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The World's Forum for Aerospace Leadership

DEPARTMENTS

EDITORIAL

Reflections.

3

INTERNATIONAL BEAT

Quantum cryptography takes to the air.

4

WASHINGTON WATCH

Aircraft issues spark growing debate.

8

CONVERSATIONS

With Trevor Taylor.

12

ELECTRONICS UPDATE

Sequestration and the pivot to Asia.

16

OUT OF THE PAST

52

CAREER OPPORTUNITIES

56

VIEWPOINT

GETTING AHEAD OF THE THREAT: AVIATION AND CYBER SECURITY

As air traffic management systems evolve, we must develop the methods to protect them from cyber attacks.

by *Emilio Iasiello*

22

FEATURES

UAV ROUNDUP 2013

Despite tight defense budgets and growing privacy concerns, experts predict increasing demand for UAVs, both military and civilian.

by *J.R. Wilson*

32

A NEW ERA FOR AVIATION

NASA has selected eight large-scale technology demonstrations for the next phase of its ERA project.

by *Edward Goldstein*

38

CAPTURING AN ASTEROID

NASA's asteroid retrieval mission will aid preparations for deflecting larger asteroids on a collision course with Earth.

by *Ben Iannotta*

42

BULLETIN

AIAA Meeting Schedule

B2

AIAA Courses and Training Program

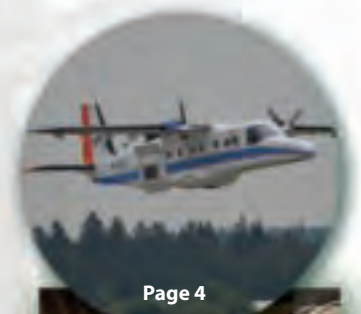
B4

AIAA News

B5

COVER

The Boeing Phantom Eye makes its second flight, at Edwards AFB. Catch up on all the new developments in UAVs by turning to page 32. And check out the supplement for details of UAVs around the world. Photo by Bob Ferguson.



Page 4



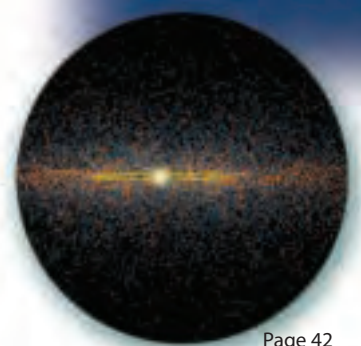
Page 8

Page 22



Page 38

Page 16



Page 42

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July-August 2013, Vol. 51, No. 7

Editorial

Reflections

"Peace should not mean hard times," an editorial written 20-some years ago, was a reflection on the impact of change. Politically, the Cold War was lurching to an end, with every brick torn from the Berlin Wall. Economically, particularly in the aerospace sector, the cool-down in international tensions had a not surprising but long-lasting effect, as the industry shrank in response to a sea change in the political climate.

In the years since, we have borne witness to contractions and expansions, as the aerospace industry was subject to the vagaries of international economic and political influences.

Bouncing back from the shrinkage of the early 90s, both the defense sector and civil and commercial ventures saw boom times, and opportunity seemed to be everywhere. Of course that pendulum had to swing back, with sequestration just the latest blow to a sector that has seen shrinking budgets over the last few years.

But taken together, for the aerospace professional and the interested spectator alike, the last two-plus decades have been spectacular. We bore witness to remarkable feats of technological triumph, from Spirit and Opportunity, the little rovers that could, to Curiosity, a marvel of precision engineering; from the sturdy Pioneer UAV, launched by catapult and snagged in a safety net, to the Avenger, capable of reconnaissance as well as combat; from space launch providers that were all government run to an explosion of commercial companies.

The highs were extraordinary—could anyone see a space shuttle lift off and not be moved? Did anyone who watched the JPL team as the announcement was made that Curiosity had landed exactly where it was meant to not join in the cheering?

And the lows were devastating. The tragic loss of the crew of the space shuttle Columbia shook us to our collective core, just as the memory of the loss of Challenger years before had finally lost a little bit of its bite.

For all of the technical marvels and outstanding accomplishments I have witnessed over the last 20-odd years, it is the people I've encountered that will stay with me most. As the editor of this magazine since 1991, I have had the opportunity to travel to amazing, exotic places (a hotel full of bats in French Guyana will not be forgotten any time soon); to see launch vehicles lift off and aircraft prototypes being built; to watch lasers being fired and engines under test. But the people, famous and not, were the real gift of this career.

Meeting folks I had only read about in books and newspapers, and some who I'm sure will be in history books yet to be written, and the less famous, truly dedicated to their careers and bound together by their love for what they do, has enriched my life beyond measure, and to them I proffer my thanks.

"Peace should not mean hard times" was the first editorial I wrote in this job, after I had run out of folks to fill in for me. This one is my last.

It has been a privilege.

Elaine Camhi
Editor-in-Chief

Quantum cryptography takes to the air



In April this year, researchers from the German Aerospace Center (DLR) and Ludwig-Maximilians-Universität (LMU) in Munich released their report on a series of flight trials that took place at the DLR's Oberpfaffenhofen flight test center in February and March 2011. The trials aimed to transfer quantum data between an aircraft in the air and a ground station.

It was the first stepping stone in a data revolution that could allow aircraft and satellites one day to operate global information networks wherein vast amounts of data are transferred almost instantaneously and entirely securely. And beyond the transfer of data lies the promise of quantum computers, which will radically increase the processing power of flight management systems, communications, sensors, and smart weapons systems.

The first application of quantum mechanics to aviation operations will most likely be in secure communications between the ground and the air.

Finding the key

"For the process of data encryption to work, there must be a Rosetta Stone—a key to translate the message," according to ID Quantique, a Swiss-based company that specializes in developing quantum-based security networks based on fiber optic net-

works. "Instead of a difficult algorithm to protect the key, quantum key distribution fires photons through fiber optic lines that have specific properties, such as precise polarization. That way the sender, 'Alice,' can send information to the receiver, 'Bob,' and the two can compare notes on a random sample of the transmission to determine if the data is received as intended. If a third party, an 'Eve,' tries to intercept or eavesdrop on that transmission, she will disrupt the properties of the photons and Alice and Bob will know there's an attempted theft."

So far, such quantum-based secure networks have relied mainly on fiber optic landlines, but in the DLR/LMU trials the quantum data were sent via a laser beam to see whether the encryption technology can be integrated within an existing optical communication system linking aircraft to ground.

"We didn't know how well this would work; it had never been done before. But we were able to create absolutely stable reception with good tracking for several minutes," says Florian Moll of the DLR Institute of Communications and Navigation.

The particular challenge with the experiment was directing the light signals precisely onto the ground station telescope. To do this, the researchers

achieved a targeting accuracy of thousandths of a degree by fitting the DLR's test bed Do 228-212 with two precise alignment systems: a coarse alignment unit within a small glass dome on the outside of the craft protecting the rotating mirror and lenses and a fine alignment unit inside the plane. A sensor and rapidly moving mirror ensured that vibrations from the aircraft were compensated for in a frequency range of up to 100 Hz.

"In the experiment there were two laser sources: one 850-nm laser that transmitted single photons and a second, 1,550-nm wavelength, for transmitting data to synchronize the quantum receiver (Bob) and transmitter (Alice)," says Moll.

"The quantum key distribution algorithm has been written so that on one base, single photons are transmitted from the aircraft to the ground station with different polarizations—horizontal and vertical. On a second base, photons with $+45^\circ$ and -45° are transmitted—so you have four polarization states and two different bases. The ground station measures the polarizations at the different bases and the expectant error level. If there is an eavesdropper trying to access the data the ground station would immediately be able to tell if the normal error threshold is exceeded," Moll explains.

Quantum theory, computers, and mechanics

Quantum theory offers explanations as to the way energy and matter behave at the atomic and subatomic (quantum) level. Subatomic particles—such as ions, photons, and electrons—may behave like either particles or waves, depending on their environment, and can exist in two different states, or both states, simultaneously (this latter phenomenon is called superposition). Each state of existence is defined as a 'quantum bit' or 'qubit', and each qubit has a significantly greater processing potential than classical digital data bits. According to a European Commission research position paper: "Quantum technology exploits the weird properties of matter at extremely small scales. Where a bit in a classical computer can represent either a '1' or a '0,' a quantum bit—or qubit—can represent '1' and '0' at the same time. Two qubits can represent four values simultaneously, three qubits eight, and so on. Under

the right circumstances, performing computations with quantum bits is the equivalent of carrying out multiple classical computations in parallel."

There are other significant features to the way these particles interact and can be measured—or not—that offer substantial performance improvements and technical challenges to developers of quantum-based computers. There are almost as many different forms of quantum computers and types of algorithms as there are computers themselves, and exact comparisons are, for the moment, nearly impossible. But according to the University of Vienna: "Not only do quantum computers promise a dramatic increase in speed over classical computers in a variety of computational tasks; they are designed to complete tasks that even a supercomputer would not be able to handle."

Next up, satellites

Although the current research program is now complete, the way is now open to develop laser-based quantum data secure communications between ground stations and satellites. This would be a tough but not insurmountable engineering challenge, Moll believes. "In the DLR/LMU trials we were transferring data around 20 km between the aircraft and the ground station. For a low Earth orbit satellite you would have to increase this range to between 400-500 km and maybe 1,000 km if the satellite were closer to the horizon. This would mean narrowing down the laser beam from 180 μ rad to less than a tenth of that. More sensitive receivers might also be necessary to cope with the higher energy loss.

"But this is not unrealistic. We have undertaken trials with the OICETS [Kirari] test communications satellite of the Japan Space Agency where the laser terminal had only 5.5 μ rad of beam divergence."

The race is on

This is not the only quantum-based ground-air encryption communication system program under development—there is a global space race under way to develop the first robust network. Major research programs outside the U.S. include the Institute for Quantum Computing at the University of Waterloo, the University of Vienna, the University of Padua, the National Institute of Information and Communications Technology in Japan, the Free University of Brussels, and the Institute of Photonic Sciences in Barcelona. The University of Padua research team has already undertaken study of the optimal design of transmitter optics over long distances, including a 144-km path between Tenerife and La Palma in the Spanish Canary islands.

At the same time there is another race under way—to develop the first



commercial and stable quantum computers for widespread industrial use. And as quantum-based computers become more stable and affordable, they will eventually find their way aboard aircraft, transforming the speed with which flight management systems can process data, the accuracy of inertial navigation systems, the adaptability of autonomous systems, the precision with which weapon systems can track and engage foes, the speed and precision of simulations, and the capability of aircraft systems to optimize the performance and efficiency of aircraft for all phases of flight.

From possibility to results

The potential of quantum mechanics and quantum computers has been well understood for some time. But it is only now that the technology is starting to deliver real results.

The first commercially available quantum computers went on the market in 2011—and aerospace organizations have been some of the most important customers. Lockheed Martin was one of the first customers for Canada's D-Wave One quantum computer, a 128-qubit machine, and the

company recently upgraded to the 439 qubit D-Wave Two, reported to be 500,000 times faster than its predecessor. In March 2013 it was reported that in a test to solve a complex optimization problem, a D-Wave machine was 3,600 times faster than a high-end personal computer.

According to Market Research Media's October 2012 "Quantum Computing Market Forecast 2015-2020," governments are currently the major driving force behind investments in quantum computing research and development work. Priority areas include quantum cryptography for secure communications, development of new weapons and the ability to break into adversary communications, and civil sectors such as new medicine and renewable energy.

However, there are considerable technical hurdles to be overcome before these computers can be mass produced. "Future technological development exploiting quantum features will have to include some robust stabilizing mechanism to protect their fragile quantum states," according to a paper issued by European industry in 2011 to suggest new research areas for Eu-

European Commission funding in this area. In Europe, much of the recent research effort has gone into control systems.

"Extensions of traditional control concepts, developed for classical systems, such as optimality, feedback, stability, robustness, filtering and identifications to the quantum systems are becoming key issues," says the paper.

Sifting through the bounty

One of the problems facing both governments and industry is the sheer number of 'breakthroughs' happening almost monthly in quantum mechanics research, promising greater computer power and faster access to market if a particular research route is taken.

As a result, 'quantum entanglement,' where entangled particles re-

main connected no matter how far apart they are, so an action on one will have a simultaneous mirrored action on the other; 'quantum discord,' where subatomic particles relate to each other without entanglement; and a host of other concepts at the early research stage all offer related but competing technology outcomes.

This February, the European Commission set up a working group to coordinate academic research in this area. The Coordination Action QUTE-EUROPE (Quantum Technologies for Europe) cell "...will continue to advance...European excellence via a structured approach towards the implementation of key topics such as a strategic vision, collaboration and dissemination. It will carry out a set of actions that are specifically targeted at coordination and cooperation in quantum information and communication technologies (QICT) research community in Europe and beyond, as well as increasing the visibility of the field to the scientific global community, industries and the public at large."

It is only a small step along the way to developing a clear understanding of which areas of research will bring robust, affordable, and stable quantum computers to the market. But each step is important. The potential of these systems is so large that any nation that can field security and weapons systems based on quantum principles while its neighbors and adversaries rely on classical digitally based systems will have an immediate and overwhelming technical advantage. The race for quantum supremacy has begun. **Philip Butterworth-Hayes**

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Correction In *Shifting fortunes for commercial X-band* (May, page 40) the paragraph about Predator and Global Hawk should have read as follows: "There are some new UAV systems, including the Navy's BAMS system, which are going to come out with an X-band-capable antenna. But if we're talking the Predators and the Global Hawks that are out there today, those are typically Ku-band systems," adds Ruszkowski."

Events Calendar

JULY 14-17

Forty-ninth AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit. Eleventh International Energy Conversion Engineering Conference. San Jose, California.

Contact: 703/264-7500

JULY 14-18

Forty-third International Conference on Environmental Systems. Vail, Colorado.

Contact: 703/264-7500

JULY 25-27

Space Frontier Foundation NewSpace 2013, Silicon Valley, California.

Contact: <http://newspace.spacefrontier.org>

AUG. 11-15

AAS/AIAA Astrodynamics Specialist Conference. Hilton Head Island, South Carolina.

Contact: Kathleen Howell, 765/494-5786; howell@purdue.edu; www.space-flight.org/docs/2013_astro/2013_astro.html

AUG. 12-14

AIAA Aviation 2013: Charting the Future of Flight (Continuing the Legacy of the AIAA Aviation Technology, Integration, and Operations Conference, and Featuring the 2013 International Powered Lift Conference and the 2013 Complex Aerospace Systems Exchange). Los Angeles, California.

Contact: 703/264-7500

AUG. 19-22

AIAA Guidance, Navigation, and Control Conference. AIAA Atmospheric Flight Mechanics Conference. AIAA Modeling and Simulation Technologies Conference. AIAA Infotech@Aerospace Conference. Boston, Massachusetts.

Contact: 703/264-7500

SEPT. 10-12

AIAA SPACE 2013 Conference and Exposition. San Diego, California.

Contact: 703/264-7500

SEPT. 23-27

Sixty-fourth International Astronautical Conference. Beijing, China.

Contact: <http://www.iac2013.org>

SEPT. 24-25

Atmospheric and Ground Effects on Aircraft Noise. Sevilla, Spain.

Contact: Nico van Oosten, nico@anotecc.com; www.win.tue.nl/ceas-asc

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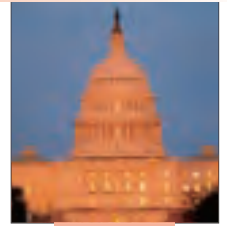
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Aircraft issues spark growing debate

PRESIDENT BARACK OBAMA USED A May 23 address to the National Defense University at Fort McNair in Washington, D.C., to announce he is shifting responsibility from the CIA to the Defense Dept. for “lethal, targeted action against al-Qaeda” by “remotely piloted aircraft, commonly referred to as drones.”

Drone decision

The move may entail less change than expected, and less than the fuss it stirred up. The CIA and military personnel have worked side-by-side all along, but the change is a jolt for CIA professionals. Over half of the agency’s work force came on board after September 11, 2001, maturing in an envi-

ronment where the traditional job of gathering intelligence has given way to paramilitary operations. Returning to traditional intelligence gathering, which demands long hours of tedious office work, will require a cultural shift by the agency—one some lawmakers on Capitol Hill may oppose.

With a torrent of revelations about the drone program spilling from the administration, it is now widely understood that the ‘trigger puller’ in every CIA-managed drone strike—against militants in Pakistan, Yemen, Somalia, and Mali—was always a uniformed Air Force officer. Lawyers in this administration and the previous one imposed this requirement to be in compliance with the law of armed conflict, also called the LOAC, which requires that a military member handle matters on the battlefield. The arrangement is more than cosmetic: The Air Force also trains the CIA contractors who work on all aspects of the armed drone program, and the aerial vehicles remain Air Force property.

In what the *Wall Street Journal* called a “heavily lawyered word change,” drone attacks now will be directed only against terrorist groups that directly threaten Americans, not groups threatening U.S. allies and interests more broadly. The administration now will use lethal force against targets that threaten “U.S. persons” rather than, as in the past, groups that threaten “U.S. interests.” This appears to mean, for example, that the Pakistani Taliban will no longer be targeted, because it threatens the government in Islamabad but not the one in Washington. In his address, Obama named only al-Qaeda and referred to no other extremist groups.

This may seem a technicality,

but it folds the drone program fully within the LOAC and thus provides better justification for the effort. In any event, the number of drone missions has been declining for months and is expected to dwindle further.

Obama put it this way: “To say a military tactic is legal, or even effective, is not to say it is wise or moral in every instance. That’s why, over the last four years, my administration has worked vigorously to establish a framework that governs our use of force against terrorists, insisting upon clear guidelines, oversight, and accountability that is now codified in presidential policy guidance that I signed yesterday.”

The legality of drone strikes has been quietly debated in Washington for years. Reflecting the view of many, Sen. Rand Paul (R-Ky.) welcomed the change but accused the White House of “looking at some flashcards” instead of using “due process” to decide who should be killed by drone strikes. Referring to the White House’s Tuesday national security meetings where the ultrasecret ‘kill list’ is discussed, Paul said decisions should not result from “a PowerPoint presentation on ‘terror Tuesdays.’”

No one denies that the attacks kill adversaries, but many believe they push new recruits toward violent extremism and depart from traditional U.S. values. Targeting any U.S. citizen, even one fighting abroad as a member of al-Qaeda, is a particularly contentious issue in the nation’s capital. Obama acknowledged that drones have killed four U.S. citizens—only one of whom was targeted—but insisted it is done “only in the most extraordinary circumstances.”

Moreover, not everyone in Washington accepts the president’s view that drone strikes are effective.

“They’re effective in the sense that they kill people,” said author and ana-



Maj. Rick Wageman operates the virtual cockpit of an MQ-1 Predator at a base in southern Afghanistan. USAF photo/Staff Sgt. Samuel Morse.



Sen. Rand Paul

lyst Norman Polmar in a telephone interview. “But they’re counterproductive. They do more harm than good to our interests. And going after U.S. citizens without due process is a breach of faith with our laws, with our Constitution and with our courts.”

Most on both sides of the aisle believe that lethal drones do not belong outside conflict zones. But some agree with Sen. Lindsey Graham (R-S.C.), who said “the homeland is the battlefield” now, tying the April 15 Boston Marathon bombings to conflicts overseas. Referring to the two brothers accused of planting bombs that killed three and injured 264, Graham said, “It would have been nice to have a drone up there [over Boston].” So far, government has not sorted out how such aircraft might be used on U.S. soil for law enforcement or military purposes.



Rep. Mike Pompeo

Obama says targeted killings will not take place in the U.S.

A sidenote: The larger, more versatile MQ-9B Reaper has now replaced the MQ-1B Predator as the drone of choice for these missions, and the lightweight, precision AGM-176 Griffin air-to-surface missile is gradually replacing the heavier, larger warhead AGM-114 Hellfire. The changes mean increased accuracy, hence fewer unwanted civilian casualties.

The FAA and GA

Thanks to special legislation passed in May, the FAA reversed a plan to close air traffic control (ATC) towers at 149 major U.S. airports. The legislation in effect exempts ATC from sequestration, which is impacting all government agencies, including the military (the USAF has temporarily grounded 17 combat squadrons and the Navy is canceling deployment of two carrier air wings). Other FAA operations will still be affected.

Pressure is mounting on the FAA to make life easier for the builders and owners of small private aircraft. Among other issues, the general aviation (GA) community wants to cut costs and red tape in the certifying of small planes. In May, Rep. Mike Pompeo (R-Kansas) introduced a bill that will simplify certification and licensing processes. He says it will “revitalize” an industry that has long faced challenges. The proposed legislation also would halt an administration plan to end tax breaks on corporate jets.

“This is a direct approach,” Pompeo said in a statement. “We want to be very open and direct about our support for aviation.”

Pompeo represents a district in Wichita, which bills itself as the ‘air capital of the world,’ and is the former CEO of Thayer Aerospace (now called Nex-Tech Aerospace). Wichita is home to Beechcraft, Bombardier, Cessna, Learjet, and Spirit (formerly Boeing), among others, and has lost 15,000 aviation jobs since 2001.

According to the Experimental Aircraft Association (EAA), GA supports



Sen. Amy Klobuchar

about 1.2 million high-paying jobs and pumps \$150 billion into the U.S. economy each year. But manufacturing and sales have been in a steady downward glide for more than three decades. FAA Administrator Michael Huerta met with leaders from the GA community on May 14, but primarily to talk about safety, not about the interest of lawmakers and industry groups in reversing the downward business trend.

Pompeo issued a statement saying companies that bring new aircraft designs to market face regulatory barriers that hurt innovation. He is not proposing a bailout, he said, but noted that “we can cut red tape and at the same time improve safety, effectively revitalizing the industry by cutting the cost of new planes.” To cite one example of what he calls “too much government,” Pompeo said the cost of adding an angle-of-attack indicator into a noncertified experimental aircraft is \$800; in a certified aircraft, the same piece of equipment is \$5,000 because of the added certification paperwork and testing.

Pompeo’s proposed legislation has support from Rep. Dan Lipinski (D-Ill.), Rep. Sam Graves (R-Mo.), Rep. Todd Rokita (R-Ind.), and Rep. Rick Nolan (D-Minn.).

On the other side of the building, Sen. Amy Klobuchar (D-Minn.) says she will introduce a companion bill. Aircraft builder Cirrus is in Duluth, part of Klobuchar’s constituency.

