the South, is in the midst of a multi-year partnership with The Museum of Modern Art. Through 2013, the partnership will bring many international exhibitions to Atlanta. Past exhibitions have included masterpieces by Claude Monet and Leonardo da Vinci.

…try a "Coke and a smile."

Born and raised in Atlanta, Coca-Cola is synonymous with our city. Visit the World of Coca-Cola to learn the story of the famous soft drink, now celebrating its 125th year. Go back to the early years of Coke's creation in Atlanta and follow the global brand through the decades. After you've refreshed yourself with more than 60 products from around the world, step out of the museum's front door and into the hub of the tourism district.

…race the gold shoes for a gold medal.

As host of the 1996 Centennial Olympic Games, Atlanta continues to commemorate the Olympic legacy. Centennial Olympic Park was the world's gathering place during the Games and includes the Fountain of Rings, the world's largest fountain utilizing the Olympic symbol of five interconnecting rings.

Hotel Reservations

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

Hyatt Regency Atlanta
265 Peachtree Street NE,
Atlanta, Georgia, USA 30303
Tel: +1 404 577 1234; Fax: +1 404 588 4137
Reservations: 888.421.1442

Room rates are $145 per night for single or double occupancy plus applicable taxes. Please identify yourself as being with the AIAA conference. These rooms will be held for AIAA until **28 June 2012** or until the block is full. After 28 June 2012, any unused rooms will be released to the general public. You are encouraged to book your hotel room early.

Government Employees—There are a limited number of sleeping rooms available at the government per diem rate. Government I.D. is required upon check-in.

Step into the 22-story Atlanta hotel atrium lobby and you'll understand the difference between a hotel and a Hyatt. The award-winning Hyatt Atlanta hotel places the treasures of the city at your feet. Stroll to top local downtown Atlanta attractions including Peachtree Center Mall, Georgia Aquarium, Georgia World Congress Center, AmericasMart, CNN Center, Phillips Arena, and Georgia Dome.

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 Event Preview 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!

Car Rental

Hertz Car Rental Company saves members up to 15% on car rentals. The discounts are available at all participating Hertz locations in the United States, Canada, and where possible, internationally. For worldwide reservations, call your travel agent or Hertz directly at 800.654.2200 (U.S.) or 800.263.0600 (Canada). Mention the AIAA members savings CDP #066135 or visit www.hertz.com. Don't forget to include the CDP number.

The organizing committee would like to thank the following companies for their support of the 2012 JPC and IECEC Conferences: ATK, NASA MSFC, Lockheed Martin Aeronautics Company, Jacobs Technology, U.S. Army Research, Development & Engineering Command (ARMDEC), Battelle Memorial Institute, and the Japan Aerospace Exploration Agency (JAXA).

Special Thanks to the Topic Area Organizers who help put together the technical program.

JPC Topic Area Organizers

Advanced Propulsion Concepts for Future Flight
John W. Robinson
The Boeing Company (Retired)

Air-Breathing Propulsion Systems Integration
Michelle L. McMillan
SynGenics Corporation

Gas Turbine Engine
Gerard E. Welch
NASA Glenn Research Center

High Speed Air-Breathing Propulsion
Venkat Tangirala
General Electric Global Research Center—Combustion Technologies

Hypersonic and Combined Cycle Propulsion
Tim O'Brien
Aerojet

Electric Propulsion
Eric Pencil
NASA Glenn Research Center

Emerging Commercial Space Propulsion
Bruce Pittman
NASA Space Portal,
NASA Ames Research Center

Energetic Components and Systems
Steven F. Son
Purdue University

Hybrid Rocket Propulsion
Brian Evans
Space Propulsion Group

Liquid Rocket Propulsion
Ivett A. Leyva
Air Force Research Laboratory

Nuclear and Future Flight Propulsion
Greg Meholic
The Aerospace Corporation

Propellants and Combustion
Christopher Brophy
Naval Postgraduate School

Propulsion Education
Robert A. Frederick Jr.
University of Alabama in Huntsville

Public Policy
Carol Cash
Carol Cash & Associates

Solid Rocket Propulsion
Mark T. Langhenry
Raytheon Missile Systems

Space Transportation and Future Generation Space Transportation
Leo Daniel
Massachusetts Institute of Technology

IECEC Topic Area Organizers

Aerospace Power Systems
Mark Liffring
The Boeing Company

Abbas Salim
Lockheed Martin Space Systems (Retired)

Energy Conversion Device Technology
Edward Lewandowski
NASA Glenn Research Center

Energy Storage Technology
Richard Shaw
Lockheed Martin Space Systems

Terrestrial Electricity Delivery & Grid Reliability
Bill Lear
University of Florida

Terrestrial Energy-Efficient & Renewable Energy Systems
Thomas Bradley
Colorado State University

Essam Khalil
Cairo University, Cairo, Egypt

Terrestrial Fossil Energy Systems
Ahsan Choudhuri
University of Texas at El Paso

Terrestrial Nuclear Energy Systems
Pavel Tsvetkov
Texas A&M University

Thermal Management Technology
Michael Choi
NASA Goddard Space Flight Center

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

8–11 April 2013
Boston Park Plaza Hotel &Towers
Boston, Massachusetts

Abstract Deadline: 5 September 2012

Abstract Submittal Guidelines for SDM Conferences

Abstract submissions will be accepted electronically through the AIAA website at **www.aiaa.org/sdm2013**. The website will open for abstract submission on **9 May 2012**. The deadline for receipt of abstracts via electronic submittal is **5 September 2012**. The electronic submission process is as follows:

1) Access the AIAA website at **www.aiaa.org/sdm2013**.
2) On the right-hand side, click the "Submit Paper" button.
3) To access the submission site, you must be logged in to the AIAA website.
a. If you already have an account with AIAA, enter your User Name and Password in the "Login" box on the left-hand side and click the arrow button.
b. If you do not have an account with AIAA, complete the steps for "Create Account".
4) Once logged in, you will be provided an active link for "Begin a New Submission or View a Previous Draft/Submission". Click the link to be directed to the Welcome page of the submission site.
5) Click the Submission tab at the top of the page to begin your submission.
6) Once selected, you will be provided with general information on the conference's abstract submission requirements and policies. To begin the submission, click the "Create a New Submission" link on the left-hand side. ***Please Note***: If you have previously visited the site and begun a draft submission, click the "View Submissions" link on the left-hand side to resume your submission.

Special Notes

1) If authors wish to revise an abstract that has already been submitted, they must go to "View Submissions" and select "Return to Draft" to make any corrections. This removes the abstract from the organizers' view. Authors then need to submit the abstract again for it to be considered. An abstract cannot be returned to draft if it has been reviewed.
2) All student papers authors must notify Prof. John Whitcomb, Student Papers Chair (email: jdw@tamu.edu) of their abstract number to be considered for the student paper competition.
3) Once the abstract submission deadline passes, authors will no longer be able to submit new submissions or return previous submissions to draft for revisions. Be sure that all of your submission data—authors, keywords, title, and abstract file—are accurate before finalizing your submission as no modifications can be made to this data after the submission site closes.
4) The author designated as the presenter at step 4 will be the only person given access to upload the final manuscript for accepted submissions.

Authors having trouble submitting abstracts electronically should email AIAA technical support at **ts.acsupport@thomson.com**. Questions about the abstract submission or full draft manuscript themselves should be referred to the appropriate Technical Chair.

The deadline for receipt of abstracts via electronic submission is **5 September 2012, 2359 hrs, Eastern Time, USA**.

Selection of papers for all conference sessions will be based on extended abstracts of no less than 1,000 words (5–6 pages in length with 12-point font, including cover page, figures, tables and text) in which the authors must clearly identify the aspects of the work that are new and significant. The extended abstract or draft paper should clearly describe the purpose and scope of the work to be included in the final manuscript, methods used, key results, and contributions to the state of the art. The submittal should include illustrations and data that support the results and contributions asserted.

Both abstracts and final manuscripts must address the accuracy of results adequately. Abstracts will be reviewed and selected based on technical content, originality, importance to the field, clarity of presentation, accuracy validation, and the potential to result in a quality final manuscript. Note that all abstracts are chosen by a competitive process based on anonymous peer review using these criteria. The review and acceptance process will be weighted in favor of authors submitting more relevant documentation of their proposed papers. The length of the final manuscript should be appropriate for a conference paper, not a major project, final report, or final thesis.

The abstract should not be submitted to more than one technical topic. If an author is unsure which topic is most appropriate, it is the author's responsibility to communicate with the technical topic organizers in question well before the abstract deadline to determine the topic area under which the abstract best fits. There will be too little time in the review process for an abstract rejected by one topic to be considered for review under another.

Questions pertaining to the abstract or technical topics should be referred to the corresponding technical topic chair.

Authors will be notified of paper acceptance or rejection on or about **28 November 2012**. Instructions for preparation of final manuscripts will be provided by AIAA for accepted papers only.

"No Paper, No Podium" Policy

If a written paper is not submitted by the final manuscript deadline, authors will not be permitted to present the paper at the conference. It is the responsibility of those authors whose papers or presentations are accepted to ensure that a representative attends the conference to present the paper. This policy is intended to improve the quality of the conference for attendees.

Publication Policy

AIAA will not consider for presentation or publication any paper that has been or will be presented or published elsewhere. Authors will be required to sign a statement to this effect.

Final Manuscript Guidelines

An Author's Kit containing detailed instructions and guidelines for submitting papers will be made available to authors of accepted papers. Authors must submit their final manuscripts via the conference website no later than **19 March 2013**.

Warning—Technology Transfer Considerations

Prospective authors are reminded that technology transfer guidelines have considerably extended the time required for review of abstracts and completed papers by U.S. government agencies. Internal (company) plus external (government) reviews can consume 16 weeks or more. Government review if required is the responsibility of the author. Authors should determine the extent of approval necessary early in the paper preparation process to preclude paper withdrawals and late submissions. The conference technical committee will assume that all abstracts, papers, and presentations are appropriately cleared.

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.

Important Dates

Website Open for Abstract Submission	9 May 2012
Abstract Deadline	5 September 2012
Author Notification	28 November 2012
Final Manuscript Deadline	19 March 2013

54TH AIAA/ASME/ASCE/AHS/ASC STRUCTURES, STRUCTURAL DYNAMICS, AND MATERIALS CONFERENCE

Materials Genome to Flight-Worthy Innovative Structures

The 54th Structures, Structural Dynamics, and Materials Conference (SDM) is sponsored by AIAA, ASME, ASCE, AHS, and ASC. This established annual conference is a widely acknowledged event that provides a unique forum dedicated to the latest developments in the collective disciplines of structures, structural dynamics, materials, design engineering, and survivability. The 54th Conference will also host the 21st AIAA/ASME/AHS Adaptive Structures Conference, the 15th AIAA Non-Deterministic Approaches Conference, the 14th AIAA Dynamic Specialist Conference, the 14th AIAA Gossamer Systems Forum, and the 9th AIAA Multidisciplinary Design Optimization Specialist Conference. Plenary presentations, given by recognized, forward-thinking invited speakers, will be a special feature of the conference. This year's presentations will address integration of fundamentals of materials development to structural design to enable accelerated materials technology transition to efficient and innovative flight-worthy aircraft and spacecraft structures.