It is unclear, though, whether such

legislation can make it through the Senate. Even if enacted into law, it may help manufacturers of small and medium-sized aircraft used for everything from business travel to crop dusting—but may not help them very much. Many other indicators point downward. The EAA says the number of active private pilots has declined by almost 30% since 1984, the number of student pilots by 42%. The FAA reports that during 2011, the last year for which figures are available, there were 118,657 student pilots compared to 128,663 in 1990. However, up to 80% of those who begin civilian flight training never finish. FAA statistics show the number of airline transport pilots up to 142,511, compared to 107,732 in 1990, but as many as one-third of them will retire in the next three to five years. The number of private pilots was 149,666, down from 194,441 in 1990.

According to the General Aviation Manufacturers Association, 42.1% of business jet deliveries were to customers in North America in 2010, compared with 49.4% in 2009. President Obama frequently uses the executive jets as an explicit symbol when arguing that tax rates for the wealthy should be raised. Obama supporters argue it is only fair to ask affluent private-plane buyers to pay a bit more in taxes when social programs that help the poor are facing sharp cutbacks.

The opposing argument was defined as long as three years ago when the corporate jet-bashing began and National Business Aviation Association president Ed Bolen said, “The president has inexplicably chosen to vilify and mischaracterize business aviation—an industry that is critical for citizens, companies, and communities across the U.S., and one that can play a central role in the economic recovery he says he wants to promote.”

A bigger issue

Whether in Washington or Wichita, it is not clear that a new law or a tax break will make much difference. Something is going on that is more significant than a drop in the numbers of pilots earning licenses or GA air-



A B-2 from Whiteman AFB gets airborne while another B-2 waits for clearance at Andersen AFB, Guam. USAF photo/Master Sgt. Kevin J. Gruenwald.

craft emerging from assembly-plant doors.

“Just look at all those people with their hand-held devices,” said analyst David Sibbett in a telephone interview. “Publishers of books and magazines about aviation are struggling. Aviation museums are finding it hard to keep going. Companies that make scale model airplanes are struggling. We loved ‘things with wings’ when we were kids, but youngsters today are more attracted to digital technology. Simply put, people aren’t as interested in aviation as they once were.”

The point about books, museums, and models is indisputable. The conclusion may be an exaggeration. But anecdotal evidence suggests that American youngsters today are less excited about aircraft than they once were. Possibly that is because aircraft are now a routine part of life: Exact figures are elusive, but one study suggests that 81% of adult Americans have flown in an aircraft at least once, and that in 1970 the figure was 14%.

On guard on Guam

While grounding squadrons and reducing flying hours by fully 203,000 in response to the budget squeeze, the Air Force is struggling to maintain what it calls the ‘continuous bomber presence’ (CBP) on Guam.

The CBP is an ongoing show of force by nuclear-capable B-52 Stratofortress and B-2 Spirit bombers. It has been under way at Guam’s Andersen AFB since 2004. Every six months, a new batch of six to eight bombers and 300-350 airmen rotate through Andersen, where they maintain a high pro-

file to spotlight the administration’s ‘pivot’—or shift in priorities—toward Asia. For the past several years, the B-52 alone has been handling the job.

While deployed to Guam, these B-52s fly long-duration sorties over vast expanses of the Pacific. The planes make use of training ranges in Australia, in Korea, and off Hawaii, and rehearse warfighting with sister services and allies. The CBP does not go unnoticed in Beijing and especially in Pyongyang. North Korean state radio called the B-52’s cameo role in a recent drill an ‘unpardonable’ act by ‘capitalist lapdogs.’

Referring to the statutorily mandated 18% cut in the USAF budget for FY13, which ends September 30, Air Force Chief of Staff Gen. Mark Welsh told the Senate on February 12 that diminished flying hours “will come from combatant commander requirements such as...Continuous Bomber Presence missions in the Pacific.”

In March, reacting to North Korean rhetoric, Pentagon spokesman George Little said, “The B-52 Stratofortress can perform a variety of missions, including carrying precision-guided conventional, or nuclear, ordnance.” Little added, “We will continue to fly these training missions as part of our ongoing actions to enhance our strategic posture in the Asia-Pacific region.”

When CBP began nine years ago, B-52, B-1B Lancer, and B-2 Spirit squadrons shared the deployments. Today, Air Force bomber inventory includes just 162 planes—76 B-52s, 66 B-1Bs, and 20 B-2s. Welsh and his two most recent predecessors have all said that a new bomber—currently being

called the 'long range strike bomber'—heads their priority list of 'wants.' But funding for a new bomber has never seemed less likely than now.

The CBP is "the sort of thing that makes the U.S. a world power," said Capt. Bandy 'Spike' Jeffrey, a radar navigator with the 96th Expeditionary Bomb Squadron, in a telephone interview. "We are exercising the U.S. presence out here."

B-52s come to Guam from Barksdale AFB, Louisiana, and Minot AFB, North Dakota. These bases take responsibility for the Guam commitment during alternating years. Each has two squadrons, with one replacing the other after six months.

The age of the B-52, ironically, is less a problem than the geriatric condition of the newer bomber platforms. The B-2, touted for its stealth or radar-evading properties, is the youngest

bomber in years but the oldest in terms of the instruments and avionics beneath the skin. It rolled out of assembly-plant doors with an onboard computer based on the IBM 286. "It's very hard to convince people that the B-2 is not a new airplane," Maj. Gen. William A. Chambers of the Air Staff said in a speech last November. "The B-2 is packed with 1980s-era network gear and software and needs a new 'digital backbone.'" The aircraft has received new, state-of-the-art radar but otherwise is in need of instrument, avionics, and sensor upgrades for which no funding is in sight.

The third member of the nation's bomber trio, the B-1B, has received more internal improvements than the others and has proven itself repeatedly as a conventional bomber and close air support platform, but remains prohibitively costly to fly.

The B-52 is in the best shape of the three bombers in terms of internal improvements, as well as incorporation of new technology such as advanced targeting pods and satellite-guided bombs.

The 23rd Bomb Squadron from Minot replaced the 96th on Guam in May, and Welsh says the CBP will be maintained through FY13. It is widely expected that the Pentagon will find a way for it to continue in the new fiscal year, but possibly at some reduced level. The sight of a B-52 operating in Western Pacific skies is so important to U.S. interests that the Air Force plans to find savings elsewhere before it seriously ponders ending these bomber deployments.

Robert F. Dorr

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Robert F. Dorr's new book, Mission to Tokyo, is a history of American bomber crews in WW II.

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Trevor Taylor

How can governments on both sides of the Atlantic increase their defense and aerospace capabilities to deal with an increasing range of threats while ensuring spending on defense remains under control? What is the role of industry in this process?

The challenge for industry—and even more so for these governments—is that the kind of difficult problems the military are being asked to deal with are essentially focused on issues such as counterterrorism and counter-insurgency rather than a confrontation against large state forces. For the armed forces concerned, this means there are different threats, operational capabilities, and sorts of equipment needed at a time when it is not clear whether confrontation between states on a large scale has really gone away for good.

So the real difficulty for governments and industry is to produce armed forces and equipment that allow for the kind of capability required to deter states and to undertake large-scale operations, while at the same time enabling counterinsurgency campaigns that we've seen in Iraq and in Afghanistan. Even with generous funding, that would be an intellectual and practical challenge. To do it at a time of restricted funding makes it even harder.

So what's the solution?

Industry's role is to speak to governments about the art of the possible in terms of technology (and cost), while the government's role is to think about requirements. On occasions, industry can suggest a piece of equipment or capability that would be useful—but it's up to governments to take the lead on requirements specification and prioritization.

In terms of how industry should position itself to meet this challenge,

the range of options is pretty clear. Many companies have decided to exit defense altogether, either by putting themselves up for sale or by selling off their defense interests. So there's no assurance that the range of companies currently interested in defense is going to stay in this sector. Some of them have obviously opted also for the wider and growing security market—but you have a different set of customers in this area and to a certain extent a different set of technologies.

But defense companies have to be active in global as well as national markets, and that's a big challenge for U.S. companies because, while the scale of the domestic market and U.S. government power gives them a huge advantage, the export control system is a disadvantage for U.S. companies trying to act globally.

Firms can also collaborate and promote collaborative projects, giving access to a larger market. In terms of looking at where they should invest, technologies such as remotely piloted

“Industry's role is to speak to governments about the art of the possible in terms of technology (and cost), while the government's role is to think about requirements.”

air systems are obviously appealing: They have a role in large- and small-scale conflicts as well as having growing potential in the security and wider civil market, as does the whole networked information systems sector. The broad proposition that the more armed forces, the better off they will be, applies to large and small conflict areas. The centrality and importance of information will mean its protection and disruption will be a continuing agenda item.

History would suggest that while governments on the one hand say they want to encourage consolida-

tion among defense companies, they have also, in many cases, acted to prevent it happening.

In this area governments can be schizophrenic. In the late 1980s the U.K. and French governments agreed that Europe's defense electronics and aerospace industries should restructure to better compete and collaborate with U.S. businesses. Out of this rather confused process the European Aeronautic Defence and Space Company was formed. EADS is fundamentally a commercial company, but it operates under significant political constraints. And perhaps that's inevitable, as in the defense and aerospace sectors governments are reluctant to see companies lose their national identities, especially in many countries in continental Europe. The U.K. has taken a more relaxed view of this for the last 15 years.

The U.K. defense industrial policy document published in 2002 said that a company would be treated as British if it had significant value in the U.K. The second and third largest defense employers in the U.K. are Italy's Finmeccanica, which owns Selex and Agusta-Westland, and France's Thales, which owns a stream of defense businesses in the U.K.

The British government supports these firms' British operations, but even so, it puts national restrictions on what they can do in terms of employees, technology transfer, information control, and so on.

So do you think that in Europe, at least, the 'red lines'—lines which governments consider cannot be crossed in terms of allowing foreign companies to take over national strategic industries—are starting to shift? Has the recent financial crisis encouraged governments to be more open to industrial defense consolidation?

Clearly, shrinking defense budgets are making life difficult for defense

businesses, raising questions about their long-term futures. I'm not sure that the British or any other European government thought about a merger between BAE Systems and EADS until it was a possibility. The German government, which appears to believe it

"You need to understand the threats; but the world keeps changing, so governments struggle in that area."

should have been consulted more carefully, did not hesitate to defend its perceived national interest.

In nuclear submarines, including the propulsion systems, nuclear weapons, and some related fields, it is recognized by the U.K. and France that they must have national suppliers and technology that they control. This is not changing and is not likely to. In guided weapons, MBDA has emerged as a permanent entity with its own personality in a number of states, despite being technically a joint venture.

The helicopter and space businesses are already dominated by transnational businesses. In combat air, the UAV/UCAV position remains in play, and we are all aware how long Dassault has maintained its independence. The impact of the F-35 program on intra-European defense cooperation is not finally visible. Altogether the picture is mixed and not especially coherent, and of course there is the possibility for more transatlantic linkups in both directions.

You mention the F-35 program. Will this be the last multinational program of its type, and what lessons are being learnt about international defense cooperation from how the program is developing?

In the 1970s, China's Foreign Minister Chou En Lai, when asked to assess the impact of the French Revolution on Western civilization, is reputed

to have replied, "It's too soon to say."

In broad terms, the F-35 is in the same position. It could yet turn into a success or a drastic failure and an embarrassment. There are still risks left in the program. What we do know is that it cost a lot more—and it's a lot later—

than was originally envisaged, but then other aircraft and defense projects have been in that position.

I have a suspicion that there will have been some lessons learnt about relying on U.S. commitments, because the U.K. is now in a position of significant de-

pendence and vulnerability on this project and little apparent say in how it is proceeding. The U.K. is at an advanced stage of building two aircraft carriers with the only fixed-wing combat aircraft that could be operated from them still in development.

In 2010 France and the U.K. signed a defense cooperation treaty. How is cooperation now progressing as a result of this treaty?

There are different views on this. For the British the big test case is the French willingness to go along with the joint future naval air-to-surface

Trevor Taylor is a professorial research fellow in defense management at the Royal United Services Institute in Whitehall, London, where he heads a research program in defense industries and society. He is also a member of the Acquisition Focus Group, which publishes regularly in RUSI Defence Systems. In addition, he is professor emeritus at Cranfield University, where he still teaches, and where he was head of the Dept. of Defence Management and Security Analysis from 1997 to 2009. He also works regularly for the Naval Postgraduate School in Monterey, California, where he is an adjunct faculty member.

A joint author of a book on the U.K. defense industry, he was for six years an elected council member of the former Defence Manufacturers Association. He was previously professor of international relations at Staffordshire University and,

between 1990 and 1993, was head of the International Security Programme at the Royal Institute of International Affairs (Chatham House) in London.



“Somebody could break that pattern, but there do seem to be knowledge barriers to entry in defense that make it very difficult for new entrants.”

missile—because the U.K. needs a replacement, it needs something new to go on its helicopter fleet, and France is struggling to find the money. So far there’s no final commitment on that, but it’s a real test for many people in the acquisition community in the U.K.: Is France willing to make a sacrifice to help the U.K. when it really needs it—on the understanding that at some stage the U.K. will return the favor?

Operationally the level of cooperation between the armed forces is thought to have gone pretty well, and there are joint training and exercises in a number of areas. The French-led intervention in Mali saw the U.K. play a supporting role.

The whole UCAV area is complicated, not least because France has both Dassault and EADS developing capabilities in this area with no final decision on who should do what.

Do you think governments are getting better, on both sides of the Atlantic, at procuring complex defense and aerospace equipment?

I think some in government are coming to terms with the uncertainty attached to the process. There is in the financial planning community a longing for certainty, which just cannot be present when you’re dealing with a project as complex as the F-35. It’s quite difficult to predict until quite late in the day exactly how much it is going to cost and when it is going to be ready. And even late in the day things go wrong.

People who study complexity understand this, and people who study these systems understand it, so maybe political authorities are getting a bit wiser to accepting that certainty just is not possible. Whether we are getting better at managing it is an open ques-

tion. Certainly if managing means not making firm commitments when you don’t really understand fully what you are doing, in some cases governments are getting a bit better at not making premature firm commitments to time, cost, and performance. America’s Government Accountability Office produces useful material on this.

So where do you see the future defense and security threats coming from?

You need to understand the threats; but the world keeps changing, so governments struggle in that area. As I said earlier, there is value in capabilities that are useful in a variety of scenarios. And it’s almost impossible to say which kind of operation or where the U.K. or USA might operate next. If you look at the countries where the U.K. has operated in the last 20 years, it’s a list that would have been impossible to predict. So I think governments cannot expect that being taken by surprise is a thing of the past.

We need to look at developing generic capabilities. Systems that enable you to move troops, that enable you to survey, that enable you to hit targets precisely, that give you protection against even quite crude weapons—these are quite generic capabilities that will be useful everywhere.

So if you were the managing director of a major U.S. aerospace and defense company, how would you position your company to exploit the new opportunities emerging, while ensuring you are not too badly impacted by government budget cuts?

I see the broad issue for any U.S. defense company is the extent to which it is going to rely on the U.S. market and the extent to which it is

really going to try and sell to the wider world. And if it opts for external markets, what kind of changes to its business practices and business models is it going to make? This obviously has implications for the company’s whole marketing machinery, which I think in many cases is quite heavily focused on Washington.

[A company] also needs to assess the impact of the kind of changes being proposed to the export control regime. The export control issue really is divided into two parts: What is controlled (for what do you need a license), and the time taken and likelihood of obtaining one. The first is a legal issue, but there’s also a policy field around the circumstances where a license may or may not be issued.

In terms of the U.S. market, I think that you have to make sure that whatever it is you are offering is tied into the broad information space and the centrality of knowledge in military activity. For people who make platforms it’s probably the case that in terms of stealth and speed they will struggle to make advances of a step-level change. But the people who make things that go inside platforms are going to be a source of great advantage.

So how do platform-makers ensure that, electronically and information-wise, they are competitive?

Our rough calculation is that only about 10% of research and development in the world is being done in the defense sector. But of the remaining 90%, quite a lot is interesting to defense, and there are all kinds of questions about how the defense world keeps track of the civil 90%. How does it know what opportunities are coming up, and how does it in some cases get the people in the civil world to allow their technology to go into defense applications? Once it gets a defense label on it, it becomes controlled and its markets become restricted.

This issue about how defense organizations best exploit the global R&D picture is not just about the loss in dominance of defense in R&D but the loss in dominance of the U.S.

within the global R&D picture. Europe and Japan are comparable in size in general R&D to the U.S. but have a much smaller percentage of defense R&D expenditure. So that is an interesting subject for companies to address, and it's tied in to the whole information and electronics space.

Looking ahead five years, how different do you think the global defense market will look?

In five years' time the defense market won't look so different from today, unless there is dramatic political change in the [Persian] Gulf. The trends that we can see in defense are still very likely to be in place in that period.

Beyond 7-10 years, however, it becomes more difficult to tell. The ex-

perience we have so far is that, by and large, new entrants struggle in the defense sector to match what has been done by the established players.

Somebody could break that pattern, but there do seem to be knowledge barriers to entry in defense that make it very difficult for new entrants. If you look at the efforts that India and

"I don't think anyone really knows about China, although everybody has a view."

China have made, they have found it very difficult to catch up. Brazil has done well in the smaller commercial aircraft market, but that is very different to producing the sort of integrated combat systems that you need on a modern combat aircraft.

China does seem to be making strenuous efforts to catch up to the West in this area.

I don't think anyone really knows about China, although everybody has a view. I haven't seen myself any real sign that the Chinese are making any drastic leaps forward. They've obviously focused effort in the cyber area,

but as far as specialist defense systems are concerned I have not seen that they've made great advances. I'm

rather skeptical about their aircraft—their copying instinct still seems pretty strong, so I'd be very surprised if, in the combat aircraft area and weapons area, China were anything like competitive with the U.S., Europe, or even Russia.



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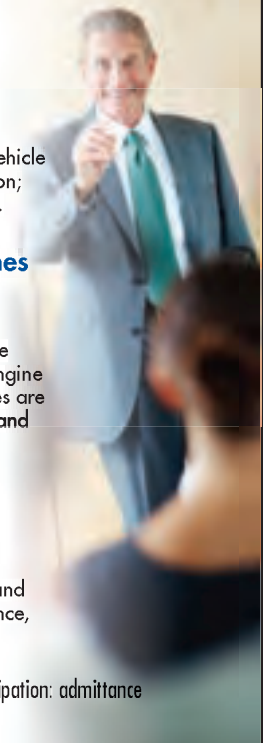
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Sequestration and the pivot to Asia

DEFENSE MARKETS HAVE FACED CONSIDERABLE uncertainty during the past year. Electronics markets, which have a guaranteed long-term future, may nonetheless see temporary downturns in many sectors. Major primes have already made preemptive cuts, including Boeing Defense, Space & Security, which has cut at least 8,000 jobs in the past two years. Moreover, in August 2012, U.S. contractors were granted an exemption from issuing 60-day warnings to workers laid off because of sequestration cuts. Many believed that a solution would be found, but now sequestration is here.

Some firms claim that in response to U.S. funding uncertainty they are focusing on international sales. In October 2012, Tom Kennedy, president of Raytheon Integrated Defense Systems, stated, "We have uncertainty" and are "trying to control what we can control" by boosting new international sales. However, the numbers generally belie these 'new market' strategies, as most companies would need to double international sales to boost overall revenues by just a few percentage points. And defense budgets are being cut faster in many parts of the world than in the U.S.

Some important U.S. programs of record will now undoubtedly be canceled, in addition to programs that have already been descope, such as the Army's ACS/EMARSS and Block 30 Global Hawk. Many efforts, including programs of record, upgrades, and new R&D programs, may be postponed.

Real and not-so-real cuts

In the FY14 DOD budget request released in April many RDT&E program lines allot unrealistically low funding levels to major programs beyond roughly FY14 or FY15—for example, both B-1B and B-2 squadron funding is essentially zeroed. This will of course *not* happen, and funding will

be restored. This is in most cases a budgeteers' trick.

The services can *threaten* major legacy program cancellations, but the attempt to do this with the Block 30 Global Hawk showed the most likely result: Congress will restore funding to crucial programs, fully aware of the trick. 'We can't pay our pilots!' and 'We must stand down two carriers!' are somewhat disingenuous when DOD funding levels are still higher than at any time in history until just a couple of years ago, even with sequestration. And every year we have fewer ships and fewer manned aircraft, as Cold War fleets (F-16s and F-15s, Ticonderoga cruisers) are still being retired to pay for smaller numbers of miraculous

(and miraculously more expensive) future programs (JSF, DDG-1000, and DDG-51 Flight III).

These are primarily ploys to ask for restored or increased funding. Congress will ensure that most important in-service legacy programs continue.

As another example, in November 2012 Congress declined the USAF's FY13 request to reduce the Air National Guard's (ANG) force structure, instead recommending the Air Force hold off reductions until a commission studied the situation. The service had originally suggested substantial cuts to ANG personnel. But like the Global Hawk, this was likely another service budget trick that was blocked by Congress.



Congress has blocked repeated efforts to make Global Hawk Block 30 cuts.

In addition, Congress blocked the Air Force's attempt to transfer MC-12W Project Liberty ISR aircraft to the ANG (probably to justify new ISR funding for the USAF). Considering that Special Operations Command still relies on Project Liberty in Afghanistan, and plans to do so even after the draw-down, this seemed a particularly questionable attempt to justify new program funding.

More electronics cuts likely

Instead, the medium-term effect of reduced budgets and sequestration will probably be many more cancellations of newer programs in the next few years, with effects through the next three to five years. The services hope to keep these programs, so there is no word today about which will be cut as they pray for the kind of ever-increasing defense budgets that a decade of war brought. But the likely reality is that continuing program cuts will occur for at least the next few years.

Already, in the FY14 DOD budgets, many *minor* R&D programs have been canceled after FY12 or FY13. This will probably hold, though some other new starts will continue. The moderate/large program cuts are just waiting for the next budget, or a catastrophic 'save' such as a major terrorist attack on U.S. soil or a new war overseas—events no one should ask for, of course. For once, perhaps, we should pray for peace and budget cuts.

In November 2012, Rob Doolittle, a spokesman for General Dynamics, said, "It is really impossible to anticipate what the impact [of sequestration] will be on any given program." That same month analyst Todd Harrison of the Center for Strategic and Budgetary Assessments said, "If they come up with a deal to avoid sequestration, I think the defense portion of that deal will be cuts [at] about half the level that sequestration would require. [But] instead of an even \$25 billion across every year for the next 10 years, it could be more back-loaded, and it certainly would give DOD the flexibility to target those cuts, to allocate them



JSTARS played the critical role of airborne surveillance and battle management command and control in Libya. USAF photo/Tech. Sgt. John Lasky.

in a thoughtful, strategic manner."

With sequestration now in effect, in mid-2013 we still have little information regarding the real major and moderate program cuts. Aside from the minor development program cuts and temporary tricks of cutting major legacy program support, we are waiting for further discussion and decisions.

Much discussion has addressed the many UAVs rushed into service in Afghanistan and Iraq. Will a \$30-billion or \$40-billion fleet end up parked in hangars? Despite a lack of firm plans, in April 2012, Air Force Brig. Gen. Scott Bethel declared his personal belief that the eight other combatant commands will clamor for these UAVs even if U.S. Central Command finds some excess to requirements. Teal Group believes there will be no shortage of demand for UAVs, and recent production line reductions may also be restored.

We do not see a mass retirement of recently purchased UAVs or other ISR assets (witness the Global Hawk and MC-12W attempts blocked by Congress), although older or obsolete systems such as the Army's small rotary-wing RQ-16A T-Hawk may be retired as technology advances. On the

other hand, some urgent-needs programs such as Project Liberty probably will *not* last long, with at least partial retirement, transfer, or mothballing in the next three to five years.

But in most cases new systems will replace the old, to enable the current ISR force level to be maintained or increased. Aside from Block 30 Global Hawk, there has been little call to reduce ISR capabilities, while there have been continuing calls to grow ISR for new theaters of operation like Asia.

Pivot sparks new needs

Lt. Gen. John C. 'Craig' Koziol, director of DOD's ISR Task Force, said in May 2012, "I think it's really important to have hyperspectral imagery, being able to use it along with wide-area surveillance, because you get really very detailed features on the ground in support of mission planning."

In an August 2012 editorial, Gen. John Michael Loh, former USAF vice chief of staff, argued that the "pivot toward the Pacific" will require a new type of ISR, moving from short-range UAVs and large fixed-base battle management centers to longer range, all-weather aircraft (to handle more adverse and extreme Pacific weather),



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wide-area surveillance sensors, and airborne battle management command and control (BMC2) centers. The U.S. does not have large, fixed BMC2 centers in Asia, with the exception of the Air Operations Center in South Korea.

All-weather sensor needs for long endurance platforms in less benign climates than the Middle East and Central Asia are also driving new developments in radio frequency synthetic aperture radars. This includes several programs developing SARs as replacements for today's electrooptical wide field-of-view sensors.

Col. Derrick Dykes, chief of Air Combat Command's C2 and ISR requirements division, said in May 2012 that PED (processing, exploitation, and dissemination) is where he would spend his next 'ISR dollar' if he had a choice, because the amount of data being collected is already more than the military can process and act on.

A2/AD: A shift in focus

With mission focus shifting to A2/AD (antiaccess/area-denial) environments, Col. Dykes agrees that, "We are looking at refocusing on operations in a contested environment." This includes assessing the need for penetrating collection capabilities both manned and unmanned, which the service has neglected since the 1998 retirement of the SR-71 Blackbird.

In addition to longer range and penetrating aircraft (and stealth), the Navy and Air Force's air-sea battle concept also will require greater range for standoff sensors in A2/AD environments—where it will not be possible to overfly a sovereign nation's territory as we could in Iraq and Afghanistan. This is not a strong point of today's ubiquitous gimbaled UAV EO/IR sensor balls.

Market emphasis may shift back somewhat to high-altitude sensors, and this could rejuvenate the remains of the old Cold War fighter tactical reconnaissance industry, with firms like Goodrich, or BAE Systems Electronic Systems in Greenlawn, N.Y. (formerly Fairchild Systems and, briefly, a Lockheed Martin division). Sleeper firms like these could win important con-

tracts for new near- and medium-term ISR sensors.

We should perhaps take Libya as a template for the future, more than Iraq and Afghanistan. The need was immediate and unforeseen. Large legacy piloted aircraft took back their Cold War roles of controlling the battlespace—initially AWACS during the no-fly zone and then JSTARS for ground surveillance and targeting. Senior commanders have all praised JSTARS and testified to the critical role of airborne surveillance and BMC2.

Teal Group believes this strategic sea change will encourage development of new sensors for a variety of *current* longer range ISR aircraft. This will be true especially for aircraft larger than the Beech King Air class, and especially for maritime patrol, to include the Navy's P-8I Poseidon and P-3C Orion, and international medium-scale ISR aircraft (between King Airs and JSTARS). New development programs—and larger development funding lines—will grow for longer range sensors for A2/AD environments.

For example, the USAF decided in June 2012 not to upgrade JSTARS, or buy a business-jet-based manned ISR platform—what its two-and-a-half-year analysis of alternatives determined was most needed for the 'pivot to Asia.' But with funding priorities likely to change and all Air Force long-range plans skewed today to ensure the future of the F-35, we believe this may be revisited sooner than claimed—another hidden text.

In either case, long-rang oblique photographic sensors like Goodrich's SYERS, a derivative of the U-2 sensor, have been tested aboard JSTARS. And long-range targeting pods (Lockheed Martin's Sniper and Northrop Grumman's Litening) are an increasingly ubiquitous fit for high-altitude bombers such as B-1s and B-52s.

Despite sequestration, Teal Group expects sensors to 'go long and go wide' for new environments in East Asia and over the Pacific, and for new threats that show a greater ability to defend themselves.

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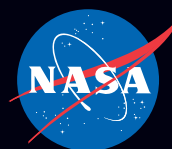
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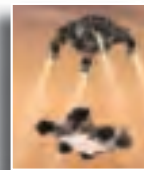


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Getting ahead of the threat:

by **Emilio Iasiello**

Emilio Iasiello is the chief threat analyst at iSIGHT Partners, a global cyber intelligence firm, supporting federal and commercial entities to manage cyber risks. He has worked in cyber threat analysis since 2002, both as a government contractor and a civilian with the Dept. of State and the DOD, respectively.

Since May 1962, when the first U.S. airline was hijacked to Cuba, to the catastrophic events of September 11, 2001, the individual—whether terrorist, ideologue, or criminal—has been the biggest threat to airline operations and passenger safety. Motivated by 9/11's unprecedented fallout, the aviation industry committed itself to revamping its security apparatus, collaborating with government, industry, and labor to enhance its ability to identify and mitigate the physical threat to aviation.

Many significant accomplishments have resulted from this effort, including the creation of the Transportation Security Administration to oversee U.S. public transportation; establishment of DOT Rapid Response Teams, charged with developing recommendations to improve security; and the development of a common aviation industry strategy to address onboard criminal and terrorist acts.

As air traffic management systems become increasingly sophisticated and reliable, they also become more vulnerable to cyber attack from bad actors. As we develop more and more tools to increase our interconnectivity, we must also develop the methods to protect them.

However, while the aviation industry continues to refine physical security practices, it still has not addressed the potential cyber threats against its information infrastructure and the 'fragilities' that can be exploited therein. Part of the reason may be rooted in a few anecdotal instances of hackers successfully compromising airline information assets.

Nevertheless, the absence of evidence does not equate to an absence of threat. In its 2003 National Strategy for the Physical Protection of Critical Infrastructures and Key Assets, the government classified the transportation sector as of vital economic importance and the aviation industry in particular as a key symbol of U.S. technological and industrial achievement. As a result, the industry should be compelled to develop a comprehensive strategy to shore up its cyber security posture through policies, standards, and an international regulatory framework to position itself ahead of the threat rather than reacting to it.

NETWORK VULNERABILITIES

Successful civil aviation operations rely on a highly networked and interconnected environment that includes voice and data communications traversing the aircraft, the air traffic management system, and any ground or satellite stations feeding data through this cycle. These innovations promise to revolutionize our aviation experience with state of the art equipment to facilitate

Aviation and cyber security

processes, increase flight safety, improve communications, and streamline operations. However, the more networked an enterprise, the greater the opportunities to exploit any inherent weaknesses. Aircraft-to-ground, aircraft-to-aircraft, and in-aircraft access points can all be exploited.

•By 2020, ADS-B (Automatic Dependent Surveillance Broadcast) will be a compulsory requirement on the majority of aircraft, as part of the U.S. Next Generation Air Transportation System (NextGEN) initiative, as well as Europe's SESAR project, according to Airport Technology, an online resource for the aviation industry. ADS-B is a surveillance technology that will be replacing radar as the primary means of tracking aircraft. As a data infrastructure, ADS-B will provide traffic and weather information, offering better communication between the aircraft and air traffic control.

As these efforts are implemented worldwide, there are concerns regarding the security of the system and the information traversing its infrastructure. To date, the ADS-B system remains unprotected and vulnerable to cyber attack. Communications between aircraft and air traffic controllers remain unencrypted and unsecured, potentially granting hostile actors a vector from which to cause disturbances in air transportation.

The FAA asserts that ADS-B signals will be confirmed by radar, while automatically weeding out 'fake' signals using a process called multilateration to determine the ori-

gin of every ADS-B signal. While such redundancies should help foster safe operations, the FAA does not offer any specifics on how this would work, citing sensitivity considerations.

Multilateration employs a number of ground stations that implement a method known as Time Difference of Arrival to accurately locate aircraft. However, multilateration is not exempt from potential tampering. Nodes are susceptible to attacks by malicious actors seeking to manipulate data or the nodes themselves, for example, reporting false position and distance information or modifying measured positions and distances of wireless nodes.

In addition, several aspects of NextGEN place the new system in its current form at risk to cyber-based attacks. It is unknown how the FAA's security action plan would respond should any of its devices and solutions be exploited.

•COTS. NextGEN will use information services that have implemented COTS hardware and software technology. While popular and accessible, COTS technology presents significant security challenges for its operators, due to the difficulty in verifying the security of COTS products. These systems regularly are used without ownership of, knowledge of, or access to source and application code. That same code is of-

Communications between aircraft and air traffic controllers remain unencrypted and unsecured, potentially granting hostile actors a vector from which to cause disturbances in air transportation.

In 2011, Iran stated that it had captured a U.S. drone by spoofing the GPS signals it received, fooling the drone into thinking it was landing at its home base.

ten developed overseas, with little documentation, minimal configuration management, or both. And as COTS use expands, identified weaknesses can be exploited to attack all the users of that same system.

In addition, COTS software is generic and does not typically address instance-specific features of an enterprise's unique operating environment. Also, hidden functions can be embedded into COTS technology as developers and operators tend not to test for things they do not know about.

- GPS. NextGEN will replace radar with GPS as the primary means of aircraft identification. Several incidents have demonstrated that GPS has been subject to intentional and unintentional targeting and disruption by both state and nonstate actors. For example, in a 2012 demonstration to FAA and Dept. of Homeland Security representatives, researchers using only \$1,000 worth of equipment hijacked a small drone, highlighting the exposure of unencrypted GPS signals. In the U.S., nonmilitary drones rely on signals from open civilian GPS, which make them prone to spoofing.

In 2011, Iran stated that it had captured a U.S. drone by spoofing the GPS signals it received, fooling the drone into thinking it was landing at its home base. By jamming the remote control communications, the drone is forced into autopilot, thereby being susceptible to receiving spoofed coordinates. Earlier, in 2009, Newark Liberty International Airport experienced sporadic outages of the GPS Ground-based Augmentation System used for precision approach landing. The ground station 300 ft away experienced signal interference every day at about the same time. The FAA discovered the cause of the outage was a GPS jammer being used by a truckdriver to avoid being tracked by his employer.

- Cockpit IT systems. New generation aircraft include advanced cockpit IT systems that use generic Internet Protocol. These cockpit systems are integrated with ground networks through high-speed communication links on the ground (over wireless technologies) and in flight (over broadband satellite networks). Wireless access points are notoriously very weak, often unsecured, and susceptible to signal interception and manipulations. COTS technologies are also used to support these systems.

- Satellites/ground stations. Aircraft rely-

ing on satellites for communications provide another avenue of access to malicious actors. By gaining access to a satellite or its ground station, an attacker can deny or degrade, as well as forge or otherwise alter, the satellite's transmission.

AVIATION HACKING INCIDENTS

Physical attacks continue to be the biggest threat facing aviation. However, unconventional threats such as hacking have surfaced in recent years that endanger aviation facilities and operations. Technology used in the aviation transportation system infrastructure is not immune to cyber threats, and the networks that support critical airport information assets are susceptible to both virtual and physical threats. The 21st century has ushered in a vast cyber threat landscape, bolstering the need to ensure the confidentiality, integrity, and availability of information and information systems as passenger numbers and flights increase globally.

Recent incidents demonstrate an escalating interest from actors targeting aviation. In 2011, radio hackers broke into frequencies used by British air traffic controllers and gave false instructions to pilots or broadcast fake distress calls. In 1998, three similar incidents were reported; in 2010, 18 were reported, and halfway through 2011, 20 were noted. In 2011, the Australia-based Internet security company Pure Hacking performed a penetration test on an airline network. With one hack, the tester escalated privileges that resulted in the complete compromise of an airline network. This included capturing credit cards, plans, communications, and databases.

In 2009, the FAA admitted that the nation's air traffic control systems were vulnerable to cyber attack, following 2008 incidents when hackers accessed personnel records and network servers.

THREAT ACTOR LANDSCAPE

The threat actor landscape is vast, composed of groups and individuals with the intent to target critical infrastructures to meet tactical and strategic objectives. While capabilities may hinder some of these actors, resources are becoming more available and at an increasingly reduced cost.

Simply put, the window of opportunity is an expanding aperture. Aviation relies on the public trust for its success; hostile actors can undermine this trust through cyber attacks meant to deny, degrade, disrupt, or

destroy aviation's information systems or the information itself, and publicizing their actions. In this regard, the target of the attack is not the system so much as the public's confidence in the integrity of networks and systems. The players may range from attention seekers to hostile nations.

- Hackers/hacktivists. These groups represent the largest segment of the hostile online underground, ranging from individuals to large groups with varying levels of sophistication. Typically, those inclined to attempt to compromise the aviation industry most likely are seeking a challenge and/or notoriety rather than actually trying to impact airline operations. Also, white-hat hackers such as security consultants may try to compromise aviation in order to reveal vulnerabilities in an attempt to raise awareness for security purposes.

Hacktivists, however, would seek to target aviation if doing so supported their political/ideological beliefs. In 2011, the TSA reported that unidentified hackers, allegedly from overseas, launched cyber attacks against a railroad company, disrupting rail signaling and traffic in the northwestern U.S. for two days.

- Terrorists. Aviation remains a prime target for terrorists and terrorist organizations that are seeking a visible, damaging impact on a significant public infrastructure. Though this group has largely used the Internet for communications, planning, recruitment, and propaganda, there has been limited evidence of terrorists or terrorist sympathizers actually conducting cyber attacks.

In March 2012, *Assessing Cyber Threats to Canadian Infrastructure*, a paper prepared for the Canadian Security Intelligence Service, noted that "passenger flights, cargo flights, and airport facilities have all been subject to terror attacks as part of al-Qaeda's economic jihad against the West." In addition, laptops taken from al-Qaeda operatives have held information related to programming data and software sites for SCADA (supervisory control and data acquisition) systems, power, and water company sites, indicating a growing interest in critical infrastructure as a possible target.

- Nation states. Typically, hostile cyber activity has targeted the aviation industry (primarily companies involved in the manufacturing process) in order to steal sensitive and proprietary information, rather than against airports, airport/aircraft communications, or aircraft in flight.

Although aviation may be a tactical ob-

jective for terrorists, it would serve more often as a strategic target for a nation state. Any type of network mapping or reconnaissance directed against airports, aircraft, or air traffic communications would support a strategic objective that could be leveraged should nation state relations deteriorate and military conflict become evident.



Is the hacking threat against aviation real? Absolutely. As a key critical infrastructure and an essential link to commerce and passenger transportation, the global aviation industry will remain a target for adversaries seeking to make a statement or cause substantial loss to life and financial bearing. Like many emerging threats, cyber attacks still loom in the periphery, bordering on the 'not yet realized,' and are seen more as a stylized fiction than an actual possibility.

...the target of the attack is not the system so much as the public's confidence in the integrity of networks and systems.

However, the U.S. has borne witness that all it takes is one incident to transform possibility into reality. The consequences of not foreseeing such an event cost the aviation industry considerably. According to the International Air Transportation Association, U.S. airline revenues dropped from \$130.2 billion to \$107 billion in 2002. Losses of \$19.6 billion were reported in 2001-2002, and between December 2002 and October 2005, United, Delta, Northwest, and US Airways had filed for Chapter 11 bankruptcy reorganization.

The aviation industry is being given another opportunity to prepare for a threat that as yet has not severely impacted its operations. Terrorists—a visible threat—caused people to avoid air travel after September 11. Gradually, confidence returned as more stringent security was implemented, but not before grievous loss of life as well as serious financial losses were incurred. Fast forward to today, as aircraft become more technologically advanced. If proper security considerations are not enacted, vulnerabilities can and will be exploited.

The one constant in the cyber world is that all modern and advanced technologies have either been hacked or are looking to be hacked by the bad guys. The key to being secure in this environment is being ahead of the threats, not reacting to them after they've already commenced. ▲

UAV Roundup 2013

Despite tight defense budgets, worldwide demand for UAVs is projected to increase. Military leaders say the growing capabilities of unmanned aircraft will revolutionize the conduct of warfare. As these systems become affordable, they could make some poorer nations and nonstate groups more dangerous as well. In the civil sector, applications also are proliferating, privacy concerns notwithstanding. With the opening of controlled airspace to UAVs, the commercial market could soon dwarf military demand.

For UAVs, the road to success has been long and uneven, leading a long-time aerospace executive to label them the ‘vampire’ technology—rising up one day, only to be killed the next, then revived for a repeat cycle a few years later.

U.S. and Israeli military leaders began serious studies into UAVs in the early 1960s. The USAF and Navy introduced highly classified models into combat over Vietnam.

Development of advanced UAVs continued through the 1990s, leading to their widespread use as U.S. forces moved into Afghanistan and Iraq after September 11, 2001. Then, UAV technologies took a major leap forward with the introduction of MQ-1 Predators armed with Hellfire missiles. Since then, UAVs have flown thousands of missions. Both military and civilian UAVs are in use by almost every country, including nearly 60 with their own manufacturing capability.

Unprecedented growth

UAVs have broken out of their ‘vampire cycle.’ The withdrawal of U.S. and coalition combat forces from Iraq and the ongoing drawdown in Afghanistan—combined with tight global defense budgets—might seem

prelude to a decreased demand for UAVs; yet just the opposite is true.

The *Aerospace America* Global UAV Roundup for 2011 listed 44 nations and 226 manufacturers developing and producing some 675 aircraft—194 of them in the U.S. This year, it contains 57 countries and 270 companies responsible for more than 960 distinct UAVs—144 of them in the U.S. In all three categories, numbers have increased—20% for companies, 30% for countries, and 40% for aircraft.

Some lists claim over 400 manufacturers, but many of those, although included in the 2011 roundup, are missing from the new one. Many were part of buyouts or mergers; others went out of business, some because of their countries’ economies. A few were even seized by authorities who charged their owners with fraud, a not-uncommon event in any booming industry.

The rapid change in this sector makes exact counts impossible. For example, as we write this, Germany has canceled the EuroHawk, and the founder of Tasma in the U.K. announced that he was liquidating his company.

Frost & Sullivan’s latest global military UAV market analysis predicted total sector sales between 2011 and 2020 will reach



MQ-8B Navy Fire Scout—U.S.

\$61.37 billion—\$7.31 billion in 2020 alone, an increase of more than 60% from 2010.

The U.S. will remain the largest producer and operator of UAVs throughout this decade, accounting for about 45% of the global market. Israel is the world's second largest UAV producer—and the largest exporter, selling systems to some 49 countries, with fewer use restrictions than the U.S. places on its customers.

Given U.S. leadership in this industry, significant changes in the country's defense spending also will impact the global market, both military and civilian.

"The U.S. will reduce its spending on UAS as it is adequately equipped to meet its needs. Although the country has plans to increase its inventory by more than 35% over the next 10 years, market revenues are expected to decline at least until 2020; the U.S. military UAS space is undergoing a transition from procurement to sustainment, with most future procurements likely to be limited to upgrades," Frost & Sullivan predicts.

For nations scrambling to create their own UAV fleets, the emphasis is on developing indigenous manufacturing capabilities, a trend likely to continue.

In May the National Defense Industrial Association reported that there are about

4,000 UAVs operating worldwide, the result of double-digit annual growth in demand. Most are small ISR (intelligence, surveillance, and reconnaissance) platforms, but the past five years have also seen growth in civilian applications (primarily agriculture).

Anticipated FAA regulations granting UAVs permission to fly in controlled National Air Space, along with similar measures in Europe and Asia, will provide the foundation for civilian market growth that will dwarf military demand.

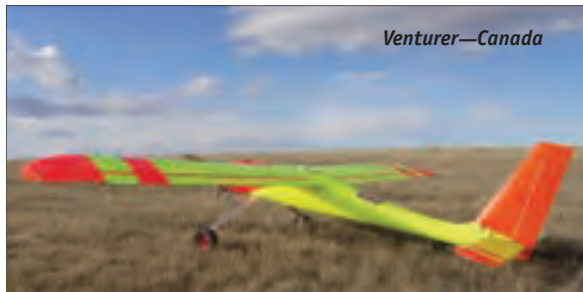
The military future

The current upsurge in demand for UAVs began with the success of the rudimentary Pioneer in Desert Storm. Improvements in computing technology, communications, and GPS navigation led to the 'decade of the robot,' launched by post-9/11 U.S. combat operations in Afghanistan and Iraq. The use of the Hellfire missiles on the Predator marked a quantum leap for UAS, providing not only persistent ISR but also a developing persistent strike capability.

Lethal UAVs also evolved into personal attack systems like the Switchblade mini-UAV (MUAV) and, though still in development, bird-like and even insect-like flap-

ping-wing reconnaissance and situational awareness micro-UAVs (MAVs).

Northrop Grumman's X-47B UCAS-D—about two-thirds the size of a V-22 Osprey—in May became the first UAV to take off successfully from a modern aircraft carrier. The U.S., Europe, Russia, China, and India are leading proponents in the development of UCAVs, including what is termed a sixth-generation optionally piloted stealth fighter. The potential use of UCAVs in combat has led some to predict that the fifth-generation F-35 may be the last manned-only fighter built by the U.S. However, the first step is expected to be an integration of manned and unmanned aircraft, flying joint missions with the F-35 pilot controlling one or more UCAVs in a coordinated strike.



Because UCAVs have far greater range than any manned fighter and can perform high-speed maneuvers impossible for a pilot, that advance would be the next major change in air warfare, following stealth and supersonic flight. A complete conversion to an unmanned fleet, which some UAV experts believe could become a reality before midcentury, would forever change the shape of not only air combat, but warfare itself.

At the other end of the spectrum, advanced batteries, electric power systems, and miniaturized computing will change the nature of ground combat. That will include a wider variety of MAVs, as well as new 'nano-UAVs' such as swarming intelligent robot 'flies,' with enhanced ability to enter buildings and perform stealthy 'perch-and-stare' ISR missions.