Structures

The field of structures encompasses the mechanics of metallic and nonmetallic components and their composite derivatives obeying elastic and inelastic constitutive laws. Specific areas of interest include the following: thermal response; structural stability and post-buckling behavior; computational structural mechanics; nondeterministic methods, probabilistic design, and uncertainty analysis; weight, reliability, and design cycle cost tradeoffs; structural integrity; durability and damage tolerance; damage detection, structural health monitoring, and novel repair concepts; advanced applications; development; verification, validation, and qualification; knowledge-based engineering; and simulation-based design. Also of interest are papers outlining structural development, analysis, and testing related to current programs and events such as Space Shuttle replacement, space exploration, and current civil and military aircraft programs. Papers are particularly encouraged that emphasize the development and fielding of innovative structural systems including multifunctionality; coupling amongst computational, analytical, and experimental methods; coupling of design and manufacturing to enhance affordability; and techniques for design/analysis cycle time reduction.

Structural Dynamics

The field of structural dynamics covers experimental, analytical, and computational methods for determining the response of aerospace systems to a variety of external and internal disturbance sources. Papers are solicited that address linear and nonlinear response of systems due to gusts, acoustics, impact, shock, thermal and operational loads. In addition, papers are requested that describe the development and implementation of active/passive approaches to vibration suppression, aeroelasticity, and fluid-structure interactions in fixed-wing and rotary-wing aircraft, spacecraft, and hypersonic vehicles with transient thermally induced dynamic loads.

Materials

In the field of materials, papers are sought on topics related to current and cutting-edge research and development of aerospace and non-aerospace materials. Submissions are encouraged in topic areas that include modeling, synthesis, processing, testing, and characterization. Application papers may include, but are not limited to, structural and nonstructural, adaptive, smart, and affordable materials. Special focus areas include multifunctional materials and their effects on structural systems, material development, constitutive models, novel experimental methods, coatings and protection, optimization, trade studies, lifecycle studies, affordability, inspection, repair, maintenance, and environmental impact. Papers on experimental and analytical methods that lead to understanding of mechanical performance, environmental sensitivity, fatigue and fracture, time- and rate-dependent behavior, durability, damage tolerance, aging, and in-service performance are included in this solicitation. Special emphasis will be given to new and emerging technologies, such as nanostructured materials, multidimensional composites, cryogenic materials, advanced fiber forms, polymers, metallics, lightweight and super-lightweight materials, and multifunctional materials.

Design Engineering

Papers are solicited on current design engineering and design process activities. Design-oriented papers should focus on innovative, novel, or otherwise distinctive designs or concepts resulting in or leading toward products that effectively satisfy requirements or demonstrate design efficiency improvements. Emphasis on current aerospace programs such as commercial access to space, very light business jets, NASA Environmentally Responsible Aviation, ESTOL, satellites, missile systems, Unmanned Air Systems, and service life extension projects are encouraged. The definition, application, and implementation of emerging design tools resulting in significant design-cycle time reduction and reduced program cost and risk should be emphasized.

Design process-oriented papers should focus on current design engineering process activities, such as process definition, analysis, architecture, and metrics, as applied to aerospace hardware products from the exploratory design phase through the detailed design phase. Papers on the advances in model-based design processes and related activities are especially encouraged. Other design engineering process-related activities that may be addressed are the interaction between processes and tools, impact of tool integration on a process, and risk reduction from the use of higher-fidelity tools earlier in the design process. Other enablers to reducing design cycle time and cost while increasing the ability to meet all cost, schedule, and technical requirements may also be addressed.

Education-oriented papers are solicited that emphasize design in curriculum development, class content, and student activities. Successful examples are especially requested.

Survivability

The field of survivability encompasses technologies for assessing and improving the survivability of air and space platforms. Papers are solicited on such topics as integrated subsystem design for survivability, survivability assessment, susceptibility and vulnerability reduction, and survivability/susceptibility/vulnerability modeling, and simulation methodologies. Air system survivability topics also include end-game and hit-point analysis, common issues between safety and survivability, live-fire testing, and damage repair. Space system survivability topics may address directed energy and kinetic energy threats as well as natural hazards such as radiation and the meteoroid/orbital debris environment.

Wind Energy Technology

For a fifth consecutive year, papers are solicited for a broad range of topics related to structures, structural dynamics, and materials research, development, and applications to wind energy technology. Materials topics include composites and new material characterization, fatigue and failure analyses, structural joining, and coatings and core materials for blades. In the area of aeroelasticity, topics include fluid structure interaction, computational and analytical methods, reduced-order modeling, and stability analysis. Blade and turbine design and analysis topics include structural and structural dynamics analysis, structural optimization, multi-objective design, damping devices, and full system dynamics modeling. A number of emerging areas of research are also of interest including innovations for large wind turbine structures, offshore technology, turbine controls for load alleviation and energy capture improvement, loads estimation and loads forecasting, system identification including operational modal analysis (OMA), adaptive structures, novel sensors and actuators, structural health monitoring, verification and validation, acoustics and thermal applications, and probabilistic methods.

Specially Organized Technical Sessions

Individuals or groups who wish to organize paper sessions or panel discussions that focus on specific topical issues should provide detailed information to the Technical Program Chair by **9 July 2012** that describes the background of the proposed session, its topical issues, and potential speakers, and clearly identifies the organizers and participants. Abstracts submitted for the special session must be submitted by **5 September 2012** online at **www.aiaa.org/sdm2013** for inclusion in the normal paper selection process.

Student Papers

Student papers should report on work primarily conducted by students in collaboration with their faculty advisors; therefore, all primary authors of papers submitted as student papers must be students at the time the abstract is submitted for consideration. Student papers will be presented during regular sessions and will be suitably recognized. A limited number of students will receive recognition for their papers at the SDM conference awards luncheon. Student paper awards include the Jefferson Goblet Student Paper Award, the Harry H. and Lois G. Hilton Student Paper Award in Structures, the Lockheed Martin Student Paper Award in Structures, and the American Society for Composites Student Paper Award.