Although much of the capability for creating such top-of-the-line aircraft has been developed by the world's technology superpowers, it also relies on commercially developed technologies, especially in on-board computing. Thus, while a true sixth-generation UCAV likely will remain in the fleets of fewer than a dozen nations during most of this century, the types of UAVs used by the U.S. and its allies in Southwest Asia will become common in the invento-

ries of nearly all nations—and of nonstate groups such as al-Qaeda as well.

Civilian UAVs and privacy concerns

"As commercial mobile robot use continues to grow, defense spending will increase as commercial systems drive capability, reliability, and price points. Specifically for UAS, as legislation barriers gain definition over the next several years, commercial spending will exceed defense spending," Derrick Maple, principal analyst at IHS Industry Research and Analysis, predicts. "Countries that delay airspace integration will lag in technology development, manufacturing, job development, and economic stimulus and will have to rely on imports."

UAVs already are making their way into civilian applications. Initially, these are low-level law enforcement and environmental monitoring efforts far from populated areas. However, generally small platforms operating in uncontrolled Class G airspace—up to 1,200 ft above ground level—have become increasingly common at universities. Demand also is growing for UAV use in monitoring crops, wildlife, forest fires, and traffic, as well as remote-area delivery of medicine, aerial news and sports photography, TV and movie production, and more.

All this has placed increasing pressure on the FAA and others to approve the use of UAVs in civilian airspace. It has also led legislators to create laws regulating both civilian use of UAVs and the extent to which they can be used by government.

While only a handful of UAVs were aimed at the civilian market in 2011, many offered today are either dual-purposed for both military and civilian applications or intended for commercial, academic, law enforcement, and even personal use.

This year the FAA forecast that some 7,500 commercial small UAVs could be flying in the U.S. within five years. While the media have focused on law enforcement demand, a March AUVSI study predicted that "the agriculture market will be at least 10 times the public safety market."

Key to obtaining approval from regulatory agencies is a proven 'sense-and-avoid' capability to prevent collisions with other aircraft. Although civilian R&D is under way, that technology, too, may come from the military, a response to pilots who faced thousands of UAVs operating in Iraq and Afghanistan.

The most vocal concerns about UAV use involve privacy. Legislatures in 33 states have introduced bills to restrict UAV use within their borders, and both parties in Congress have voiced support for similar federal legislation. In Europe, government hearings and similar studies on privacy issues also are under way.

“We urgently need greater clarity and transparency about when and how these tools are deployed,” says Eric King of Privacy International. “Not too long ago, this was the stuff of science fiction, but flying robotic devices equipped with facial recognition technology and mobile phone interception kits are increasingly commonplace.

“However, the secretive way in which surveillance drones have been put into operation—and the failure of the police to recognize and address the human rights issues involved—has created a huge potential for abuse.”

UAV opponents face a strong economic argument. A recent AUVSI report predicts that opening civil airspace to UAVs will create up to 100,000 new jobs in the next decade or so, add as much as \$100 billion to the nation’s ailing economy, enhance public safety, and enable more productive agriculture, resulting in lower food costs.

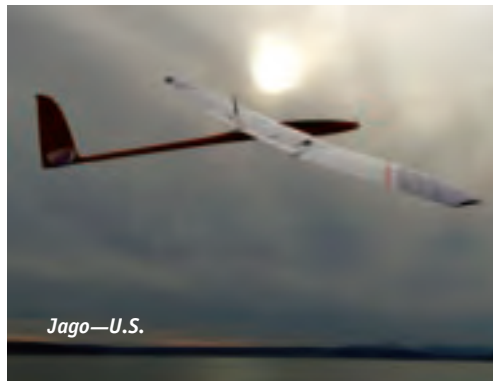
“The economic benefits to the country are enormous,” the report said. “States that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not.”

U.S.

The future development and use of military UAVs offer great opportunities to U.S. industry and defense, but not without risk.

In 2012, a Chief of Naval Operations Strategic Studies Group tasked with generating innovative concepts for the use of unmanned systems in all domains, issued a report entitled “Way Ahead Plan: The Unmanned Opportunity.”

“Incremental projections of today’s successes do not look sufficiently far into the future,” the report warned. “A mismatch between future capabilities and challenges represents risk to both the Navy and the nation....Ad hoc procurement of more unmanned vehicles, devoid of an overall concept of their use in the context of the entire naval force and the uncertain threat environment, will increase that risk.”



With implications for the other services as well, the report said the Navy must merge manned and unmanned force structure “in a cohesive and seamless fashion” if it is to meet the dynamic range of emerging challenges. To that end, it proposed an “Over-arching Concept” for UAVs.

“The Navy must adapt to evolving mission sets. Maximizing naval mission effectiveness will require integration of manned and unmanned entities in all domains (land, sea, air, space, and cyberspace). This



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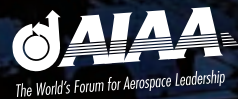
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integration will also provide new opportunities for mission accomplishment that will revolutionize concepts of operations and related doctrine—and may render some current missions, systems, and approaches obsolete,” said the report. “Integrated and netted manned/unmanned force structure will be a force multiplier.”

Stories of armed Predators and Reapers carrying out strikes in Afghanistan and Pakistan have made these aircraft the primary image of U.S. UAVs. In truth, both the platforms and the technologies they use will soon be replaced, not only by larger, more versatile, and more lethal UCAVs, but also by MUAVs such as Switchblade and even swarms of robotic flies.

As the rest of the world struggles to catch up to and even improve on current U.S. platforms and capabilities, DARPA, AFRL, NRL, and industry are pushing both to the next level.

Israel and the Middle East

Israel, needing to maintain a high level of ISR along its borders and even over the sometimes hostile states that surround it, was the first to create a modern UAV. It has remained a design and technology leader, often working with U.S. and European companies to develop new platforms and capabilities.

Second only to the U.S. in the production—and, some argue, sophistication—of UAVs, Israel also has become the world's number one exporter of unmanned systems, including to some Islamic states, such as Turkey and Azerbaijan. Since 2005, Israeli UAV exports have totaled \$4.6 billion, jumping from a nominal \$150 million in 2008 to a record \$979 million in 2010. Recently, sales have trended the other way, down to \$627 million in 2011 and only \$260 million in 2012.

Those sales are subject to the often volatile politics of Israel's customers. Turkey, for example, has grounded all of its Israeli-built UAVs to focus on domestic platforms in what is generally seen as an effort to shore up Turkish standing in the Muslim world. And in April, Israel's largest customer, India—to which it has sold nearly \$1-billion worth of Heron UAVs—announced it was rejecting a proposed joint UAV development program, reportedly worth several hundred million dollars, to focus on purely domestic projects.

In a rare interview with the Israeli daily *Haaretz*, army reserve Brig. Gen. Ophir Shoham, head of the Defense Ministry's R&D division, predicted that demand for Israel's advanced UAVs will remain high, especially in a period of austere budgets. This is because it is cheaper to buy and operate a top-of-the-line UAV than to train a pilot and acquire and maintain his aircraft.

“In recent years, there have been more pilotless sorties than piloted ones in the Israeli Air Force,” he said. “Within a few years, there will be a number of operational missions of a known character that we will be able to carry out with a small number of unmanned devices. That's the direction we are taking.”

Others in the region have had a hard time developing domestic UAVs with even a fraction of the reliability or capability of Israeli, U.S., or European systems. Most rely on platforms purchased from abroad.

Adcom in the UAE has been among the most prolific manufacturers, with a wide range of UAVs bearing the name Yabhon, though they have little else in common. The company's most recent program—the United 40—is aimed at the international market for medium-altitude, long-range UAVs, on which Turkey also has designs. Through domestic production and multiple purchases from almost every major manufacturing nation, the UAE also has become the largest UAV operator in the Arab world, with possibly the largest fleet of small unmanned helicopters in the world.

According to officials of the 2013 International Defense Exposition (IDEX) in Abu Dhabi, the Middle East market should equal \$1 billion through 2021. For the first time, IDEX dedicated an entire exhibition hall to unmanned systems during the show.

While Israel will continue to dominate UAV production in the region, the fastest growing user nations—Saudi Arabia, Egypt, Iraq, and the UAE—are not likely to be cus-





tomers. Nor is one of the most enthusiastic users of combat UAVs—the Iranian-backed, Lebanon-based terrorist organization Hezbollah, which has sent numerous UAVs into Israeli airspace in recent months.

Europe

While nearly every European nation is working hard to develop both national and EU development and manufacturing capabilities for leading-edge UAVs, NATO—with 26 of those countries as members—generally reflects the views of each. That is, of course, strongly influenced by what happens in the U.S.

“Over the next five years, NATO nations (especially the U.S.) will considerably reduce their investment in defense and security UAVs, while the non-NATO world will move into those military and police UAVs in a relatively big way,” the Market Intel Group predicted in its report, “Unmanned Aerial Vehicles for Defense and Security: Technology & Markets Forecast—2013-2021,” issued in April.

“The U.S. DOD is changing its focus from counterinsurgency to a more traditional conflict against a near-peer. That move will reduce the need for expensive UAVs, but will increase the need for fast, stealthy, survivable UAVs.”

Military UAV growth in Europe, from domestic production as well as purchases and leases from the U.S. and Israel, has been substantial. However, significant gaps remain in future defense requirements. Highly capable high-altitude/long-endurance (HALE) UAVs are beyond the budgets or technological capability of many nations, while more affordable medium-altitude/long-endurance (MALE) platforms lack some of the capabilities being sought. Thus there

is intense competition to develop UAVs that fall somewhere between MALE and HALE.

Europe also is working hard to develop its own UCAVs, from the multinational nEU-ROn to the British Taranis, EADS Baracuda, and BAE Systems Corax.

Joint efforts in Europe include working with regulatory agencies to enable UAV flights in civilian airspace (taking a lead over the U.S.), joint venture development of new technologies and platforms, and expanded use of UAVs for border and coastal patrol and homeland security.

One such effort is PERSEUS (protection of European seas and borders through the intelligent use of surveillance), a consortium of 29 companies and government agencies from 12 European nations. Approved by the EC in March 2010 and launched in 2011, the four-year project’s main objective is to integrate existing systems with new ISR technologies (especially UAVs) to build and evaluate the European Common Situational Information Picture.



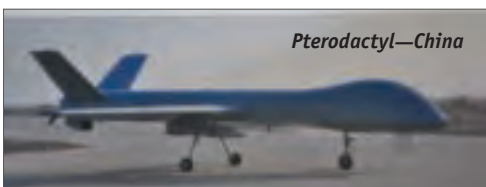


Europe also has seen faster implementation of nonmilitary UAVs, including their use in the security system for the 2012 Summer Olympics in London. With national civil aviation authorities working closely with their EU counterpart, Europe expects to see civil airspace opened to UAVs by 2016. While that is a year later than the target set by the FAA for the U.S., European officials have expressed doubt the U.S. goal is attainable.

In reality, civil UAVs already are becoming a common sight in many EU nations, especially the U.K. and France. The U.K. has given more than 130 private firms and government agencies permission to fly through civilian airspace, while France has granted limited approval for homeland security-related operations.

China and Pacific Asia

As China continues to expand its military capabilities as a regional superpower, more focused on India and Japan than the U.S. (which it would prefer to simply stalemate), it has become the world leader in robotics. Industrial robots are the greatest example of this, with more than 32,000 expected to be in service by 2014.



In addition, China has announced plans to launch patrol and coastal surveillance UAVs in 11 provinces, while the People's Liberation Army (PLA) has begun fielding some 100 unmanned VTOLs.

"China has ramped up unmanned systems development faster than any other nation and threatens to surpass the West in technology and capability," says IHS's Maple. "China has been operating UAVs for information security missions for some years now. The future holds more armed capability and export potential."

In March, the Project 2049 Institute, a Washington, D.C.-based think tank with an Asian focus, issued a report noting the PLA's growing emphasis on becoming a leading power in unmanned aviation.

"UAV systems may emerge as the critical enabler for PLA long-range precision strike missions within a 3,000-km radius of Chinese shores. Emphasis on reducing the radar cross-section of new UAV designs indicates an intent to survive in contested or denied airspace," the institute noted. "The ultimate goal of combined UAV and missile campaigns would be to penetrate otherwise robust defense networks through tightly coordinated operations planned to optimize the probability of overwhelming targets."

Despite repeated exhibits of seemingly advanced UAVs at various shows in recent years, the actual level of Chinese technology is unknown. Most experts, however, believe China will continue to lag behind in UAV development for many years.

While no other Asia-Pacific nation has the funding China can bring to UAVs, nearly all are pushing ahead with as much speed and advanced technology insertion as possible. Leading the way are Japan, South Korea, Malaysia, Singapore, Taiwan, and Indonesia. Their research, procurement, and, where possible, domestic production will continue to grow in the foreseeable future.

Asia also is a major growth market for civilian UAVs. In many cases, those nations are not as restrictive in unmanned flight through civil air space as North America or Europe, which could make them the opening front in the coming civil UAV market explosion. Japan, for example, has used UAVs to assist its aging population of farmers for more than 15 years. And Australia has long permitted the use of UAVs for real estate inspections. In addition to increasing requirements in both nations for military UAVs, their civilian markets are expected to continue growing.



Eleron 3sv—Russia

Russia

A spacefaring nuclear power that has sold fighters and other military systems worldwide, Russia has been unusually behind in developing advanced UAVs. In recent years, Russian officials have said that some \$172 million spent to develop indigenous UAVs has had unsuccessful results, failing to meet speed, altitude, and other requirements. Until those problems can be resolved, Russia's military is relying heavily on UAVs purchased from Israel.

Russia's breakthrough program appears to be a classified UAV inadvertently revealed in February during a photo opportunity for Defense Minister Sergei Shoigu. The picture showed a model of the Tranzas/Sokol Altius MALE UAV, which officials have promised will be ready in 2014.

It is part of a \$13-billion multiyear effort to develop a full line of military UAVs, from ISR to strike, through the end of the decade. The plan, announced by President Vladimir Putin, will likely include collaborative efforts with Israel and European manufacturers.

The question is how far the effort will go toward closing a multidecade gap in development. Lt. Gen. Anatoly Zhikharev, Russia's long-range aviation commander, said in a 2012 interview that the deep strike UCAVs the nation is trying to develop will not see fielding until 2040 at the earliest.

Putin's government is under increasing pressure to bring the former superpower into parity with other advanced militaries. The gap in unmanned systems development is largely due to decades of Russian military disdain for UAVs.

India and Pakistan

India is now a third of the way through a 15-year, \$6-billion plan to design and build an indigenous unmanned aerial capability. That includes production of at least 400 small UAVs and some 100 large UCAVs, along with some mid-size ISR platforms in production by the country's Defence Research & Development Organisation.

Five other Indian manufacturers currently have more than 15 platforms in development or production, all in the small-to-medium classes.

Continued tension and border clashes have spurred the UAV efforts of both India and Pakistan. The latter also reports multiple domestic companies working on nearly three dozen platforms.

The exact status—even the platform names and manufacturers—of many Pakistani and even some Indian UAVs is difficult to ascertain.



Lakshya II—India

Latin America

With only minor, isolated border skirmishes to engage their militaries out-of-country, Latin American nations' interest in UAVs focuses primarily on border security, operations against organized crime, especially increasingly powerful drug cartels, and a few remaining insurgent groups. Thus several of these countries are in the market for both MALE and HALE systems.



Guerrero—Mexico



Nauru—Brazil

Those include the Israeli Hermes 450 UAVs that Brazil has acquired for its army and navy; counter-drug-missioned platforms for Argentina and Bolivia; border patrol and environmental monitoring systems for Venezuela; and both MAVs and tactical UAVs (TUAVs) that Mexico is seeking for naval and homeland security missions.

As part of its growing dominance as the Southern Hemisphere's technology leader, Brazil also has dramatically grown its indigenous UAV capability in recent years. The country currently has at least a dozen government and industry manufacturers with over 30 UAVs in production or development—mostly small target drones and agricultural/environmental monitors.

Africa

South Africa is the only African nation with a UAV manufacturing capability. Denel Dy-



Seeker II—South Africa

namics also has been part of the global export market with its Seeker II+ TUAV and newer Seeker 400 and Hungwe UAVs. In addition to a controversial Seeker 400 sale to Saudi Arabia, which would become the platform's first foreign user, Denel reportedly has agreed to help the Saudis build their own armed UAV, something they have been unable to buy from the U.S.

As Africa's nations cope with internal warfare, regional conflicts, and pirates, they have become a growing market for UAVs dedicated to border patrol, ISR, and counterterrorism. Examples include Kenya's 2012 acquisition of its first AeroVironment RQ-11 Raven small UAS, and Mali's interest in an antiterrorism UAV.



UAVs offer even the poorest nations the option of building an aviation force for border patrol and ISR when modern manned aircraft, pilots, and maintainers are unaffordable. But the open availability of UAVs will give nonstate groups greater power as well.

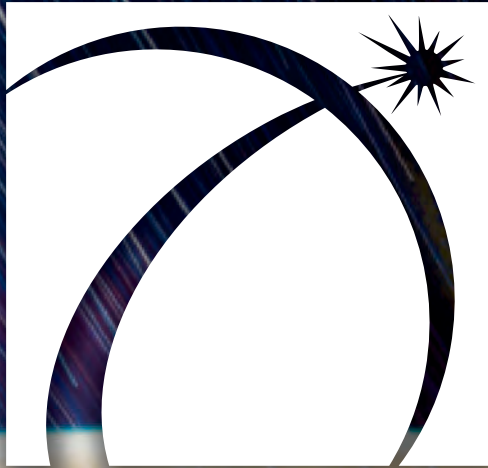
As UAV technology advances, the concept of air warfare will continue to evolve toward a state previously envisioned only in fiction. Although it is unlikely the U.S., China, India, Russia, or most of Europe will convert to entirely unmanned military air fleets, at least through most of this century, smaller nations may decide that is the best course for them, offering high-tech capabilities at far less cost.

Thus the continuing spread and evolving technologies of UAVs will have the contrary effect of giving their users greater security while also making both state and nonstate aggressors more capable and dangerous. This could lead to increased incidents of aggression by nations whose leaders, seeing no risk to their own human warfighters, take a more cavalier attitude toward the use of force.

Meanwhile, the anticipated explosion of demand and production of UAVs for nonmilitary applications is certain to become a new driver in advancing UAV technologies. It also will generate endless debate on privacy issues and place pressure on lawmakers to respond.

What can be posited with relative certainty is UAVs are emerging from a decade of war as the single most important and sought-after technology since the public Internet, with an impact on the future of humankind akin to computers, spacecraft, and manned aviation. ▲

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A new ERA for aviation

Aeronautics, the so-called ‘silent A’ in NASA, is about to get quieter, literally—and greener, too. The agency’s Environmentally Responsible Aviation (ERA) project is midway through a six-year integrated effort to research ways of significantly reducing aircraft noise, emissions, and fuel use. The project has now selected eight integrated large-scale technology demonstrations to advance aircraft concepts and technologies during the next two years.

The agency’s new technology demonstrations follow on the heels of Phase I work by three industry teams using different advanced vehicle concepts: Boeing’s blended wing body, Lockheed’s box wing, and Northrop Grumman’s flying wing. Announced January 7, the demonstrations will focus for the next three years on the following technology areas: aircraft drag reduction through innovative flow control concepts; weight savings from advanced composite materials; fuel and noise reduction from advanced engines; emissions reductions from improved engine combustors; and fuel consumption and community noise reduction through innovative airframe and engine designs.

The desired end state in 2025 would be twin-aisle aircraft that can burn 50% less fuel, with nitrogen oxide emissions reduced by 75%, and 83% reductions in the size of areas affected by harsh airport noise. The research has also demonstrated a positive potential impact on single-aisle aircraft.

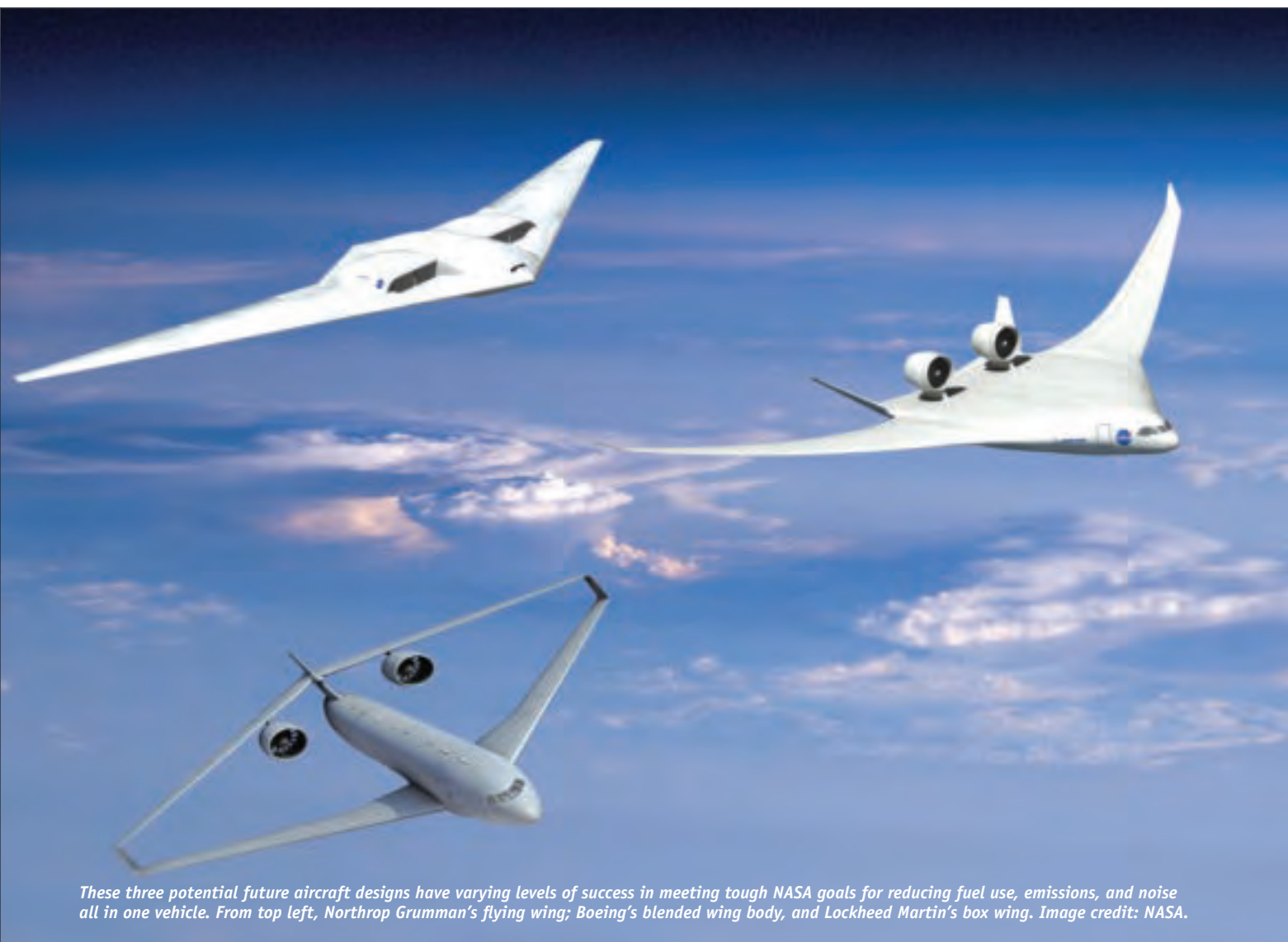
Phase II, budgeted for \$210 million and culled from about \$650 million worth of ideas, is managed from NASA Langley, with participation by three other NASA centers—Ames, Glenn, and Dryden. In a government-industry partnership that involves investments from both, the goal is to validate technologies that have matured through foundational research to a point where they can be evaluated at the systems level.

Project manager Fay Collier says what makes this engineering effort distinct is its broad focus. “In 2009 we were in formulation, and we had received guidance loud and clear from the administration, as well as from the community, that we needed to be working on integrated systems research,” he notes. “We wanted to essentially migrate what we had been doing at the fundamental level of system research—in other words, work that we had matured in the previous years, from the beginning of 2005, that was ready to move on to more of an integrated research stance, as opposed to a discipline-based stance.”

Not just for future aircraft

In ERA’s first phase, says Collier, “we were working essentially on technologies for airframe drag reduction and weight reduction, and specific fuel consumption improvements for advanced turbofan engines. Then we had an effort where we were integrating things, so we were looking for combined effects. We were looking at propulsion airframe integration and propulsion aeroacoustics.”

NASA's Environmentally Responsible Aircraft project has entered a new phase, choosing eight large-scale technology demonstrations to pursue for the next two years. The program has ambitious goals and will build on innovative concepts from three companies. In making these selections, the agency has carefully chosen technologies that will be applicable not only to these futuristic, alternative designs but to traditional aircraft as well.



These three potential future aircraft designs have varying levels of success in meeting tough NASA goals for reducing fuel use, emissions, and noise all in one vehicle. From top left, Northrop Grumman's flying wing; Boeing's blended wing body, and Lockheed Martin's box wing. Image credit: NASA.

Collier says that in Phase I, to be realistic and credible, NASA and its industry partners tried to figure out “which of these technologies might be broadly applicable to current configurations like the dominant tube and wing, as well as to enabling some of these alternative configurations.

“We know that tube and wing configurations are going to be with us for a good long time, and these alternatives may or may not ever manifest themselves in the air transportation system. We are more than likely to see them (Lockheed Martin’s box wing, Boeing’s blended wing body, Northrop’s advanced flying wing) on the military side than on the civil aviation side. That’s okay. A lot of times that’s the way it happens—these innovations work their way through DOD before they find their way into civil aviation.

“The key there,” notes Collier, “was that when we developed the basic portfolio, we were very cognizant of how the technology we picked to demonstrate could

impact both tube/wing and these alternative configurations.”

Industry views

From Lockheed Martin’s perspective, principal investigator K.C. Martin says his company’s motivation for working with NASA was to “look at technologies applicable across a wide range of vehicle sizes and types that would have applications to the agency’s primary mission, which is increasing knowledge in civil aviation and in general aerospace sciences. And advancements would have a corollary application for Lockheed Martin with our military and security customers.”

Martin adds, “The technologies that we really pushed hard under ERA were some of our composites technologies that we shared with NASA—basically ways to build lighter, deeper air structures. The box wing itself really requires the ability to tailor the elastic and the strength axes on those wings to make them hold together. So the application of composite technology there was really a nice fit. With our teammate Rolls-Royce we really wanted to investigate the upper limit of where a turbofan sort of cycle can go.”

Abdollah Khodadoust is senior manager at Boeing Research & Technology. The company’s Phase I work with the remotely piloted 500-lb X-48B blended wing body configuration, which resembles a manta ray, involved 92 test flights out of Edwards AFB. The flights “successfully demonstrated that this configuration can and in fact does perform really well, even though it is a tail-less configuration, in low-speed conditions that are representative of takeoff and landing.” He adds, “It is the low-speed portion of the flight envelope that is one of the tall poles of the tent, in terms of technology, that really needed to be understood—in the sense of whether this configuration can fly effectively in near-stall conditions.”

Boeing has used the X-48B airframe in a new configuration called X-48C, which has flown since last August. The X-48C is configured with two small 89-lb-thrust turbojet engines instead of the three 50-lb-thrust engines on the B-model, to evaluate the impact of noise-shielding concepts on low-speed flight characteristics.

Khodadoust says that as a PhD student a quarter century ago he was inspired by hearing the father of the blended wing body design, Robert Liebeck, describe his concept and predict that one day people

Boeing Phase I work included the remotely piloted X-48B blended wing body configuration.



NASA’s remotely piloted X-48C, which demonstrates technology concepts for cleaner and quieter commercial air travel, completed an eight-month flight research campaign on April 9.



would be flying on it. “We’ve spent some level of energy and time on this concept, Boeing and its partners, as well as NASA, and we’ve really started to march down that direction,” notes Khodadoust. “From a professional standpoint I see this as a huge opportunity for us to reinvigorate the interest and enthusiasm in aerospace and in aeronautical engineering.”

Steve Komadina, the program lead at Northrop Grumman Aerospace Systems, notes that in Phase I, “The NASA program helped develop requirements and plans for technology development between now and 2020 and showed that innovative aircraft designs are required to meet future environmental goals. Northrop Grumman has high interest in maturing these technologies for application to future customer needs.”

Moving into Phase II

Turning to Phase II, Ed Waggoner, director of the Integrated Systems Research Program Office in NASA’s Aeronautics Mission Directorate, notes that the agency’s commitment to conducting the research in three years, with no allowances for schedule slips, was “a different way for us to do business. It’s kind of a way for us to say, ‘Look, if you want us to focus on this, if you will invest in us, then what we will do is commit to delivering research results by a specific time period.’” That time criticality, he adds, “has allowed us to put rigor in our management processes, from a change and configuration management point of view; from every decision that we make, in how we deal with risk, how we’re doing with our resources, to put that additional rigor in there to ensure we will be delivering what we promised to deliver at the end of this time. And I am totally confident that we’re going to be able to do that.”

For Phase II, the selected demonstrations and their goals are as follows:

- *Active flow control enhanced vertical tail flight experiment:* Tests of technology that can manipulate, on demand, the air that flows over a full-scale commercial aircraft tail.

In experiments at the Caltech Lucas Adaptive Wall Wind Tunnel, NASA has found that use of active flow control technologies on key aircraft control surfaces and lift-enhancing devices (flaps) yields significant benefits. These include reduced fuel consumption through a decrease in the size and weight of wings and control surfaces, and reduction of an aircraft’s noise

footprint due to steeper climb and descent. Phase II will involve a full-scale wind tunnel test followed by a flight test.

- *Damage arresting composite demonstration:* Assessment of a low-weight, damage-tolerant, stitched composite structural concept, resulting in a 25% reduction in weight over state-of-the-art aircraft composite applications.

This demonstration project focuses on building large transport aircraft that are cheaper and more efficient to fly. It is an extension of NASA’s work with Boeing Research & Technology on optimizing carbon fiber composites in a blended wing structure by reducing the use of fasteners and rivets. A robotic method for stitching together the fuselage wall of a hybrid-wing aircraft has proved promising in tests for helping to suppress common interlaminar failure modes. NASA’s name for the concept, which was first developed in the former East Germany, is PRSEUS (pultruded rod, stitched, efficient, unitized structure).

In Phase I, ERA tested large PRSEUS panels at the FAA’s R&D center and at Langley’s structural lab. In Phase II, NASA and Boeing R&T will build and test a 30-ft multibay center cross section of a hybrid wing vehicle, subjecting it to combined pressure and building loads.

“If that is successful, it will advance the maturity of the concept to TRL 5 in 2015,” says Collier. “For advanced composite structural concepts, progressing from coupon testing to large-scale testing at TRL 5, the certification authorities are able to get more engaged because of the advanced maturity and available test data.”

NASA is convinced that this technology has broad application to current and near-term commercial aerospace designs. It will also lead to reduced weight and maintenance costs relative to the current structural concepts, the agency believes.

- *Adaptive compliant trailing edge flight experiment:* Demonstration of a nonrigid wing flap in order to establish its airworthiness in the flight environment.

A PRSEUS tension panel with bolted repair is tested in the 1-million-lb machine at NASA Langley.



NASA is partnering on this project with the Air Force Research Laboratory and a small Ann Arbor, Michigan, company called FlexSys. They are modifying a Gulfstream G-III aircraft by replacing both of its conventional 19-ft-long aluminum flaps with FlexSys's advanced, shape-changing composite flaps, which have continuous bendable surfaces. These flaps will be gapless, forming a seamless transition region with the wing while still being attached at the forward edge and sides. In test flights at Edwards AFB, the concept will be matured to TRL 6, and airworthiness will be established. The hope is that these improved flaps, when integrated into future aircraft designs, will eliminate a major source of airframe noise generation and will simultaneously reduce weight.

- *Highly loaded front block compressor demonstration:* Tests to demonstrate UHB (ultra-high-bypass) or advanced turbofan efficiency improvements enabled by a two-stage, transonic front block of the high-pressure engine compressor.

NASA and GE will use a multistage turbomachinery rig in a test campaign aimed at solving some of the flow problems associated with highly loaded compressor blades. "We're building up to an ultimate three-stage test using a facility that we've been modifying during Phase I at the Glenn Research Center. We hope to enable a 2-3% thermal efficiency gain from the high-pressure compressor system, and that's a direct translation to fuel burn," says Collier.

- *Second-generation UHB ratio propulsor integration:* Continued development of a geared turbofan engine to help reduce fuel consumption and noise.

Focusing on propulsion efficiency, this partnership between NASA and Pratt & Whitney is aiming at "an improvement in two major metrics" through next-generation geared turbofan designs, says Collier. "The UHB turbofan concept dates back to the 1980s, with the engine using a large-diameter, low-pressure fan at the front to force slower-moving air around the engine. By generating most of its thrust from this bypassed air, propulsive efficiency is increased and less fuel is burned. The geared configuration allows further optimization of the core turbomachinery, which also reduces fuel burn. For the same thrust, this engine design's slower rotating fan and lower air velocities produce less noise."

- *Low nitrogen oxide fuel flexible engine combustor integration:* Demonstration of a full annular engine combustor that produces very low emissions.

Collier says this demonstration will focus "on a combustor design that can take advantage of the development of alternative fuels." It also will "push the combustor design so that it has lower oxides of nitrogen during the takeoff and landing cycle." He adds, "While doing that we want to make sure that when we put it into an engine we do not adversely affect the fuel burn gain that we're working in the other research area. In many cases those two things can be traded against each other. In this case we are trying to push the combustor design so that we get both fuel burn reduction and NO_x reduction."

Two promising concepts were tested at Glenn's Advanced Subsonic Combustor Rig during Phase I, and one of these will be downselected for a focused development effort in Phase II, ending with a TRL 5 demonstration in 2015.

- *Flap and landing gear noise reduction flight experiment:* Analysis, wind tunnel, and flight tests to design quieter flaps and landing gear without weight or performance penalties.

During Phase I, NASA and industry identified reduction of aircraft landing gear noise and flap edge noise as crucial to meeting community noise reduction targets. Computational studies and wind tunnel testing at Virginia Tech were used to develop promising concepts in these areas. In Phase II, these ideas will be further refined and tested in the Langley 14x22-ft subsonic wind tunnel using a high-fidelity half-span model of a Gulfstream aircraft. A few of the most promising concepts will be flight

A semispan jet model has just completed testing in NASA Langley's 14x22 ft subsonic wind tunnel to evaluate flap and landing gear noise reduction technologies. A microphone array to record and differentiate sounds depending on flap and landing gear modifications can be seen in the background. Credit: NASA Langley/Sean Smith.



tested on a Gulfstream, raising the TRL to 6, and confirming the noise reduction potential of these innovations.

• *UHB engine integration for a hybrid wing body*: Verification of powerplant and airframe integration concepts that will allow fuel consumption reductions in excess of 50% while reducing noise on the ground.

The aviation community has made great strides on aircraft noise prediction and reduction since the early 1970s, especially since the changeover from the straight jet engine to the high-bypass-ratio front-fan engine. Now the challenge is to achieve reductions in the individual sources contributing to both airframe and engine noise. For this work, NASA's ERA team has examined ideas for improving landing gear, for making airframes quieter (such as high-lift systems), and for making propulsion quieter, especially in relation to engine fans.

The targeted technologies are linked in a process called propulsion airframe aeroacoustics, where the airframe and propulsion technologies are integrated and tested using powered noise simulators at the Langley 14x22-ft subsonic tunnel. Collier says that "with engines placed on top of the airframe as they are on a hybrid wing body,"

this research will "look at engine operability and make sure that we understand the flow at the engine face for some of those low-speed conditions that we're talking about, to be sure that the engines can handle that operational condition."



Asked to describe how this project fits in with his 23-year NASA career, Collier says, "I tell people this is the best job at NASA, and it is. It's carrying on a tradition of developing technology and sharing those lessons with the aviation industry. And hopefully a good number of these ideas will find their way into the fleet somehow.

"We also are in constant coordination with the DOD and the FAA through joint participation in formal and informal committees and working groups to help ensure broad applicability. However, we cannot guarantee that the technology will be picked up. ERA has essentially been put in place to help accelerate the maturation and introduction of technology that's promising from a performance perspective by reducing risk. And the industry has contributed to our labeling it as promising, because they are also interested in making a partnership investment." ▲

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Capturing an asteroid

NASA's NEOWISE survey shows that more potentially hazardous asteroids, or PHAs, are closely aligned with the plane of our solar system than previously suggested. PHAs are asteroids with the closest orbits to Earth's and large enough to survive passage through the atmosphere and cause damage on a regional, or greater, scale. Credit: NASA/JPL-Caltech.

NASA's budget for 2014 includes a \$105-million increase for spending on asteroid work. The agency was quick to suggest that its plan is tied to planetary defense. The money would go toward preparing for an asteroid retrieval mission in which a 7-10-m-wide asteroid would be bagged up robotically and towed closer to Earth.

The robotic phase of the mission would be launched in 2017; in 2021, astronauts would climb into NASA's new Orion crew capsule and rendezvous with the asteroid in days, instead of the months it would have taken them under the Obama administration's previous plan. Under the new plan they would then visit the asteroid, chip away samples, and bring them home.

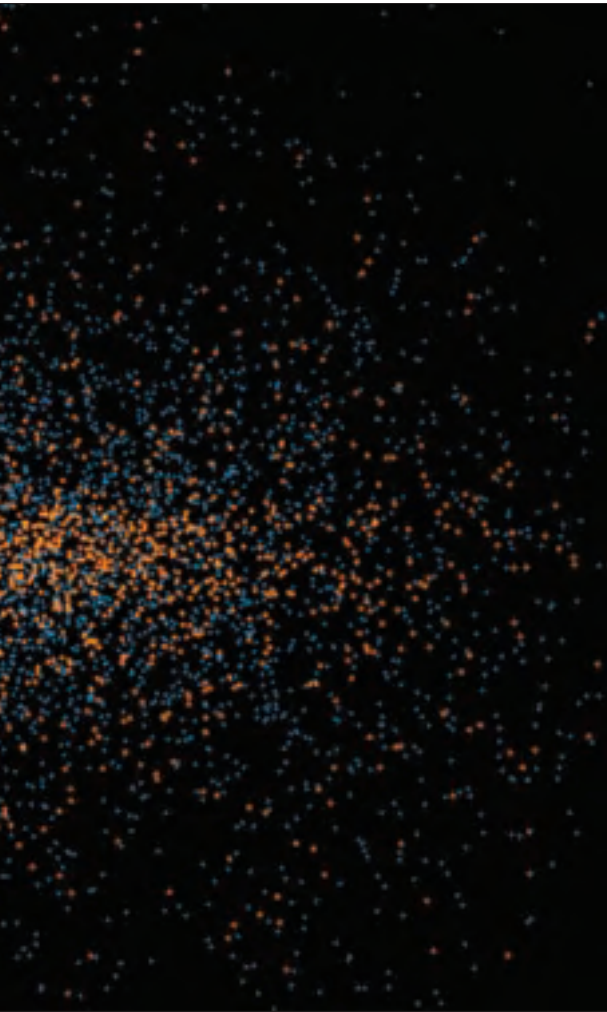
That sounds like asteroid mining, but a senior NASA official downplayed this as a motivation for the mission: CFO Elizabeth

Robinson told reporters that defending Earth from asteroids was probably "first and foremost" on President Obama's mind. Sen. Bill Nelson (D-Fla.) told the Associated Press the "plan combines the science of mining an asteroid...with developing ways to deflect one."

In reality, the retrieval mission will teach NASA little about how to deflect asteroids large enough to threaten cities, regions, or civilization itself, said agency officials and outside experts. This year's congressional budget deliberations are likely to explore whether NASA's latest plan is bold enough, given the cosmic warning shots experienced by the world on February 15, when one asteroid flew by and another object exploded over Chelyabinsk, Russia.

NASA's asteroid hunters want to make sure the retrieval mission's relevance to planetary defense is not overstated as Congress figures the way ahead: "This asteroid

by Ben Iannotta
Contributing writer



NASA is making plans for bagging an asteroid, moving it to a closer orbit, and bringing a sample home. The idea is not just to study it but also to learn how best to deflect a larger one if it is found to be on a collision course with Earth. Support for the program has grown in Congress since two separate asteroid impacts took the world by surprise on February 15.

retrieval mission isn't really a demonstration for planetary defense," says Lindley Johnson, program executive in the Near Earth Object Observation program.

Bagging a 500-ton body and towing it millions of kilometers is a technique that cannot be scaled up to the larger asteroids that are the real threats.

Johnson is not alone in that assessment: "Five hundred tons is 500 tons. That's a lot of stuff to move around," says Al Globus, a NASA-funded research engineer at San Jose State University. Moving a larger asteroid would require deflecting it, he says.

Shifting the focus

Globus was part of an informal team called the Asteroid Mining Group that drafted a 2012 AIAA paper critiquing NASA's previous plan to send astronauts on a six-month ride to rendezvous with an asteroid by 2025. "A Comparison of Asteroid Near-Earth

Object Missions" argued for robotically dragging an asteroid back to lunar space.

A parallel study by the Caltech/JPL Keck Institute for Space Studies laid the groundwork for NASA to shift its asteroid plan to a retrieval mission.

In terms of planetary defense, the best thing advocates can say about the retrieval proposal is that grabbing an entire asteroid would be a first. It also would give impetus to improving detection of such objects, because it would entail quickly identifying one that is not too big or spinning too fast for thrusters to slow its rotation for the tow.

Politically, the proposal does something members of Congress in Florida and Texas want: It spells out a role for the Orion crew capsule and the new Space Launch System. Some lawmakers also see February 15 as a clarion call for a bold planetary protection plan. It is not clear whether the retrieval mission will satisfy them.



According to the B612 Foundation, "Sentinel is a space-based infrared survey mission to discover and catalog 90% of the asteroids larger than 140 m in Earth's region of the solar system." Credit: Ball Aerospace.

In hearings after the February 15 events, lawmakers asked lots of tough questions. They wanted to know who would be in charge of planetary defense in a crisis. They wanted to see a clear set of technology milestones established in collaboration with other countries. That way, with budgets tight everywhere, the cost of new detection telescopes or deflection demonstrations could be shared.

"I'd like to include all countries—except China," said Rep. Dana Rohrabacher.

Slow progress

As it stands, NASA does not have any firm plans on the books for a deflection demonstration mission or for a space-based telescope that would find the thousands of asteroids that are eluding ground telescopes.

NASA is spending a few hundred thousand dollars a year on an international research project called the Asteroid Impact & Deflection Study, a collaboration by ESA, Germany's DLA aerospace center, and the Johns Hopkins University Applied Physics Lab. The idea is that NASA would do the deflecting, and another spacecraft would observe from a distance to see if the attempt succeeded.

On the detection front, NASA calculates that 95% of the solar system's 1-km-class planet-killers have been identified by a federation of ground-based telescopes and amateur astronomers. That leaves thousands of smaller asteroids that could wipe out regions or cities. The trouble is that many of these bodies cannot be seen with ground-based telescopes.

There is consensus that the best way to find them would be to launch an asteroid-hunting infrared instrument into space. Its sensitivity would be improved outside the atmosphere, and it would have a better view of the asteroid belt without the Earth or the Sun in the way. "The Chelyabinsk object came in from the daytime side of the Earth, so there's no way that we could detect it from ground-based telescopes," NASA's Johnson says.

NASA has no plans to launch such a satellite. This is true even though in April JPL announced that its proposed Near Earth Object Camera passed a test mimicking the temperatures and pressures of deep space. Advocates wanted to launch it under the agency's Discovery Program, but the proposal was not funded.

The best chance for a free-flying aster-

oid hunter rests in the hands of a nonprofit group called the B612 Foundation (named for the asteroid in a children's book by Antoine de St-Exupery). The group's chairman, former astronaut and Google executive Ed Lu, must inspire millionaires and billionaires to chip in money to build Sentinel, a Kepler-sized infrared satellite. It would be sent to an orbit trailing Venus, where it would stare out at the asteroids lurking beyond Earth.

"The big challenge is convincing people that they can make a difference in the future of the Earth," Lu says. "It's happening. It's a slow process." People do not sit right down and send "a \$10-million check," he says. Confidence must be built.

NASA has a cashless Space Act Agreement with B612 to provide software, technical advice, and Deep Space Network communications time as Sentinel is launched. Ball Aerospace, which built the Kepler planet-hunting space telescope, is on contract to develop Sentinel, although B612 has raised only a fraction of the funds it would need to pay Ball.

Sentinel and other options

The foundation figures it should cost about \$400 million to build and launch Sentinel. That is quite a bit less than NASA's rough estimate of \$750 million for commissioning and managing construction of an asteroid hunter. B612 would gladly accept a cash contribution from NASA for Sentinel, but that looks unlikely: "If we had that in our budget, we'd probably be building it ourselves," Johnson says.

The government's attitude toward B612 may be shifting, though. Lawmakers pressed John Holdren, President Obama's science advisor, to explain what the U.S. is doing to find asteroids before they find us. Holdren pointed to B612, saying, "...the single most important thing we could do to improve our capacity to see any asteroid of potentially damaging size coming would be an orbiting infrared telescope of the sort that the B612 Foundation is working on."