Student paper awardees will be selected on the basis of paper quality and the effectiveness of the students' presentations. Finalists for student paper awards will be required to present their papers in both the assigned conference technical session and possibly in an additional evening award selection session prior to the conference awards luncheon. Award selection panels are comprised of representatives from SDM technical committees. Papers not presented by students will not qualify for awards. Interested individuals should submit abstracts clearly identified as student papers through AIAA's website at **www.aiaa.org/sdm2013** by **5 September 2012**. Full papers accepted for conference presentation are due **19 March 2013**. The notation "SDM 2013 Student Papers Competition" must be placed above the title of the paper on the first page of the abstract to be eligible for the competition. Questions about the abstracts themselves or manual abstract submissions should be referred to the Student Papers Technical Chair, Prof. John Whitcomb, Aerospace Engineering Department, Texas A&M University, email: jdw@tamu.edu.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

General Chair
Anthony M. Waas
University of Michigan
734.764.8227
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21ST AIAA/ASME/AHS ADAPTIVE STRUCTURES CONFERENCE

The 21st Adaptive Structures Conference, sponsored by AIAA, ASME, and AHS, will be held in conjunction with the 54th Structures, Structural Dynamics, and Materials Conference. The Adaptive Structures Conference is the premier conference focused on the advancement of adaptive structures technology and its application to aerospace systems. This conference brings together basic and applied researchers from diverse disciplines in academia, government, and industry; as such, the range of relevant topics is quite broad. Topics may include, but are not limited to:

- adaptive and morphing aircraft (fixed, rotary, and flapping wing aircraft as well as hybrids)
- adaptive space and planetary vehicles and systems
- modeling, simulation, optimization, design, validation, and certification of adaptive and multifunctional structures
- structural health monitoring for damage detection and material state awareness
- data and information processing for structural health management
- novel structural concepts to support adaptive structures
- active noise, vibration, and aeroelastic control
- smart sensor and actuator device design and structural integration
- smart and multifunctional materials including formulation, characterization, long-term durability, and modeling

Please join us in Boston with researchers from around the world at the foremost conference on Adaptive Structures.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

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15TH AIAA NON-DETERMINISTIC APPROACHES CONFERENCE

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

Authors are invited to submit abstracts for papers on all aspects of non-deterministic approaches associated with the design, analysis, fabrication, operation, structural health management, and condition-based maintenance of aerospace systems. Non-deterministic approaches to emerging technologies such as biotechnology, genetics, social dynamics, nanotechnology, and information technology are also welcome. Previous NDA papers have featured the development of general non-deterministic approaches and applications in the following areas: fundamental analytical NDA solution methods; stochastic simulation and stochastic finite element methods; reliability-based optimization and design; random fatigue and fracture; materials characterization; simulation, assessment, and certification of multidisciplinary systems; structural health management; reliability updating; and model verification and validation, among many others.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

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14TH AIAA DYNAMIC SPECIALIST CONFERENCE

The 14th AIAA Dynamics Specialists Conference will be held in conjunction with the 54th Structures, Structural Dynamics, and Materials Conference. The conference theme is emerging structural dynamics technologies that will enable development of the next generation of aerospace vehicle systems including Micro Air Vehicles (including flapping wing approaches), Unmanned Air Vehicles, Rotorcraft and Tilt-Rotors, Composite Business Jets and Transports, Military Aircraft, Quiet Supersonic Aircraft, Hypersonic Vehicles, Commercial Launch Vehicles, Space Exploration Vehicles, Ultralight (thin-membrane or sandwich) Structures, Turbomachinery, and Next Generation Large-Scale Off-Shore Wind Turbines. The focus is on unique structural dynamic issues and their solutions that will enable these new systems to meet and/or exceed their requirements. Areas of specific interest include, but are not limited to: structural dynamics; nonlinear dynamics and stability; passive damping and active control; aeroelasticity (including computational fluid dynamic modeling approaches, reduced-order aerodynamic models for nonlinear analyses, modeling uncertainties, and innovative experimental approaches); aeroservoelasticity; aerothermoelasticity; dynamic test techniques; aircraft loads and dynamics; extreme loading environments; acoustics and noise; limit cycle oscillation; energy harvesting; and structural health monitoring and prognosis.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

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14TH AIAA GOSSAMER SYSTEMS FORUM

An emerging class of large-scale, lightweight structures is enabling a paradigm shift in design, launch, and operation of spaceflight systems. Spacecraft with structural characteristics optimized for operation in space and for the ability to collapse into small packages for launch yield order-of-magnitude reductions in mass, launch volume, and life-cycle cost of large spaceflight systems. The objective of the Gossamer Systems Forum is to provide an opportunity to discuss recent research findings and newly proposed concepts emerging from this technology. Subjects of interest include requirements, systems, analyses, design, materials, subsystems, manufacturing, qualification, standards, and databases related to lightweight spacecraft systems and/or deployable spacecraft system. Applications of interest for space systems include, but are not limited to, antennas, radiators, sun shields, solar sails, solar arrays, reflectors, concentrators, optics, telescopes, collectors, occulters, habitats, ballutes, and landing balloons. Papers of interest include technical issues related to system concepts, applications, simulation tools, pressurization, materials, structures, structural dynamics, controls, thermal control, rigidization, deployment, packaging, mechanisms, space environmental effects, ground testing, model verification, manufacturing inspection, flight testing, and other activities necessary for development of reliable gossamer-class spacecraft systems.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

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9TH AIAA MULTIDISCIPLINARY DESIGN OPTIMIZATION SPECIALIST CONFERENCE

Multidisciplinary design optimization (MDO) focuses on optimizing the performance and reducing the costs of complex systems that involve multiple interacting disciplines, such as those found in aircraft, spacecraft, automobiles, industrial manufacturing equipment, and various consumer products, and also on the development of related methodologies. MDO is a broad area that encompasses design synthesis, sensitivity analysis, approximation concepts, optimization methods and strategies, artificial intelligence, and rule-based design—all in the context of integrated design dealing with multiple disciplines and interacting subsystems or systems of systems. Contributions to large-scale MDO applications in high performance and distributed computing environments, novel visualization and interaction approaches, and single discipline optimization methods—provided they enhance and support multidisciplinary applications—are also welcome.

See Abstract Submittal Guidelines section at the beginning of the SDM calls (page B33) regarding procedures for abstract submission, information on publication policy, and technology transfer considerations.

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Upcoming AIAA Professional Development Courses

21–22 April 2012

The following Continuing Education classes are being held at the 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference; the 20th AIAA/ASME/AHS Adaptive Structures Conference; the 14th AIAA Non-Deterministic Approaches Conference; the 13th AIAA Gossamer Systems Forum; and the 8th AIAA Multidisciplinary Design Optimization Specialist Conference in Honolulu, Hawaii. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for an SDM course, go to **www.aiaa.org/SDM2012.**

	Early Bird by 26 Mar	*Standard (27 Mar–20 Apr)*	*On-site (21–22 Apr)*
AIAA Member	$1260	$1360	$1460
Nonmember	$1338	$1438	$1538

Fundamentals of Composite Structure Design **(Instructor: Rikard Heslehurst, Senior Lecturer, School of Aerospace, Civil and Mechanical Engineering of the University College, UNSW at the Australian Defense Force Academy)**

This seminar has been developed specifically for engineers who require some fundamental understanding of the structural design requirements for composites. The application of composite materials is discussed initially in terms of the constituent component material properties and manufacturing processes based on the design requirements analysis. The tailoring of structural properties through lamination and fiber orientation placement are discussed in relationship to strength of materials issues and load/deformation response. This seminar will cover the design requirements of stress analysis for the design detail such as joints, structural stiffening against instability, and other structural discontinuities.

Introduction to Bio-Inspired Engineering **(Instructor: Chris Jenkins, Head of Mechanical & Industrial Engineering, MSU, Bozeman, MT)**

The primary purpose of this course is to inform engineers and other technical professional in the use of bio-inspired engineering (BiE) to expand the design space of possible solutions to technical problems. We do that by first understanding how nature solves problems and learning how to translate biological knowledge into engineering practice.

Aeroelasticity: State-of-the-Art Practices **(Instructors: Dr. Thomas W. Strganac, Texas A&M University, College Station, TX; Dr. Carlos E. S. Cesnik, University of Michigan; Dr. Walter A. Silva, NASA Langley Research Center; Dr. Jennifer Hegg, NASA Langley Research Center; Dr. Paul G. A. Cizmas, Texas A&M University; Paul Taylor, Principal Engineer and Group Head for the Dynamics Group at Gulfstream Aerospace in Savannah, GA)**

This course provides a brief overview of aeroelasticity and examines many new "fronts" currently being pursued in aeroelasticity that include reduced-order models, integrated fluid-structural dynamic models, ground vibration testing, wind tunnel tests, robust flutter identification approaches for wind tunnel and flight test programs, aeroservoelasticity, and aeroelasticity of very flexible aircraft. The course will emphasize current practices in both analytical and experimental approaches within industry and government labs, as well as advances as pursued by these organizations with the support of university research.

Introduction to Non-Deterministic Approaches **(Instructor: Dr. Ben H. Thacker, Director, Materials Engineering Department, San Antonio, TX; Dr. Michael P. Enright, Principal Engineer, Materials Engineering Department, San Antonio, TX; Dr. Sankaran Mahadevan, Professor, Civil, Environmental and Mechanical Engineering, Vanderbilt University, Nashville, TN; Dr. Ramana V. Grandhi, Professor, Department of Mechanical and Materials Engineering, Wright State University, Dayton, OH)**

This course is offered as an introduction to methods and techniques used for modeling uncertainty. Fundamentals of probability and statistics are covered briefly to lay the groundwork, followed by overviews of each of the major branches of uncertainty assessment used to support component and system level life cycle activities, including design, analysis, optimization, fabrication, testing, maintenance, qualification, and certification. Branches of Non-Deterministic Approaches (NDA) to be covered include Fast Probability Methods (e.g., FORM, SORM, Advanced Mean Value, etc.), simulation methods such as Monte Carlo and Importance Sampling, surrogate methods such as Response Surface, as well as more advanced topics. An overview of emerging non-probabilistic methods for performing uncertainty analysis will also be presented.

2–3 June 2012

The following Continuing Education class is being held at the 18th AIAA/CEAS Aeroacoustics Conference in Colorado Springs, Colorado. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for the Aeroacoustics course, go to **www.aiaa.org/Aeroacoustics2012.**

	Early Bird by 7 May	*Standard (8 May–1 Jun)*	*On-site (2–3 Jun)*
AIAA Member	$1278	$1378	$1478
Nonmember	$1355	$1455	$1555

Phased Array Beamforming for Aeroacoustics **(Instructor: Robert P. Dougherty, Ph.D., President, OptiNav, Inc., Bellevue, WA)**

This course will present 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.

14–15 June 2012
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 10 May 2012	*Standard (11 May–8 Jun)*	*On-site (9–14 Jun)*
AIAA Member	$885	$1050	$1190
Nonmember	$995	$1155	$1295

The Space Environment—Implications for Spacecraft Design **(Instructor: Alan Tribble)**
This course provides an introduction to the subject of spacecraft-environment interactions, also known as space environments and effects or space weather effects. It addresses each of the major environments: vacuum, neutral, plasma, radiation, and micrometeoroid/orbital debris. In each section, the basic physics behind the environment is reviewed, but the emphasis is on quantifying the magnitude of the various interactions and identifying mitigation techniques and design guidelines.