Sentinel would be built on the same model satellite frame as the 1,052-kg Kepler infrared spacecraft, but Kepler cannot be used for asteroid hunting. It is tuned to look for Earthlike planets thousands of light-years away, not asteroids at a distance of only 50 million km. It does not have the right focal plane or field of view for asteroid searches, says Johnson. So far, B612 has some prototype personal-pizza-sized in-

frared detectors manufactured under a contract with Ball Aerospace, the Kepler prime contractor.

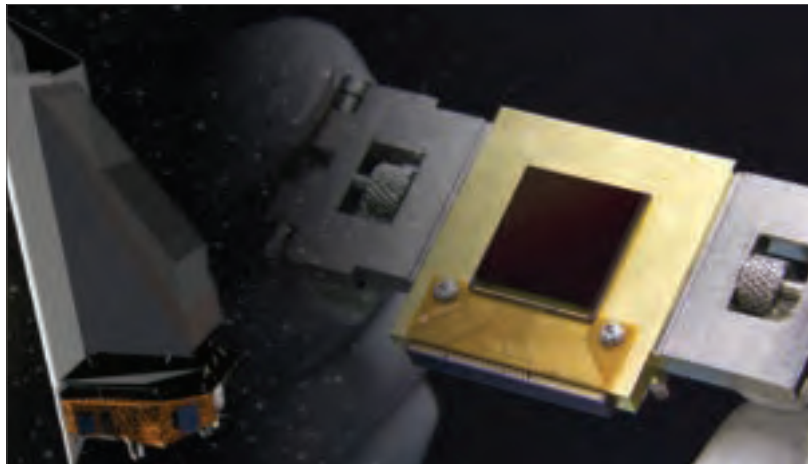
Another idea would be to install an infrared sensor on one of the commercial or government geosynchronous satellites now on the drawing board or in development. Last August, NASA issued a request for information, inviting experts to submit ideas for a 75-kg IR sensor that could ride as a hosted payload on one of those satellites. NEOCam remains a candidate for that application, Johnson says.

Later this year in Socorro, New Mexico, NASA also plans to get a turn testing a new ground device called the Space Surveillance Telescope. It was designed by DARPA and the Air Force with a primary mission of detecting space debris and threats to satellites.

Surprise visitors

NASA Administrator Charles Bolden has a word he likes to use to describe progress toward planetary defense, and the word is incremental. The question is whether that will be enough for Congress, given what happened on February 15.

The main event that day was supposed to be the close approach of 2012 DA14, a 40x15-m asteroid discovered about a year earlier by a Spanish astronomer. But as that asteroid was closing in, another object, later estimated to be 17 m wide, exploded over the city of Chelyabinsk, breaking windows, raining down chunks of itself, and reportedly injuring a thousand people. No one saw it coming.



The NEOCam sensor (right) is the linchpin for the proposed Near Earth Object Camera, or NEOCam (left), space mission. Image credit: NASA/JPL-Caltech/Teledyne.

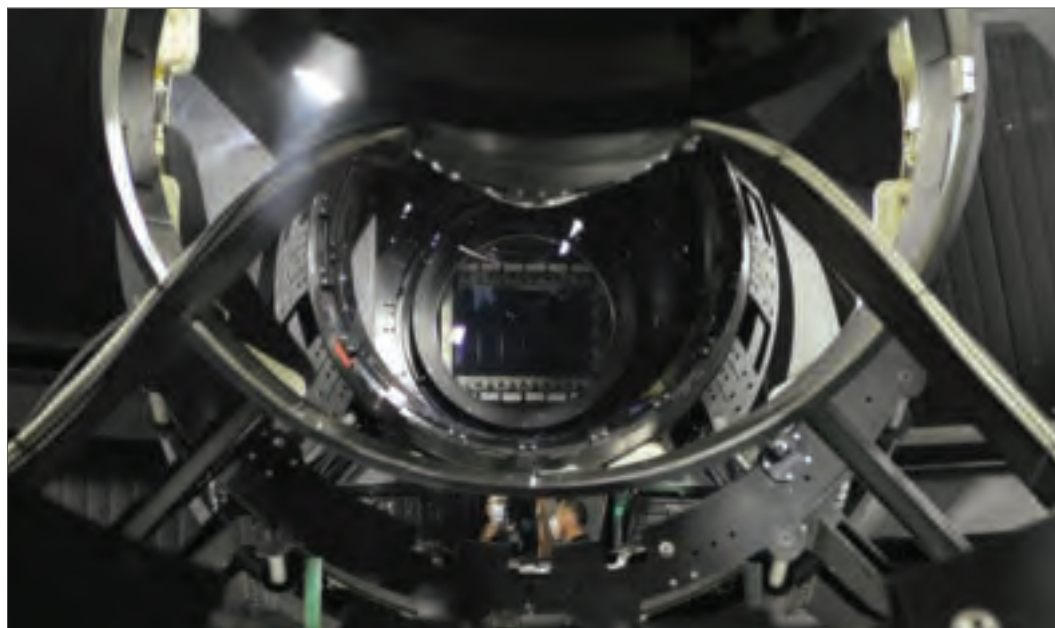
For some members of Congress, the day of the asteroids changed everything. Until then, lawmakers who talked a lot about planetary defense were seen as “on the ‘kooky’ side,” said Rep. Bill Posey (R-Fla.) at a March hearing of the House Science, Space and Technology Committee. The asteroid coincidence (NASA insists the two events were unrelated despite Internet chatter to the contrary) proved that low probability does not mean no possibility.

Holdren said the odds of calamity remain slim, but he added that the “the potential consequences are so large that it makes sense to take the risk seriously.”

But what constitutes ‘seriously’?

The threat

In the retrieval mission, any asteroid that NASA plans to bag would be small enough



DARPA's Space Surveillance Telescope program enables ground-based, broad-area search, detection, and tracking of small objects in deep space for purposes such as space mission assurance and asteroid detection.

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National Harbor is just 15 minutes from the heart of Washington, D.C. So much of aerospace begins and ends in the Washington, D.C. area – beginning with Congress and ending at the Smithsonian National Air and Space Museums. The area is home to NASA Headquarters, NASA Goddard Space Flight Center, the National Oceanic and Atmospheric Administration, the Federal Aviation Administration, the U.S. Naval Research Laboratory, and the Pentagon, plus the headquarters of Lockheed Martin Corporation, Orbital Sciences Corporation, and Aurora Flight Sciences, along with scores of aerospace company branches. It's also home to some of the finest young minds in aerospace, at the University of Maryland, George Washington University, Catholic University, Howard University, Johns Hopkins University, and the U.S. Naval Academy. It's the perfect location to draw participants from all sectors of the aerospace field.





An object entered the atmosphere over the Urals on February 15, 2013. The fireball exploded above Chelyabinsk city, and the resulting overpressure caused damage to buildings and injuries to hundreds of people. Photo by Alex Alishevskikh.

to break apart high in the atmosphere and cause no damage. Experts are most concerned about objects ranging from tens of meters across to about 140 m—a size that could “devastate the better part of a continent,” Holdren said.

Asteroid hunters are not sure exactly how many such asteroids are out there, but they have developed estimates by observing the part of the asteroid belt they can see with ground-based telescopes.

Former astronaut Rusty Schweickart, who helped found the B612 Foundation, compares the process to estimating crops on a farm: “You take a one-square-meter plot of typical land and you count all the mushrooms in one square meter and you multiply,” he says.

NASA estimates there are 13,000-20,000 asteroids in the 140-m class. Observers have found only about 10% of them. When a new asteroid is reported, the finding is sent first to the Minor Planet Center at the Smithsonian Astrophysical Observatory, then on to NASA JPL to be charted on its Near Earth Object Program Web page.

The numbers sound scary, but Holdren emphasized that the threat has to be kept in perspective. An asteroid like the one that released 440 kilotons of energy over Chelyabinsk is a once-in-a-century event, he said. An asteroid like the one that released 15 megatons of energy over Siberia's Tunguska region in 1908 is expected only once in a thousand years.

If such an event happened over an urban area, there would be hundreds of thousands of casualties. “But the probability of this occurring is much smaller than the one-in-a-thousand-year

probability,” Holdren said. “That is because land covers only 30% of the area of the Earth, and urbanized areas cover only 2-3% of the land area.”

Of course, it is not as if fate has to wait a thousand years. A fact of odds-making is that a ‘500-year flood’ can happen in successive years, noted Rep. David Schweikert (R-Ariz.).

Deflection techniques

No one has ever deflected an asteroid, but the community has a sense of the options available and the conditions under which they might be used. The closest thing to a demonstration took place when NASA's Deep Impact probe intentionally slammed into the comet Tempel 1 in 2005. That demonstrated all of the components for one kind of deflection, a kinetic impactor, Johnson says.

“The most likely technique to be used to deflect an asteroid would be a kinetic impactor, where you hit it with enough force to change the velocity by a few millimeters or centimeters per second,” he adds. If that could be done when the object is still a couple of years away, the tiny change in velocity would be enough for the object and Earth to miss each other in their orbits.

Given enough time and a relatively small asteroid, another option would be to hover a spacecraft close to it and use the craft's gravity to change the asteroid's orbit slightly, a concept called the gravity tractor, says Johnson.

There is also a last resort for that asteroid that eludes detection until it is only weeks out. It is not the prayer that Bolden told the House committee he would recommend saying. A rocket or rockets with nuclear weapons would be sent into space.

“Probably nuclear energy is what we're talking about,” Air Force Gen. William Shelton told the House committee.

The blast, however, would be intended to change the object's trajectory, not blow it to bits. Fragments might still be big enough to cause damage on the ground, and debris could damage communications and military satellites.

Lu examined deflection techniques before his organization switched gears to focus on detection. “True, [deflection] has not been tested, and we firmly believe someone ought to test these things before you have to use them for real. But there doesn't seem to be any sort of physical question about whether or not this is going to work,”

Damage to a building belonging to the Chelyabinsk Zinc Plant company was a result of the 2013 Russian meteor event.



he said to explain the shift. "You can't deflect anything that you don't know exists yet, so you've got to do detection first."

In his view, the gravity tractor would be applied to refine a deflection. "You do what's called a primary deflection to make it miss, and then you need to go back in and make sure that you haven't just put it in a return keyhole," he said, meaning an orbit that brings the asteroid back on collision course a few years later.

Who's the boss?

The administration believes it has done enough to define who would be in charge if an asteroid were suddenly discovered to be bearing down on Earth and possibly the U.S. Holdren said the answer will depend on the asteroid.

"For some deflection missions, you'd want NASA to be in charge. For other kinds of deflection missions, you would want DOD to be in charge," he said. "It does not make sense from a standpoint of the mitigation mission to specify in advance which agency would do it."

The idea of the government sitting

down in the midst of a crisis to decide who would do the deflection has been unsettling to some in Congress.

"We got about three or four minutes of chatter but we never got an answer about who's in charge," Posey said. "A good part of the population thinks it's just a matter of calling Bruce Willis in." Posey recommended that the White House establish a clearer protocol and present it to Congress.

As it stands, the Defense Dept. has no role in detecting asteroids. Military and intelligence satellites look earthward or at other satellites.

"We are focused on things in Earth orbit," as Shelton put it. He said there might be "serendipitous times" when a sensor spots something that would be helpful to asteroid hunters but that this would be rare.

One thing is certain: The issues are in clearer focus because of February 15.

"The most important question we have to answer about the solar system is, where is the next rock that's going to hit us?" Globus said. "There are other really interesting and important problems, but this is the most important one." ▲

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Out of the

25 Years Ago, July 1988

July 7 The USSR successfully launches Phobos 2, a Mars probe that will enter orbit around the planet on January 29, 1989. It will soon begin transmitting data, including high-quality images of the Martian moon Phobos. Unfortunately, radio communications with the probe are later lost. The craft's sister, Phobos 1, became inoperative en route to Mars in August 1988. NASA, *Astronautics and Aeronautics*, 1986-90, pp. 180, 204, 206, 209, 236.

50 Years Ago, July 1963

July 1 NASA announces the award of a four-month contract to Boeing to study a concept for a lunar base program that might follow Project Apollo. However, nothing comes of the study, and after Apollo, NASA pursues development of the space shuttle. NASA, *Astronautics and Aeronautics*, 1963, p. 262; D. Baker, *Spaceflight and Rocketry*, p. 154.

July 3 The first Minuteman wing is declared operational at Malmstrom AFB, Great Falls, Mont. NASA, *Astronautics and Aeronautics*, 1963, p. 262.

July 6 Led by Tatyana Voinova, eight Soviet women parachutists establish new world records for landing accuracy in group jumping from an altitude of 600 m (1,968 ft). The average deviation from the center of the landing circle is 22.15 ft. This is almost 200% better than the previous record. NASA, *Astronautics and Aeronautics*, 1963, p. 262.

July 7 Retired Army Brig. Gen. Frank P. Lahm, who in 1909 became the second Army pilot to officially fly the service's first airplane, dies at age 85. Born in 1877, The son of a balloonist, he grew interested in aviation at an

early age. In 1907 he met Wilbur Wright, who taught him to fly. Lahm became the Army's first certified pilot in 1909 and was later known as the 'nation's first military aviator.' He served in WW I as the chief of the Second Army in France and later became the commander of the first Air Corps Training Center at Randolph Field, Texas (later, Randolph AFB). Thus he was also known as 'father of Air Force flight training.' *Aviation Week*, July 15, 1963, p. 35; *New York Times*, July 9, 1963.



July 12 The first KH-7 'close-look' 4,000-lb reconnaissance satellite is launched into orbit from Vandenberg AFB, Calif., by an Atlas-Agena D. This also marks the 100th launch of an Agena upper stage. D. Baker, *Spaceflight and Rocketry*, p. 154.

July 19 NASA pilot Joseph A. Walker reaches a world record altitude of 347,000 ft and a speed of 3,710 mph in the X-15 No. 3 rocket research plane. On August 22, he will beat this altitude, flying to 354,200 ft. Technically this qualifies him as an astronaut under NASA's 62-mile rule for entry into space. D. Jenkins, *X-15: Extending the Frontiers of Flight*, pp. 415, 630-631.



July 19 The FAA awards aviatrix Betty Miller a medal for exceptional service to aviation for being the first woman to fly solo across the Pacific. Miller completed the 7,400-mi. distance from Oakland, Calif., to Brisbane, Australia in 54 hr 8 min of flying time over 13 days. Piloting a Piper Apache, she made stops in Hawaii, Canton Island, Fiji, and New Caledonia. *New York Times*, July 20, 1963.

July 20 A five-segment, 12-in.-diam. solid-propellant rocket motor, the largest produced in the U.S., is successfully test fired at the United Technology Center at Coyote, Calif. This is the first full-scale evaluation of the motor that is to boost the Titan 3C space launch vehicle. The motor has a maximum thrust of 1.2 million lb and total burning duration of about 112 sec. *Aviation Week*, July 29, 1963, pp. 52-53.

July 23 Curtiss-Wright unveils its triservice X-19 VTOL aircraft at its plant in Caldwell, N.J. The X-19 is the first of three VTOLs being built under an Army-Navy-Air Force program. Designed to combine the agility of a helicopter with the speed of a fixed-wing plane, the aircraft features two Lycoming T55 turboshaft engines. *Aviation Week*, July 29, 1963, p. 25; *New York Times*, July 24, 1963.



July 26 A Thor-Delta vehicle launches the Syncom II communications satellite from the Atlantic Missile Range. Later the spacecraft transmits 'The Star-Spangled

Past

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

Banner' as well as a voice message and an experimental teletype transmission. Once in synchronous orbit, it also provides telephone, teletype, and photo facsimile communications between Lakehurst, N.J., and Lagos, Nigeria. *Aviation Week*, Aug. 5, 1963, p. 75; NASA Release 63-152.

And During July 1963

—Japan begins missile development tests by successfully launching two experimental air-to-air missiles and one surface-to-air missile into the Pacific Ocean from Niijima Island. These are part of an 11-launch test series scheduled to last until early August. *Aviation Week*, July 15, 1963, p. 34.

—IBM completes the first production prototype digital computer model for the upcoming Project Gemini two-man spacecraft. The heart of Gemini's complex inertial guidance system, the computer is designed to accomplish the nation's first rendezvous and docking of a manned spacecraft with an Agena D vehicle. To date it is the most advanced computer ever made by IBM. *Aviation Week*, July 15, 1963, pp. 58-59, 61, 63, 65, 67.

75 Years Ago, July 1938

July 1 Hellmuth Hirth, one of Germany's pioneer aviators, dies after inadvertently walking into a revolving propeller. Hirth flew before WW I and in 1913 wrote an account of his experiences. After the war, he established an aircraft engine factory in Stuttgart and produced high-quality engines that featured the shock-dampened crankshaft, which had been patented by his father. *Flight*, July 14, 1938, p. 50.



July 7-8 RAF pilots under Squadron Ldr. Ronald Kellett complete the longest nonstop formation flight to date. Flying four Vickers Wellesley bombers from Cranwell, England, to Egypt, they cover the 4,300-mi. distance in 32 flying hours at an average speed of 135 mph. *Flight*, July 14, 1938, p. 42; *Aircraft Year Book*, 1939, p. 467.



July 10-14 Howard Hughes and a crew of four make a record 14,874-mi. round-the-world flight in 3 days 19 hr 8 min 10 sec in a specially modified Lockheed 14. This beats the record set by Wiley Post, whose time was 7 days 18 hr 49 min. Hughes averages 214 mph excluding stops. His route is New York, Paris, Moscow, Omsk, Yakutsk, Fairbanks, Minneapolis, and back to New York. *Flight*, July 21, 1938, p. 58; *Aircraft Year Book*, 1939, p. 467.

July 17-18 Douglas Corrigan is immortalized as 'Wrong-way Corrigan' when, allegedly by mistake, he flies nonstop from Floyd Bennett Field, N.Y., to Baldonnel Airport, Dublin, in a Curtiss Robin powered by a 165-hp Wright Whirlwind J-6 engine, covering the 3,150 mi. in 28 hr 13 min. A few days earlier, Corrigan had flown 3,200 mi. nonstop from Long Beach, Calif., to New York, and planned to return to California. After being denied permission to fly across the Atlantic



because of the poor condition of his aircraft, he tells authorities that he set his compass incorrectly, flying for 25 hr above the clouds, and realizing his mistake only when he flew lower over the Irish countryside. *Flight*, July 28, 1938, p. 90.

July 21-22 The Mercury upper component of the Short-Mayo ' composite' aircraft separates from the Maia lower component near Foynes Harbor, Ireland, and makes the fastest East-West Atlantic crossing on record, to Montreal, a distance of 2,860 mi., in 20 hr 20 min. The Mercury carries 600 lb of freight, also making this the first commercial flight over the North Atlantic. *Flight*, July 28, 1938, pp. 79-80.

100 Years Ago, July 1913



July 1 The Royal Netherlands Army establishes an aviation division equipped with Farman F.22 biplanes and based at Soesterberg. D. Baker, *Flight and Flying: A Chronology*, p. 62.

Out of the

25 Years Ago, August 1988

Aug. 29 Two Soviet cosmonauts and the first Afghan in space, Abdul Mohmand, are launched into orbit on Soyuz TM-6, which docks with the Mir space station. Mohmand and cosmonaut Vladimir Lyakhov return to Earth on Sept. 7 in Soyuz TM-5. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 310.

50 Years Ago, August 1963

Aug. 1 The Mariner II Venus probe completes its first orbit of the Sun. Launched on Aug. 27, 1962, the spacecraft passed within 21,648 mi. of Venus on Dec. 14 and has sent back 111 million bits of information on that planet and on interplanetary space. NASA Marshall, *Roundup*, Aug. 7, 1963, pp. 1, 2.



Aug. 5 A historic international treaty banning nuclear weapons testing in the atmosphere, in outer space, and under water is signed by Secretary of State Dean Rusk, British Foreign Secretary Lord Home, and Soviet Foreign Minister Andrei Gromyko. *New York Times*, Aug. 6, 1963, p. 12.

Aug. 17 Centaur, the world's first high-energy upper stage that burns liquid hydrogen and liquid oxygen, is fired for the first time at the General Dynamics Astronautics facility in San Diego, where it was developed. It can boost a satellite payload to geosynchronous orbit or an interplanetary space probe into or near escape velocity. Centaur is made up of two RL-10 engines. Later, when used with boosters like the Atlas and Titan, it launches such spacecraft as the Viking 1 and 2 to Mars, Voyager 1 and 2 to the far planets and into interstellar space, and the Helios 1 and 2 probes toward the Sun. *Missiles and Rockets*, Aug. 26, 1963, p. 12.

Aug. 20 British Aircraft's first BAC 111 twin-jet short-range airliner makes its maiden flight at Hurn, England. Among the most successful British airliner designs, it serves until its retirement in the 1990s. *Aviation Week*, Aug. 26, 1963, p. 30; BAC 111 file, NASM.

Aug. 21 The Titan II is successfully launched on a 5,800-mi. flight in which the first Project Gemini malfunction detection system is tested. A scientific instrument pod carried on the missile studies radiation from its exhaust plumes. *Aviation Week*, Aug. 26, 1963, p. 37.

Aug. 22 NASA pilot Joseph A. Walker flies the X-15 No. 3 rocket research aircraft to a record altitude of 67 mi. During the flight he reaches a maximum speed of Mach 5.58 and experiences near weightlessness. D. Jenkins, *X-15: Extending the Frontiers of Flight*, pp. 415-417, 631.



Aug. 22 Lockheed's C-141 StarLifter jet transport is rolled out of the company's plant at Atlanta, Ga. A replacement for slower piston-engined cargo planes such as the C-124 Globemaster II, it serves successfully for more than 40 years with the USAF's Air Mobility Command, the Air Force Reserve Command, and the Air National Guard. *Aviation Week*, Aug. 26, 1963, pp. 30-31.

Aug. 23 The Syncom II satellite relays its first live telephone conversations, between President John F. Kennedy in the U.S. and Prime Minister Sir Abubakar Balewa in Nigeria as well as others in the two countries. *Aviation Week*, Sept. 2, 1963, p. 24.

75 Years Ago, August 1938

Aug. 1 In the longest nonstop mass flight ever made, 41 long-range Navy Consolidated PB-1 patrol bombers fly to San Diego from Seattle, a distance of 1,400 mi. *Aero Digest*, September 1938, p. 32.

Aug. 2 British airplane designer Frank Barnwell dies in the crash of a light monoplane that stalled soon after takeoff. Born in 1880, Barnwell was an apprentice in a ship-building



25 Years Ago, August 1988

Aug. 29 Two Soviet cosmonauts and the first Afghan in space, Abdul Mohmand, are launched into orbit on Soyuz TM-6, which docks with the Mir space station. Mohmand and cosmonaut Vladimir Lyakhov return to Earth on Sept. 7 in Soyuz TM-5. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 310.