23–24 June 2012
The following Continuing Education classes are being held at the 28th Aerodynamics Measurement Technology, Ground Testing, and Flight Testing Conferences, including the Aerospace T&E Days Forum; 30th AIAA Applied Aerodynamics Conference; 4th AIAA Atmospheric Space Environments Conference; 6th AIAA Flow Control Conference; 42nd AIAA Fluid Dynamics Conference and Exhibit; 43rd AIAA Plasmadynamics and Lasers Conference; and 44th AIAA Thermophysics Conference in New Orleans, Louisiana. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for a Fluids course, go to **www.aiaa.org/NewOrleans2012.**

	Early Bird by 29 May	*Standard (30 May–22 Jun)*	*On-site (23–24 Jun)*
AIAA Member	$1248	$1348	$1448
Nonmember	$1325	$1425	$1525

Perturbation Methods in Science and Engineering **(Instructor: Joseph Majdalani, Professor, Mechanical & Aerospace Engineering, University of TN Space Institute, Tullahoma, TN)**
This course is a must for all engineers and scientists aspiring to develop theoretical solutions to accompany their numerical and/or experimental work. The majority of problems confronting engineers, physicists, and applied mathematicians encompass nonlinear differential/integral equations, transcendental relations, equations with singularities/variable coefficients, and complex boundary conditions that cannot be solved exactly. For such problems, only approximate solutions may be obtained using either numerical and/or analytical techniques. Foremost among analytical approximation techniques are the systematic methods of asymptotic perturbation theory. The ability to derive closed-form analytical approximations to complex problems is becoming a lost art. Numerical solvers are relied on routinely to the extent that mastery of approximation methods is becoming a desirable tool and a must among engineers and scientists, especially those aspiring to establish new theories and/or achieve deeper physical insight than may be gained on the basis of numerical modeling alone.

Space Environment and Its Effects on Space Systems **(Instructor: Vincent Pisacane, Heinlein Professor of Aerospace Engineering, USNA, Ellicott City, MD)**
This course is intended to serve two audiences. First, those relatively new to the design, development, and operation of spacecraft systems. Second, those experts in fields other than the space environment who wish to obtain a basic knowledge of the topic. The topics and their depth are adequate for the reader to address the environmental effects on spacecraft instruments or systems to at least the conceptual design level. Topics covered include spacecraft failures, solar system overview, Earth's magnetic and electric fields, Earth's neutral environment, Earth's plasma environment, radiation interactions, contamination, and meteorites and orbital debris.

Turbine Engine Ground Test and Evaluation **(Instructor: Andrew Jackson, Turbine Engine Project Engineer, Arnold Engineering Development Center, Arnold AF Base, TN; and Stephen Arnold, Turbine Engine Analysis Engineer, Arnold Air Force Base, TN)**
This course will explain the role of altitude test facilities in the development and sustainment of turbine engine technology. Examples of altitude test programs will be reviewed to highlight the cost and risk reduction potential of the altitude test. A description of the Arnold Engineering Development Center's Engine Test Facility (EFT) will illustrate the complexity of the facilities required for a successful altitude test. The importance of pretest planning and program management to produce meaningful results will be discussed and will be a major subtext throughout the course. The critical measurements that are required in the altitude test will be described at an intermediate level. The role of engine models in support of test planning, data validation, and data analysis will be discussed. The importance of estimating data uncertainty and confidence level of test results through sound application of statistical techniques will be presented.

Stability and Transition: Theory, Experiment and Modeling **(Instructors: Hassan A. Hassan, Professor, Aerospace Engineering, NC State University, Raleigh, NC; Helen Reed, Department of Aerospace Engineering, Texas A&M; William Saric, Department of Aerospace Engineering, Texas A&M)**
The course is comprehensive covering fundamentals, experiments, modeling, and applications dealing with stability and transition.

Computational Heat Transfer and Thermal Modeling **(Instructor: Dean Schrange, Development of Commercial-grade Simulation Software, Research and Development in Thermal and Fluid Management, Strongsville, OH)**
This CHT (Computational Heat Transfer) course provides a singular focus on the thermal modeling and analysis process, providing a unique perspective by developing all concepts with practical examples. It is a computational course dedicated to heat transfer. In the treatment of the general purpose advection-diffusion (AD) equation, the course material provides a strong introductory basis in CFD. The course couples the computational theory and practice by introducing a multistep modeling paradigm from which to base thermal analysis. 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 course is also designed around 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).

1 July–31 December 2012
2012 Home Study Courses
To register, go to **www.aiaa.org/CourseListing.aspx?id=3200.**

Intro to Computational Fluid Dynamics **(Instructor: Klaus Hoffmann)**
This introductory course is the first of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics.

Advanced Computational Fluid Dynamics **(Instructor: Klaus Hoffmann)**
This advanced course is the second of the three-part series of courses that will prepare you for a career in the rapidly expanding field of computational fluid dynamics.

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

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

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

Introduction to Computational Fluid Dynamics

	Early Bird by 1 Jun	*Standard (2 Jun–1 Jul)*
AIAA Member	$1140	$1250
Nonmember	$1245	$1355

Advanced Computational Fluid Dynamics

	Early Bird by 1 Jun	*Standard (2 Jun–1 Jul)*
AIAA Member	$1185	$1295
Nonmember	$1290	$1400

Computational Fluid Turbulence

	Early Bird by 1 Jun	*Standard (2 Jun–1 Jul)*
AIAA Member	$1245	$1350
Nonmember	$1350	$1455

Introduction to Space Flight

	Early Bird by 1 Jun	*Standard (2 Jun–1 Jul)*
AIAA Member	$1050	$1190
Nonmember	$1155	$1295

Fundamentals of Aircraft Performance and Design

	Early Bird by 1 Jun	*Standard (2 Jun–1 Jul)*
AIAA Member	$1050	$1190
Nonmember	$1155	$1295

9–10 July 2012
The following standalone course is being held at the Ohio Aerospace Institute in Cleveland, Ohio.

Optimal Design in Multidisciplinary Systems
(Instructors: Prabhat Hajela and J. Sobieski)
When you are designing or evaluating a complicated engineering system such as an aircraft or a launch vehicle, can you effectively reconcile the multitude of conflicting requirements, interactions, and objectives? This course discusses the underlying challenges in such an environment, and introduces you to methods and tools that have been developed over the years.

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

	Early Bird by 4 Jun	*Standard (5 Jun–2 Jul)*	*On-site (3–9 Jul)*
AIAA Member	$885	$1050	$1190
Nonmember	$995	$1155	$1295

14–15 July 2012
The following Continuing Education class is being held at the 42nd International Conference on Environment Systems in San Diego, California. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for the ICES course, go to **www.aiaa.org/ICES2012.**

	Early Bird by 18 Jun	*Standard (19 Jun–13 Jul)*	*On-site (14–15 Jul)*
AIAA Member	$1288	$1388	$1488
Nonmember	$1365	$1465	$1565

Spacecraft Design & Systems Engineering **(Instructor: Don Edberg, Professor of Aerospace Engineering, California State Polytechnic Univ. Pomona, Redlands, CA)**
This course presents an overview of factors that affect spacecraft design and operation. It begins with an historical review of unmanned and manned spacecraft, including current designs and future concepts. All the design drivers, including launch and on-orbit environments and their affect on the spacecraft design, are covered. Orbital mechanics is presented in a manner that provides an easy understanding of underlying principles as well as applications, such as maneuvering, transfers, rendezvous, atmospheric entry, and interplanetary transfers. 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.

2–3 August 2012

The following Continuing Education classes are being held at the 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference in Atlanta, Georgia. 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 courses, go to **www.aiaa.org/JPC2012.**

	Early Bird by 2 Jul	*Standard (3–28 Jul)*	*On-site (29 Jul–3 Aug)*
AIAA Member	$1265	$1365	$1465
Nonmember	$1343	$1443	$1543

Hybrid Rocket Propulsion **(Instructor: Joseph Majdalani, Professor, Mechanical and Aerospace Engineering, University of TN Space Institute, Tullahoma, TN)**
This course is quintessential for all professionals specializing in chemical propulsion. The mechanisms associated with hybrid combustion and propulsion are diverse and affect our abilities to advance and sustain the development of hybrid technology. It is our penultimate goal to promote the science of hybrid rocketry that is safe enough to be used in both academia and the private sector. A historical demonstration of hybrid rocket capability is the 2004 X-prize winner SpaceShipOne. This technology can also be used in outreach activities in conjunction with hands-on design projects and payload launches that involve student teams. Interest in hybrid rocketry can thus be translated into increased awareness in science and technology, helping to alleviate the persistent attrition in our technical workforce. The fundamentals of hybrid rocket propulsion will be reviewed with special emphasis on application-based design and system integration, propellant selection, flow field and regression rate modeling, solid fuel pyrolysis, scaling effects, transient behavior, and combustion instability. Advantages and disadvantages of both conventional and unconventional vortex hybrid configurations are examined and discussed.

Advanced Solid Rockets **(Course is sponsored and taught by the distinguished members of the AIAA Solid Rockets Technical Committee, lead by David Poe, Aerojet)**
Solid propulsion is vital to tactical, space, strategic, and launch vehicles. The course examines fundamental and advanced concepts related to solid rockets. Theoretical and practical aspects of the field are covered. This course is based on the “Advanced Solid Rocket Propulsion” graduate-level mechanical engineering course taught at the University of Alabama at Huntsville (UAH). All instructors are experienced solid rocket experts and many were involved with the UAH course. The individual presentations included in this short course include broad rocket motor and system design principles, internal ballistics modeling, propellant fundamentals, component design (motor case, nozzle, and igniters), component and motor manufacturing, combustion instability, and motor failures.

Hydrogen Safety **(Instructors: Steve Woods, NASA White Sands Test Facility, Las Cruces, NM; Miguel Maes, Las Cruces, NM; Stephen Mcdougle)**
This course is intended to provide the student with a working knowledge of safety issues associated with the use of hydrogen. Using the aerospace industry standard, “Guide to Safety of Hydrogen and Hydrogen Systems” (AIAA G-095-2004), this course presents basic safety philosophy and principles and reviews a practical set of guidelines for safe hydrogen use. The information presented in this course is intended as a reference to hydrogen systems design and operations and handling practices; users are encouraged to assess their individual programs and develop additional requirements as needed.

NPSS: A Practical Introduction **(Instructor: Paul Johnson, Wolverine Ventures, Fort Wayne, IN; Edward Butzin, Wolverine Ventures, Jupiter, FL; Dr. Ian Halliwell, Senior Research Scientist, Avetec, Heath, OH)**
This course will give attendees a working knowledge of NPSS software and allow them to create and/or modify system models using this tool. The course material will discuss the object-oriented architecture and how it is used in NPSS to develop flexible yet robust models. A detailed presentation of NPSS execution options, syntax, and interfaces with external codes will be addressed. Overviews of NPSS operation (i.e., Solver, etc.) will also be included. Attendees will be interactively involved with the material by performing exercises on their personal hardware that demonstrates and clarifies the material being discussed in the lecture. All attendees will be provided with a reduced capability version of NPSS for their use during the course and will be permitted to keep it after the course is completed.