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Aug. 21 The Titan II is successfully launched on a 5,800-mi. flight in which the first Project Gemini malfunction detection system is tested. A scientific instrument pod carried on the missile studies radiation from its exhaust plumes. *Aviation Week*, Aug. 26, 1963, p. 37.

Aug. 22 NASA pilot Joseph A. Walker flies the X-15 No. 3 rocket research aircraft to a record altitude of 67 mi. During the flight he reaches a maximum speed of Mach 5.58 and experiences near weightlessness. D. Jenkins, *X-15: Extending the Frontiers of Flight*, pp. 415-417, 631.



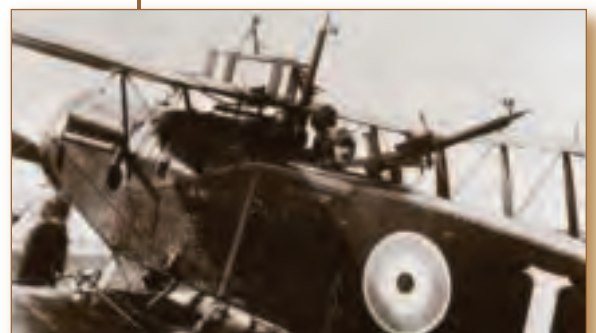
Aug. 22 Lockheed's C-141 StarLifter jet transport is rolled out of the company's plant at Atlanta, Ga. A replacement for slower piston-engined cargo planes such as the C-124 Globemaster II, it serves successfully for more than 40 years with the USAF's Air Mobility Command, the Air Force Reserve Command, and the Air National Guard. *Aviation Week*, Aug. 26, 1963, pp. 30-31.

Aug. 23 The Syncom II satellite relays its first live telephone conversations, between President John F. Kennedy in the U.S. and Prime Minister Sir Abubakar Balewa in Nigeria as well as others in the two countries. *Aviation Week*, Sept. 2, 1963, p. 24.

75 Years Ago, August 1938

Aug. 1 In the longest nonstop mass flight ever made, 41 long-range Navy Consolidated PB-1 patrol bombers fly to San Diego from Seattle, a distance of 1,400 mi. *Aero Digest*, September 1938, p. 32.

Aug. 2 British airplane designer Frank Barnwell dies in the crash of a light monoplane that stalled soon after takeoff. Born in 1880, Barnwell was an apprentice in a ship-building



Past

An Aerospace Chronology

by **Frank H. Winter**

and **Robert van der Linden**

firm in his youth. In 1911 he joined Bristol (then called British and Colonial Aeroplane), where he became chief draftsman and, eventually, chief aircraft designer. Some of the most successful Bristol machines were his designs, including his most famous, the Bristol fighter, used in great numbers during WW I. *Flight*, August 11, 1938, p. 124.

Aug. 10-14 German aviators claim record-breaking round-trip nonstop Berlin-New York flights for the Focke-Wulf Fw 200 Condor prototype, redesignated Fw 200S-1 and named Brandenburg. Pilot Alfred Henke and a crew of three fly the ship in 24 hr 56 min 12 sec, returning two days later in 19 hr 55 min 1 sec. The feats are celebrated in Germany as national events. *Aero Digest*, September 1938, p. 21; *Interavia*, Aug. 20, 1938, p. 9.

Aug. 15 A monument is dedicated at Point Barrow, Alaska, near the spot where comedian Will Rogers and aviator Wiley Post crashed exactly three years earlier. W. Shrader, *Fifty Years of Flight*, p. 65.

Aug. 17 Orville Wright, Col. Charles Lindbergh, Jerome C. Hunsaker, and others are reappointed to the National Advisory Committee for Aeronautics by President Franklin D. Roosevelt. W. Shrader, *Fifty Years of Flight*, p. 65.

Aug. 22 The Civil Aeronautics Act becomes effective. It coordinates all nonmilitary aviation under the Civil Aeronautics Authority, which will have extensive powers over air transport, aircraft ownership, airline organization, and fostering development of civil aviation in general, superseding the Bureau of Air Commerce. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 36; *Flight*, Aug. 11, 1938, p. 128.

Aug. 23 U.S. speed pilot Frank Hawks and his mechanic crash to their deaths



when Hawks's 'fool-proof' Gwinn Aircraft Aircar becomes tangled in a telephone line shortly after takeoff at East Aurora, N.Y. Hawks set some 214 flight records during his colorful career, which featured a goodwill flying tour to all 48 states in 40 days for the Will Rogers Memorial Commission. *Airpost Journal*, September 1938, pp. 14-16.

Aug. 24 In a simulated horizontal bombing attack, guns of the USS Ranger fire on the nation's first drone target aircraft, a radio-controlled JH-1. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 36.

Aug. 31 In France's first transatlantic survey flight to the U.S., a Latecoere Model 521 Lieutenant-de-Vaisseau-Paris lands in Port Washington, N.Y., from Horta in the Azores. The 2,397-mi. flight takes 22 hr 48 min. *Aero Digest*, October 1938, p. 103.

100 Years Ago, August 1913

Aug. 20 Flying from Syretzk Aerodrome in Kiev, Ukraine, 26-year-old Imperial Russian Air Service pilot Lt. Peter N. Nesterov demonstrates the world's first vertical circle, or loop-the-loop, with his Nieuport IV aircraft, at a height of 1,800 ft. Built under license by the Dux Factories in Moscow, the aircraft features a 70-hp Gnome rotary engine. Following his stunt, Nesterov is given 30 days' detention for 'useless audacity.' C. Gibbs-Smith, *Aviation*, p. 166; *Flight*, Sept. 29, 1913.

And During August 1913



—John William Dunne's tailless, swept-back Dunne No. 8 biplane successfully flies to Paris from the Royal Aero Club's Eastchurch flying grounds in England. The plane has an 80-hp Gnome engine. Although Dunne's concept does not contribute significantly to later swept-back designs, it does inspire the British professor G.T.R. Hill, who in 1926 produces the tailless Pterodactyl, which has more influence in swept-back development. C. Gibbs-Smith, *Aviation*, pp. 169, 190; *Flight*, June 22, 1912, p. 563.

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Faculty Positions
Heat Transfer and
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Autonomous Maritime Systems
Naval Postgraduate School
Monterey, California

The Department of Mechanical and Aerospace Engineering seeks applicants for two (2) tenure-track faculty positions at the assistant professor level in the areas of Heat Transfer and Thermal/Fluid Sciences with emphasis on Energy Systems, and in Dynamic Systems and Control with emphasis on Autonomous Systems with expertise in surface vehicles, underwater vehicles and robotic systems. Candidates must have the ability to teach at the graduate level, obtain a security clearance, and create nationally recognized research programs. Exceptional candidates at the associate professor level will also be considered.

Adjunct research faculty, lecturers, and postdoctoral positions in all areas in the department are also available. Candidates must have an earned Ph.D. in Mechanical/Aerospace engineering or a closely related field. Good oral and written communication skills are essential. The Department has 15 tenure-track faculty, 22 adjunct faculty, and 16 support staff and offers Masters, Engineers, and Doctoral Degrees.

Candidates should send an application letter, along with curriculum vitae and names of three references by October 1, 2013 by email to millsaps@nps.edu, or mail to:

Prof. Knox T. Millsaps, Code ME/Mi
Chairman, Mechanical and Aerospace
Engineering
Naval Postgraduate School,
Monterey, CA, 93943-5100

Position will remain open until filled. The Naval Postgraduate School (www.nps.edu/mae) is an Equal Opportunity/Affirmative Action Employer.

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The School of Aerospace Systems at the University of Cincinnati seeks highly qualified, experienced candidates for the Alan B. Shepard Chair in the area of space exploration. This appointment is intended for the tenured professor level, and at least a portion of the salary for this position will be supported by a recent 20 million dollars contribution to the university's endowment specifically for space exploration. The position will remain open until filled, but the department anticipates that interviews for viable candidates will begin in the fall of 2013. Of particular interest are candidates with demonstrated competence in some of the following areas:

- 1) Manned and unmanned spacecraft and space mission design
- 2) Spacecraft dynamics, attitude estimation and control
- 3) Orbital mechanics and trajectory analysis
- 4) Space propulsion systems
- 5) Spacecraft structural analysis and design
- 6) Autonomous systems for space rendezvous, docking and servicing
- 7) Robotic systems for space exploration
- 8) Spacecraft system health monitoring and prognostics
- 9) Small and micro-satellite design
- 10) Spacecraft power and thermal management systems
- 11) Spacecraft system engineering and integration

Candidates applying for this position must hold a doctorate degree in aerospace engineering or a related field in engineering, and are expected to have a documented record of excellence in academic research in one or more of the areas above, preferably as the leader of a research team with industry and government collaboration. Evidence supporting this record of excellence must include substantial past and current funding for research, success at supervising graduate students and/or post-doctoral fellows, a strong record of publishing scholarly work, and some component of professional service. A strong commitment to teaching and mentoring at the undergraduate and graduate levels is also vital. The successful applicant will be expected to establish strong research activities of national prominence in space exploration, complement the department's needs for teaching and supervision in areas of competence related to space exploration, and contribute to service activities in the department, university, and the professional community.

The school offers fully ABET-accredited five-year BS degree in aerospace engineering with a mandatory coop program and MS and PhD degrees in both aerospace engineering and engineering mechanics. In addition, the department has an Accelerated Engineering Degree (ACCEND) program where highly motivated students can get both BS and MS or BS and MBA degrees in five years and a quarter.

Interested applicants are requested to submit complete curriculum vitae with names and addresses of three references, detailed vision statement for developing a research center, and teaching interests. To apply for position (213UC4621) and upload the application material, please see jobsatuc.com.

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AIAA Bulletin



Female astronauts, including AIAA Executive Director Sandy Magnus, pose for a photograph before a National Tribute to Sally Ride at the John F. Kennedy Center for the Performing Arts, 20 May, in Washington, DC. From left, astronauts Pam Melroy, Kay Hire, Cady Coleman, Kathy Sullivan, Tam O'Shaughnessy (Sally Ride's life partner and chair, board of directors of Sally Ride Science), Bonnie Dunbar, Sandy Magnus, Julie Payette, and Ellen Ochoa.

JULY-AUGUST 2013

AIAA Meeting Schedule	B2
AIAA Courses & Training Program Schedule	B4
AIAA News	B5
Standard Conference Information	B26
Committee Nominations	B27
AIAA Courses and Training Program	B29

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

Meeting Schedule

DATE	MEETING (Issue of <i>AIAA Bulletin</i> in which program appears)	LOCATION	CALL FOR PAPERS (<i>Bulletin</i> in which Call for Papers appears)	ABSTRACT DEADLINE
2013				
14–18 Jul	43rd International Conference on Environmental Systems (ICES) (Mar)	Vail, CO	<i>Jul/Aug 12</i>	1 Nov 12
15–17 Jul	49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit 11th International Energy Conversion Engineering Conference (IECEC)	San Jose, CA	<i>Jul/Aug 12</i>	21 Nov 12
11–15 Aug†	AAS/AIAA Astrodynamics Specialist Conference	Hilton Head Island, SC (Contact: Kathleen Howell, 765.494.5786, howell@purdue.edu, www.space-flight.org/docs/2013_astro/2013_astro.html)		
12–14 Aug	AIAA Aviation 2013: Charting the Future of Flight Continuing the Legacy of the AIAA Aviation Technology, Integration, and Operations (ATIO) Conference and Featuring the 2013 International Powered Lift Conference (IPLC) and the 2013 Complex Aerospace Systems Exchange (CASE)	Los Angeles, CA	<i>Oct 12</i>	28 Feb 13
16–18 Aug†	DC-X First Flight 20th Anniversary	Alamogordo, NM (Contact: Cathy Harper, 575.437.2840 x41153, cathy.harper@state.nm.us, http://dc-x.spacequest.org)		
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	<i>Jul/Aug 12</i>	31 Jan 13
10–12 Sep	AIAA SPACE 2013 Conference & Exposition	San Diego, CA	<i>Sep 12</i>	31 Jan 13
23–27 Sept†	64th International Astronautical Congress	Beijing, China (Contact: http://www.iac2013.org)		
24–25 Sept†	Atmospheric and Ground Effects on Aircraft Noise	Sevilla, Spain (Contact: Nico van Oosten, nico@anotec.com, www.win.tue.nl/ceas-asc)		
6–10 Oct†	32nd Digital Avionics Systems Conference	Syracuse, NY (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)		
13–16 Oct†	22nd International Meshing Roundtable	Orlando, FL (Contact: Cherri Porter, 505.844.2788, cporter@sandia.gov, www.imr.sandia.gov)		
14–16 Oct	31st AIAA International Communications Satellite Systems Conference (ICSSC) and 19th Ka and Broadband Communications, Navigation, and Earth Observations Conference	Florence, Italy (Contact: www.icssc2013.org)	<i>Feb 12</i>	31 Mar 13
21–24 Oct†	International Telemetry Conference/USA	Las Vegas, NV (Contact: Lena Moran, 575.415.5172, lmoran@traxintl.com, www.telemetry.org)		
3–7 Nov†	22nd International Congress of Mechanical Engineering – COBEM 2013	Ribeirao Preto, Brazil (Contact: Joao Luiz F. Azevedo, joaoluiz.azevedo@gmail.com, www.abcm.org.br/cobem2013)		
5–7 Nov†	8th International Conference Supply on the Wings	Frankfurt, Germany (Contact: R. Degenhardt, +49 531 295 3059, Richard.degenhardt@dlr.de, www.airtec.aero)		
5–7 Nov†	2013 Aircraft Survivability Symposium	Monterey, CA (Contact: Laura Yuska, 703.247.2596, lyuska@ndia.org, www.ndia.org/meetings/4940)		
2014				
13–17 Jan	AIAA SciTech 2014 (AIAA Science and Technology Forum and Exposition 2014) Featuring: 22nd AIAA/ASME/AHS Adaptive Structures Conference 52nd AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference 15th AIAA Gossamer Systems Forum AIAA Guidance, Navigation, and Control Conference AIAA Modeling and Simulation Technologies Conference 10th AIAA Multidisciplinary Design Optimization Specialist Conference 16th AIAA Non-Deterministic Approaches Conference 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 7th Symposium on Space Resource Utilization 32nd ASME Wind Energy Symposium	National Harbor, MD		5 Jun 13
26–30 Jan†	24th AAS/AIAA Space Flight Mechanics Meeting	Santa Fe, NM Contact: http://www.space-flight.org/docs/2014_winter/2014_winter.html	<i>Jun 13</i>	2 Oct 13
27–30 Jan†	Annual Reliability and Maintainability Symposium (RAMS) 2014	Colorado Springs, CO (Contact: Jan Swider, 818.586.1412, jan.swider@pwr.utc.com)		

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2–6 Feb†	American Meteorological Society Annual Meeting	Atlanta, GA (Contact: Claudia Gorski, 617.226.3967, cgorski@ametsoc.org, http://annual.ametsoc.org/2014/)		
1–8 Mar†	2014 IEEE Aerospace Conference	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)		
30 Apr	2014 Aerospace Spotlight Awards Gala	Washington, DC		
5–9 May	SpaceOps 2014: 13th International Conference on Space Operations	Pasadena, CA	<i>May 13</i>	5 Aug 13
26–28 May	21st St. Petersburg International Conference on Integrated Navigation Systems	St. Petersburg, Russia (Contact: Prof. V. Peshekhonov, +7 812 238 8210, icins@eprub.ru, www.elektropribor.spb.ru)		
16–20 Jun	AVIATION 2014 (AIAA Aviation and Aeronautics Forum and Exposition) Featuring: 20th AIAA/CEAS Aeroacoustics Conference 30th AIAA Aerodynamic Measurement Technology Conference AIAA/3AF Aircraft Noise and Emissions Reduction Symposium 32nd AIAA Applied Aerodynamics Conference AIAA Atmospheric Flight Mechanics Conference 6th AIAA Atmospheric and Space Environments Conference 14th AIAA Aviation Technology, Integration, and Operations Conference AIAA Balloon Systems Conference 22nd AIAA Computational Fluid Dynamics Conference AIAA Flight Testing Conference 7th AIAA Flow Control Conference 44th AIAA Fluid Dynamics Conference AIAA Ground Testing Conference 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference 21st AIAA Lighter-Than-Air Systems Technology Conference 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference AIAA Modeling and Simulation Technologies Conference 45th AIAA Plasmadynamics and Lasers Conference 7th AIAA Theoretical Fluid Mechanics Conference 45th AIAA Thermophysics Conference	Atlanta, GA		12 Nov 13
15–18 Jul†	ICNPAA 2014 – Mathematical Problems in Engineering, Aerospace and Sciences	Narvik University, Norway (Contact: Seenith Sivasundaram, 386.761.9829, seenithi@aol.com, www.icnpaa.com)		
28–30 Jul	Propulsion and Energy 2014 (AIAA Propulsion and Energy Forum and Exposition) Featuring: 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference 12th International Energy Conversion Engineering Conference	Cleveland, OH		Nov 13
2–10 Aug†	40th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events	Moscow, Russia http://www.cospar-assembly.org		
5–7 Aug	SPACE 2014 (AIAA Space and Astronautics Forum and Exposition) Featuring: AIAA/AAS Astrodynamics Specialist Conference AIAA Complex Aerospace Systems Exchange 32nd AIAA International Communications Satellite Systems Conference AIAA SPACE Conference	San Diego, CA		Feb 14
7–12 Sept†	29th Congress of the International Council of the Aeronautical Sciences (ICAS)	St. Petersburg, Russia (Contact: www.icas2014.com)		15 Jul 13

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18–19 Jul	Liquid Propulsion Systems—Evolution and Advancements	Joint Propulsion 2013 Conference	San Jose, CA
18–19 Jul	A Practical Introduction to Preliminary Design of Air Breathing Engines	Joint Propulsion 2013 Conference	San Jose, CA
18–19 Jul	Missile Propulsion Design and System Engineering	Joint Propulsion 2013 Conference	San Jose, CA
29–30 Jul	Introduction to Space Systems	National Aerospace Institute	Hampton, VA
29–30 Jul	Phased Array Beamforming for Aeroacoustics	National Aerospace Institute	Hampton, VA
29–30 Jul	Turbulence Modeling for CFD	National Aerospace Institute	Hampton, VA
10–11 Aug	Guidance of Unmanned Aerial Vehicles	AVIATION 2013	Los Angeles, CA
10–11 Aug	Systems Engineering Verification and Validation	AVIATION 2013	Los Angeles, CA
17–18 Aug	Emerging Principles in Fast Trajectory Optimization	GNC 2013 Conferences	Boston, MA
17–18 Aug	Recent Advances in Adaptive Control: Theory and Applications	GNC 2013 Conferences	Boston, MA
8–9 Sep	Introduction to Space Systems	SPACE 2013	San Diego, CA
8–9 Sep	Satellite Communications, Today and Tomorrow: Technical Basics and Market and Technology Trends	SPACE 2013	San Diego, CA
10–12 Sep	Human Engineering Principles for Flight Deck Evaluations	Univ. of Tennessee Space Institute	Tullahoma, TN
11 Sep	Missile Defense: Past, Present, and Future	Webinar (1300–1430 hrs EDT)	
23–24 Sep	Gossamer Systems: Analysis and Design	The AERO Institute	Palmdale, CA
23–24 Sep	Sensor Systems and Microsystems: From Fabrication to Application	The AERO Institute	Palmdale, CA

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From the **Corner Office****INVESTING TO GROW**

Michael Griffin, AIAA President

Yes, this is another Corner Office article on “change” at AIAA. It might seem that this subject is the only thing that Klaus, Sandy, and I can talk or write about lately. If we seem to be singing a one-note song, then I am sorry, but I must add that we aren’t yet done, and honestly cannot be done if we are to be faithful to you, the members, in conveying what is happening

in the Institute. I started with this theme upon assuming the role of president-elect, and will be pursuing it until I pass the presidential gavel to my successor, Jim Albaugh.

Let me take it again from the top. The aerospace profession as a whole is not expanding as it did in the 1950s and 1960s, or as it did again in the 1980s. Moreover, the profession is changing and evolving—it is growing in areas that did not exist twenty or thirty years ago, and shrinking in areas once considered to be aerospace professional bedrocks.

Aerospace professionals are also aging; the average industry or government aerospace worker is more than 50 years old. AIAA itself has more members who are over 60 than under 40. Our membership has been declining slowly for years, a disturbing trend in itself. Even a cursory analysis of that decline offers even more reason to be disturbed. Our international membership is growing—a good thing, certainly, and very reflective of the growth and broadening of the aerospace profession beyond our shores. But this means that our domestic membership is declining even faster than one might suppose from the raw statistics. A closer look reveals yet more reason for concern. Our single biggest membership problem is the simple fact that most student members do not elect to continue long-term professional membership in AIAA, dropping out a few years after graduation.

These demographic trends have consequences. Although we ran a deficit last year and will do so again this year, thanks to the health of our investment portfolio, we are in solid financial shape.

None of this is or can be healthy for an Institute that has always served as the voice of the profession, and would like to continue to do so. We are slowly beginning to confront that our long-standing structure and orientation have gradually become less relevant to the modern state of aerospace professional practice, and to make decisions based upon an understanding of that fact. But that means change and, as we all know, change is hard!

When AIAA was formed some five decades ago from its two predecessor societies, the Institute of the Aeronautical Sciences and the American Rocket Society, many if not most of its founding practitioners were of an academic bent, and strongly tied to that culture, with its parsing of the world according to the dictates of academic curricula. The profession as a whole was oriented similarly; common self-identification in those days was as an “aero guy”, a “structures guy”, a “controls guy”, etc. One rarely heard the term “system engineering”, something that is a core competency in the profession as we know it today. Most people thought of themselves as discipline specialists first and, after that, self-identified with a particular company, agency, or laboratory. No one used the term I most often employ today, the broadly and intentionally inclusive “aerospace professional”, and even system or project affiliations were less commonly offered. (And, yes, we were indeed mostly “guys”. The first class I ever taught as an adjunct professor, in 1979, had exactly one woman in a class of over three dozen engineering students; she was by far the best student in the class. Even in the engineering culture of the late 1970s, she needed to be the best to have made it that far.)