Missile Design and System Engineering **(Instructor: Eugene Fleeman, International Lecturer, Lilburn, GA)**
This course provides the fundamentals of missile design, development, and system engineering. A system-level, integrated method is provided for missile configuration design and analysis. It addresses the broad range of alternatives in satisfying missile performance, cost, and risk requirements. Methods are generally simple closed-form analytical expressions that are physics-based, to provide insight into the primary driving parameters. Configuration sizing examples are presented for rocket, turbojet, and ramjet-powered missiles. Systems engineering considerations include launch platform integration constraints. Typical values of missile parameters and the characteristics of current operational missiles are discussed as well as the enabling subsystems and technologies for missiles. Sixty-six videos illustrate missile development activities and performance. Attendees will vote on the relative emphasis of types of targets, types of launch platforms, technical topics, and roundtable discussion.

6–7 August 2012

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 2 Jul	*Standard (3–30 Jul)*	*On-site (31 Jul–6 Aug)*
AIAA Member	$885	$1050	$1190
Nonmember	$995	$1155	$1295

Systems Requirements Engineering **(Instructor: John Hsu)**
Requirements analysis and specification development are the most important contribution at the onset of a program/project. It will set a corrective direction to guide the program/project preventing the later-on redesign and rework. This course will familiarize you with an effective method for defining a set of requirements of a system. The focus is on the initial problem space definition, defining user needs, concept of operations, systems, segment, subsystem requirements, and architecture. Gain an understanding of the following requirements engineering activities: elicitation of requirements, system requirements analysis, requirements integration, interface requirements and control, functional analysis and architecture, requirements management, and verification and validation of requirements. Learn about the principles and characteristics of organizing a well-written requirements and specifications.

New and Forthcoming Titles

Designing Unmanned Aircraft Systems: A Comprehensive Approach
Jay Gundlach

AIAA Education Series
2011, 800 pages, Hardback
ISBN: 978-1-60086-843-6
Member Price: $84.95
List Price: $109.95

Tactical and Strategic Missile Guidance, Sixth Edition
Paul Zarchan

Progress in Astronautics and Aeronautics
April 2012, 900 pages, Hardback
ISBN: 978-1-60086-894-0
Member Price: $104.95
List Price: $134.95

Boundary Layer Analysis, Second Edition
Joseph A. Schetz and Rodney D. Bowersox

AIAA Education Series
2011, 760 pages, Hardback
ISBN: 978-1-60086-823-8
AIAA Member Price: $84.95
List Price: $114.95

Introduction to Flight Testing and Applied Aerodynamics
Barnes W. McCormick

AIAA Education Series
2011, 150 pages, Hardback
ISBN: 978-1-60086-827-6
AIAA Member Price: $49.95
List Price: $64.95

Space Operations: Exploration, Scientific Utilization, and Technology Development
Craig A. Cruzen, Johanna M. Gunn, & Patrice J. Amadieu

Progress in Astronautics and Aeronautics Series, 236
2011, 672 pages, Hardback
ISBN: 978-1-60086-817-7
AIAA Member Price: $89.95
List Price: $119.95

Spacecraft Charging
Shu T. Lai

Progress in Astronautics and Aeronautics Series, 237
2011, 208 pages, Hardback
ISBN: 978-1-60086-836-8
AIAA Member Price: $64.95
List Price: $84.95

Order 24 hours a day at www.aiaa.org/new

Exergy Analysis and Design Optimization for Aerospace Vehicles and Systems
Jose Camberos and David Moorhouse

Progress in Astronautics and Aeronautics Series, 238
2011, 600 pages, Hardback
ISBN: 978-1-60086-839-9
AIAA Member Price: $89.95
List Price: $119.95

Engineering Computations and Modeling in MATLAB/Simulink
Oleg Yakimenko

AIAA Education Series
2011, 800 pages, Hardback
ISBN: 978-1-60086-781-1
AIAA Member Price: $79.95
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Introduction to Theoretical Aerodynamics and Hydrodynamics
William Sears

AIAA Education Series
2011, 150 pages, Hardback
ISBN: 978-1-60086-773-6
AIAA Member Price: $54.95
List Price: $69.95

Eleven Seconds into the Unknown: A History of the Hyper-X Program
Curtis Peebles

Library of Flight
2011, 330 pages, Paperback
ISBN: 978-1-60086-776-7
AIAA Member Price: $29.95
List Price: $39.95

Basic Helicopter Aerodynamics, Third Edition
John M. Seddon and Simon Newman

AIAA Education Series
Published by John Wiley & Sons, 2011, 3rd Edition, 264 pages, Hardback
ISBN: 9-781-60086-861-0
AIAA Member Price: $49.95
List Price: $74.95

Gas Turbine Propulsion Systems
Bernie MacIsaac and Roy Langton

AIAA Education Series
Published by John Wiley & Sons, 2011, 368 pages, Hardback
ISBN: 9-781-60086-846-7
AIAA Member Price: $84.95
List Price: $119.95

Standard Information for all AIAA Conferences

This is general conference information, except as noted in the individual conference preliminary program information to address exceptions.

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.

Conference Proceedings

This year's conference proceedings will be available in an 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 the conference technical papers. For those registering on-site, you will be provided with instructions at registration.

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 Web site, **www.aiaa.org/YPGuide**.

Journal Publication

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

Speakers' Briefing

Authors who are presenting papers, session chairs, and co-chairs will meet for a short briefing at 0700 hrs on the mornings of the conference. Continental breakfast will be provided. Please plan to attend only on the day of your session(s). Location will be in final program.

Speakers' Practice

A speaker practice room will be available for speakers wishing to practice their presentations. A sign-up sheet will be posted on the door for half-hour increments.

Timing of Presentations

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

Committee Meetings

Meeting room locations for AIAA committees will be posted on the message board and will be available upon request in the 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 preliminary conference 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 conferees. A telephone number will be provided in the final program.

Membership

Professionals registering at the nonmember rate will receive a one-year AIAA membership. Students who are not members may apply their registration fee toward their first year's student member dues.

Nondiscriminatory Practices

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

Smoking Policy

Smoking is not permitted in the technical sessions.

Restrictions

Videotaping or audio recording of sessions or technical 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.