How you think and talk about yourself and your work matters, and in this arena things have changed. A lot. Not only are we far more demographically diverse, in my observations we seem to also think of ourselves differently. Ask a young aerospace professional what she does, and you will most likely hear, “I work on F-35”, or whatever system or platform with which she happens to be involved. If she’s working on the flight control system she might offer that fact in response to a question, but will most often follow it up with the comment that she wants to get some experience in other areas, soon. She is unlikely to think of herself as an aerospace engineer, and indeed is as or more likely to have a degree in electrical or mechanical engineering or computer science than to have an aerospace engineering degree with a major in controls. Is she an aerospace professional? Absolutely. Is she a member of AIAA? Based on our membership statistics, probably not.

The center of mass in the aerospace profession today lies with big systems and platforms, flight or ground, government or commercial, defense or civil. But not only that, a key part of the profession is also about adapting or using the platform for a specific mission. Our profession is far, far more about the efficient, effective, elegant integration of the mind-numbing span of technical disciplines and details to do a specific job than it is about the disciplines themselves. We have evolved from a profession in which the mere fact of basic technical feasibility in key disciplines was not always established, to one in which the successful blending of these disciplines for a specific application is the discriminator between good designs and those which turn out to be not so good.

AIAA has not evolved with the profession. The most significant elected position on the AIAA Board is not that of president; it is that of VP-TAC. We held our first conference specifically devoted to system engineering only last fall. And much of what modern aerospace professionals do when they show up at work every morning does not easily find a home within the AIAA organizational structure. If it cannot be found in an academic engineering department, you will have a hard time finding it within AIAA—even if it is how you earn your living in aerospace every day.

This is in some ways a harsh assessment, though I do not so intend. But it does reflect what I see in our world, and I believe we need to do something about it. And we are. Our most recent round of meetings, those of the Board and the equally crucial Institute Development Committee, yielded some key decisions about directional changes we intend to make to rebuild AIAA. Klaus and Sandy and I are going to be writing about these in the coming months. For now, I think it is best to close by saying that we faced a choice between shrinking the Institute, on purpose, to support and sustain those core technical activities at which we have always been simply the best, but not much more, or broadening our span and transforming the Institute to represent today’s aerospace profession more fully. The IDC and the Board have chosen the latter path, and have chosen to invest portfolio funds to help bring about that outcome. Our “new event model”, about which too much has already been said, is a key part of that effort, but it is only a part. The bottom line, even in the midst of the toughest environment we have faced in years, is that the AIAA leadership is choosing growth over shrinkage. And that means change. We’ll be talking more about those decisions and the resulting changes in coming editions of this column.

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.

PREMIER AWARDS PRESENTED AT AIAA AEROSPACE SPOTLIGHT AWARDS GALA

AIAA presented its highest awards at the Aerospace Spotlight Awards Gala on 8 May, at the Ronald Reagan Building and International Trade Center, Washington, DC. The event provided the opportunity for senior leaders in government, academia, and industry to recognize the “best of the best” in aerospace. The Gala brought together over 500 guests to salute the honorees, which included a new class of AIAA Fellows and Honorary Fellows and distinguished winners of AIAA’s premier awards.

AIAA President Michael Griffin opened the Gala with a warm welcome to the evening’s guests, followed by presentation of the 2013 AIAA Fellows and Honorary Fellows, all of which were congratulated for their achievements. After dinner, Dr. Griffin presented AIAA’s prestigious awards, which are the highest awards that the Institute and AIAA Foundation bestows.

Recognizing outstanding achievement is one of the primary responsibilities of AIAA. The honors and awards program is extensive, providing many opportunities for recognition of notable and significant contributions or technical excellence by members. Nominations are currently being accepted for AIAA’s top honors; the nomination deadline is **1 October 2013** (see page **B18** for more details) or visit <http://www.aiaa.org/HonorsAndAwardsOpenNominations.aspx?id=5858>. For more information about the AIAA Honors and Awards program, please contact Carol Stewart at carols@aiaa.org or at 703.264.7623.



Right: 2013 Honorary Fellows. From left to right: Skip Fletcher, Selection Board Chair; William H. Gerstenmaier, David Ian Poll, Allen Fuhs, David Thompson, Michael Griffin, AIAA President

Below: 2013 AIAA Fellows





Curiosity Mission Team, Mars Science Laboratory, NASA Jet Propulsion Laboratory



Charles Elachi, Director, NASA Jet Propulsion Laboratory (left), with AIAA President Michael Griffin (right), after accepting the AIAA Foundation 2013 Award for Excellence on behalf of the Curiosity Mission Team.



John Grunsfeld, Administrator for the Science Mission Directorate at NASA Headquarters and recipient of the 2013 National Capitol Section Barry M. Goldwater Educator Award, (left) with AIAA National Capitol Section Chair Bruce Milam (right).



Paul G. Kaminski, Chairman & CEO, Technovation, Inc. and Former UnderSecretary of Defense, Acquisition, and Technology, with AIAA President Michael Griffin (right) after receiving the 2013 AIAA Reed Aeronautics Award.



Scott Pace, Director, Space Policy Institute, Elliott School of International Affairs at George Washington University and recipient of the AIAA 2013 International Cooperation Award, with AIAA President Michael Griffin (right).



AIAA President Michael Griffin (left) congratulates William Ballhaus, Jr., President and CEO (Retired), The Aerospace Corporation and recipient of the AIAA 2013 Goddard Astronautics Award



Recipients of the AIAA Educator Achievement Awards: (Front row) Deborah Swan, Windsor Hills Math, Science, Aerospace Magnet School; Joan Labay-Marquez, Curington Elementary School; Lanena Berry, Houston Independent School District; Elizabeth Dabrowski, Magnificat High School (Back row) Sean McCullough, Anderson Districts I & II Career and Technology Center; James Weber, Timberland High School; Lisa Damian-Marvin, Camden Hills Regional High School



Aubrey T. (Tom) Smith (left), President, ATS Solutions, Inc. and recipient of the 2013 AIAA Distinguished Service Award, with AIAA President Michael Griffin.

MEMBERSHIP ANNIVERSARIES

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

25-Year Anniversaries

Laura L Pauley	Central Pennsylvania	Peter Q Gendron	New England	Dahsin Liu	Michigan	Eugene H Kopp	Los Angeles-Las Vegas
Edward C Smith	Central Pennsylvania	Edward L Haletky	New England	William J Stevenson	Michigan	James D Mason	Los Angeles-Las Vegas
David M Andrade	Connecticut	James R Hildreth	New England	David J Arend	Northern Ohio	Zakir H Mirza	Los Angeles-Las Vegas
Ronald S Fritsch	Connecticut	James A Holzer	New England	Eric A Bobinsky	Northern Ohio	Shitalkumar Mochi	Los Angeles-Las Vegas
Ramesh B Malla	Connecticut	Larry S Ingram	New England	James R. DeBonis	Northern Ohio	David A Nixon	Los Angeles-Las Vegas
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Shepard B Stone	Connecticut	Matthew R Jardin	New England	Paul W Giel	Northern Ohio	Kurt M Rump	Los Angeles-Las Vegas
Jonathan W Katz	Delaware	Sanjay N Patel	New England	Mark S Haberbusch	Northern Ohio	Thomas R Van Meter	Los Angeles-Las Vegas
Brett M Hoffstadt	Greater Philadelphia	Theodore A Postol	New England	James C Johnston	Northern Ohio	Scott A Wallace	Los Angeles-Las Vegas
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Anthony W Kelch	Greater Philadelphia	Jay E Wynn	New England	Lisa D Koch	Northern Ohio	Roby S Wilson	Los Angeles-Las Vegas
Kenneth H Landis	Greater Philadelphia	Kathleen C Laurini	No Section Assignment	Henry K Nahra	Northern Ohio	Xiaolin Zhong	Los Angeles-Las Vegas
Arthur N Mallett	Greater Philadelphia	Sigmund S Grudzinski	Northeastern New York	Thomas P Ratvasky	Northern Ohio	Victor S Burnley	No Section Assignment
Benjamin F Pyfer	Greater Philadelphia	Debra Faktor Lepore	Northern New Jersey	John P Riehl	Northern Ohio	Edwin C Cady	Orange County
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 Wayne C Solomon Pacific Northwest
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 Tom J Love Oklahoma
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 Phillip J Sullivan Atlanta
 Robert M Bowman Cape Canaveral
 Kenneth D Reside Cape Canaveral
 Herbert E Hunter Greater Huntsville
 Thomas J Lee Greater Huntsville
 Kenneth O Thompson Greater Huntsville
 Robert A Meyer Greater New Orleans
 Joseph A Sabatella Palm Beach
 Robert J Stewart Savannah
 Richard G Payne Columbus
 Delmar W Breuer Dayton/Cincinnati
 Walter O Detert Dayton/Cincinnati
 Evard H Flinn Dayton/Cincinnati
 Ralph P Richter Dayton/Cincinnati
 Charles R McDaniel Indiana
 Floyd V Bennett Houston
 Charles E Shoppach North Texas
 Fay A Wirth North Texas
 Ronald O Stearman Southwest Texas
 John F Wester Southwest Texas
 George R Conrad White Sands
 Space Harbor
 Bud D Nelson White Sands
 Space Harbor
 Edward A Jeude St. Louis
 Sanford N McDonnell St. Louis
 Robert D Samuelson St. Louis
 Norman A. Faber Los Angeles-Las Vegas
 Arthur P Goldberg Los Angeles-Las Vegas
 Richard A Husmann Orange County
 Donald M Layton Orange County
 Joseph F Sutter Pacific Northwest
 Frederick L Bagby Phoenix
 Roy A Hempel Phoenix
 William P Albers San Diego
 Henry E Davies San Diego
 Warner L Stewart San Diego
 Fred A Cohan San Fernando Pacific
 Edward M Arand San Francisco
 Igor M Jaremenko San Gabriel Valley
 Kazimierz J Orlik-Ruckemann International

70-Year Anniversaries

M. L Spearman Hampton Roads
 Norman Grossman Long Island
 Philip R Compton National Capital
 J. P Bergeron New England
 William B Boatright Niagara Frontier
 Alfred Ritter Southern New Jersey
 Joseph V Charyk Palm Beach
 Jerome M Goldman Indiana
 Rudolph L Leutzinger Wichita
 R. W Lowe Wichita
 Welko E Gasich Los Angeles-Las Vegas
 Irving H Kerr Los Angeles-Las Vegas
 Bohdan I Wandzura Los Angeles-Las Vegas
 William R Williams Los Angeles-Las Vegas
 James S Ackerman Orange County
 Vincent Moore Pacific Northwest
 Jack R Lind San Diego
 George E Nichols San Gabriel Valley

19th

Ka and Broadband Communications,
Navigation and Earth Observation
Conference

31st

AIAA International Communications
Satellite Systems Conference
(ICSSC)



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The World's Forum for Aerospace Leadership

2013 Joint Conference

Satellite Systems to Serve the Needs of the 21st Century

Florence - Italy , October 14-17, 2013

The 31st AIAA International Communications Satellite Systems Conference (ICSSC) and the 19th Ka and Broadband Communications, Navigation and Earth Observation Conference, the two most influential technical conferences on satellite systems, will be held jointly **14-17 October 2013**, in Florence, Italy, and the theme is: **Satellite Systems for the Needs of the 21st Century**.

Despite the steady progress of wire-line and wireless terrestrial technologies, satellites are still playing a key, and often, unique role in our society. Although the most successful application of satellites is represented by direct-to-home digital broadcasting, satellite applications are much more widespread, spanning from interactive broadband service provision to terrestrially uncovered regions directly or indirectly via backhaul services. In addition to individual reach, satellites provide key functions for governments' civil and military needs and for commercial enterprises. Security and public safety organizations rely on satellites for critical telecommunications, search and rescue operations, tracking of ships at sea, airplanes, environmental sensing and daily monitoring—more so during disaster events such as floods, earthquakes, forest fires, or tsunami to name a few. Navigation satellites are nowadays representing a key and often unique high accuracy localization technique to complement terrestrial sensors. A multitude of spaceborne sensors are providing essential information about the Earth's status for better weather and climate prediction as well for strategic purposes. These sensors are requiring downloading, processing, and distributing a growing amount of data. Our search for a better understanding of the universe, and in particular of our galaxy, calls for unprecedented communication capacity to be relayed to Earth from various sensors.

Improving on the above capabilities and providing new ways to serve mankind are some of the challenges the satellite community must face. The conference will explore these challenges and new solutions to enhance what satellites can offer in

the various application domains.

The objective of the conference is to provide an in-depth exploration of the technical, regulatory, economic, and marketing issues affecting these new and planned services.

The 2013 Joint Conference will feature:

- **75 sessions** (including a Poster Session),
- the presentation of over **260 high standard papers**,
- the Colloquium on **Satellite Services for Global Mobility**,
- a stimulating **Opening Plenary Session** and **3 Panel Sessions** with leaders from government and industry,
- the **11th BroadSky Workshop on Small Satellites, Big Possibilities**.

Student Sponsorship

The AIAA Communications Systems Technical Committee has awarded with \$500.00 each 12 full-time students whose papers have been accepted and will be presented at the ICSSC.

Information & Inquiries should be directed to:

- ICSSC Conference Technical Program Co-Chairs at icssc2013_tpc@esa.int
- Ka Conference Technical Program Co-Chair at frankgargione3@msn.com
- Joint Conference Organization at info@kaconf.org

More information can be found at:

<http://www.icssc2013.org> or <http://www.kaconf.org>

PRELIMINARY TECHNICAL PROGRAM OVERVIEW

MONDAY OCTOBER 14, 2013

Room A

08:30
17:30

Colloquium:
"Satellite Services for Global Mobility"
Chair: Xavier Lobao and Alberto Ginesi, ESA/ESTEC, The Netherlands

TUESDAY OCTOBER 15, 2013

PLENARY SESSION

08:30
08:35

Opening Session

08:40
09:40

Joint Conference Plenary Session:
Satellite Systems for the Needs of the 21st Century.

10:00

COFFEE BREAK

TUESDAY OCTOBER 15, 2013

	Room A	Room B	Room C	Room D	Room E	Room F
10:30 11:50	Ka 1: Telecommunication System 1	ICSSC 1: DVB-S2 Evolutions I	Ka 2: Telecommunication Components 1	ICSSC 2: High-capacity broadband satellite systems, services, and technologies	ICSSC 3: Satellite-aided localization systems, technologies, and applications	ICSSC Panel 1: Trends in Communications Satellite Architectures and Applications (Ka Band and upwards)
12:10	LUNCH					
13:40 15:00	Ka 3: Telecommunication Applications 1	ICSSC 4: Flexible satellite resource allocation architectures, design tools, and technologies I	11TH BROADSKY WORKSHOP "Small Satellites, Big Possibilities"	ICSSC 5: Next generation L/S/K-band GEO/MEO/LEO mobile satellite systems, services, and technologies I	ICSSC 6: Satellite bus technologies	Ka 4: Telecommunication Payloads 1
15:20	COFFEE BREAK					
15:40 17:40	Ka 5: Earth Observation Systems 1		11TH BROADSKY WORKSHOP (continued)	Ka 6: Propagation 1	ICSSC 7: Novel Space System Design Aspects	Ka 7: Telecommunication Antennas 1
19:00	WELCOME COCKTAIL RECEPTION					

WEDNESDAY OCTOBER 16, 2013

	Room A	Room B	Room C	Room D	Room E	Room F
08:30 09:50	Ka 8: Navigation System 1	Ka 9: Telecommunication Components 2	ICSSC 8: Advanced fixed satellite systems, services, and technologies	ICSSC 9: Antenna Technologies	Ka 10: Telecommunication Payloads 2	Ka 11: Earth Observation Payloads & Sensors 1
10:10	COFFEE BREAK					
10:40 12:20	Ka 12: Navigation Systems 2	ICSSC 10: Satellite Broadband Systems and Technologies	ICSSC 11: DVB-S2 Evolutions II	ICSSC 12: Communications protocols and networks	Ka 13: Market Assessment	Ka 14/ICSSC 13: Propagation 2
12:45	LUNCH - ICSSC AWARD					
14:30 15:50	Ka 15: Telecommunication New Systems 1	Ka 16: Telecommunication GS 1	ICSSC 14: Advances in satellite payload architectures and equipment	ICSSC 15: High-capacity broadband satellite systems, services, and technologies	Ka 17: Earth Observation Test & Verifications	Ka Panel: Satellite Navigation
16:10	COFFEE BREAK					
16:30 17:50	Ka 18: Telecommunication New Systems 2	Ka 19: Telecommunication Antennas 2	ICSSC 16: Flexible satellite resource allocation architectures, design tools, and technologies	ICSSC 17: Optical communications techniques and technologies	Ka 20: Navigation Space & GS	Ka 21: Earth Observation Payloads & Sensors 2
08:30 18:00	Poster Session					
20:30	CONFERENCE DINNER					

THURSDAY OCTOBER 17, 2013

	Room A	Room B	Room C	Room D	Room E	Room F
08:30 10:10	Ka 22: Telecommunication Antennas 3	ICSSC 18: Advances in Earth terminals and stations architectures and equipment	ICSSC 19: Advances in satellite payload architectures and equipment	ICSSC 20: Hybrid satellite/terrestrial mobile systems and technologies	Ka 23: Telecommunication Systems 2	Ka 24: Telecommunication Payloads 3
10:30	COFFEE BREAK					
11:00 12:20	Ka 25: Earth Observation Systems 2	ICSSC 21: Next generation L/S/K-band GEO/MEO/LEO mobile satellite systems, services, and technologies II	ICSSC 22: Digital payload architecture, technologies, and equipment	ICSSC 23: High-capacity broadband satellite systems, services, and technologies	ICSSC 24: Advanced data relay and backbone systems, services, and technologies	ICSSC Panel 2: Satellite R&D status, the trend and perspective
12:45	LUNCH					
14:00 15:00	Ka 26: Earth Observation Applications	ICSSC 25: Payload and ground segment technologies for Ka, Q/V, and W-band	ICSSC 26: Next generation L/S/K-band GEO/MEO/LEO mobile satellite systems, services, and technologies	Ka 27: Telecommunication GS 2	Ka 28: Telecommunication Components 3	
15:20	COFFEE BREAK					
PLENARY SESSION						
15:40 16:50	Special Session					
17:00	Joint Conference Closing Session					

WISHING A JOYOUS RETIREMENT TO ELEANOR ALDRICH

Duane Hyland

Long-serving AIAA staff member **Eleanor Aldrich**, AIAA Associate Fellow, announced her retirement from AIAA, effective 30 April. On 10 May, AIAA Executive Director Sandy Magnus and the Institute’s staff honored Eleanor for 25 years of unflagging commitment to the Institute.



“Eleanor has been an important part of the AIAA family for the last 25 years, both as a member of the organization as an Aerospace professional, as well as a staff member,” said AIAA Executive Director Sandy Magnus. “Her contributions to the organization are many and varied. Her enthusiasm and passion for the industry are well known and greatly appreciated. Even though Eleanor is retiring we hope that as a member she will choose to stay involved in AIAA activities when her time permits!”

Eleanor joined the AIAA staff in 1988. Her primary area of responsibility was business development, and she crafted many of the programs that we take for granted today. From originating AIAA’s signature SPACE conference, to her creation of AIAA’s Commercial Space Group, to directing AIAA’s Technical Activities Division, and undertaking special projects for AIAA senior management, Eleanor was an indispensable part of the Institute for over 25 years. In all of her leadership activities, Eleanor’s exceptional ability to build bridges between technical developers of systems and their end-users—her unparalleled ability to draw both sides together for conversations, knowledge exchange, and problem solving—stood apart. Her passion for space, for advocacy, and for advancing the AIAA banner make her one of AIAA’s most treasured assets, and perhaps one of the nation’s most passionate space advocates.

Eleanor was also responsible for forging AIAA’s commitment to the emerging “New Space” community. As one of the first to foresee the coming changes in the space community, as it shifted from large-scale government projects like Apollo or the Space Shuttle, to smaller, private commercial ventures in the areas of space tourism, transportation, and other purposes, Eleanor recognized that the emerging “New Space” community would be a valuable sector for AIAA to reach out. To forge those

needed links, Eleanor created and organized AIAA’s Commercial Space Group, which aims to bring together individuals from all disciplines—engineering, design, management and policy, as well as bankers, investors, and insurance firms—to discuss the changes in the community, to promote dialogue about those changes, and to map AIAA’s way forward in the new environment. Realizing that the group was not enough, Eleanor also reached out to the FAA to join forces on the FAA’s annual Commercial Space Conference, in addition to New Mexico State University and their commercial space conference. Her efforts have ensured that AIAA will continue to play a strong leadership role in the area of commercial space.

Looking back over her years at AIAA, Eleanor has a number of engaging memories. She recalled the particularly successful AIAA SPACE 2000 conference in Long Beach, which was chaired by Boeing’s Jim Albaugh, who today is AIAA’s President-Elect! Jim’s deputy, Larry Lewis, made good on a guarantee that the conference title would match the conference attendance number of 2000. He succeeded in that guarantee!

She also recalled a trip to Beijing with Roy Harris, John Swihart, and other aeronautical leaders who were strong supporters of AIAA. On a visit to an aeronautical research center on the outskirts of Beijing, they passed over the historic Marco Polo Bridge, named by the passage of that intrepid Italian explorer about 1275 CE. Their Chinese hosts at the aeronautical center were dismayed that, so far, the delegation had eaten only commercial food in the city, so they had organized and very graciously presented a wonderful feast of locally prepared dishes.

Eleanor shared a final memory connected to hot-air balloons. As Eleanor remembers, “I was attending a meeting of the AIAA Balloon Systems Technical Committee in Albuquerque for the first presentation of the Otto C. Winzen Lifetime Achievement Award. I was staying in the hotel’s 6th or 7th floor, and one morning during the event, I opened my shades at first light to see the rising sun and beheld an errant hot air balloon with 2 or 3 people in the basket headed straight for my window. Those people looked plenty alarmed as they barely cleared the brick wall above me!”

From her tireless commitment to AIAA, her sage advice, and her forward-looking leadership, Eleanor will be missed around the corridors of the Institute. There is little doubt that we will still hear her voice—as she remains the committed, passionate, advocate for aerospace that we have come to know, love, respect, and depend on these many years.

AIAA FOUNDATION ANNOUNCES WINNERS OF AIAA REGION I STUDENT PAPER COMPETITION

The AIAA Foundation has announced the winners of its Region I Student Paper Competition, held 5–6 April at the University of Maryland (UMD), College Park, MD. The winners are:

Masters Division

- First place: Ganesh Raghunath, UMD, for “Wireless Magneto-Elastic Torque Sensor System”
- Second place: Benjamin T. Pipenberg, Pennsylvania State University (PSU), College Park, Penn., for “Design, Fabrication, and Analysis of a 600mg Fixed-Wing Nano Aerial Vehicle”
- Third place: Kentaro Miura, PSU, for “Passive Tailboom Vibration Control Using Fluidic Flexible Matrix Composite Tubes”

Undergraduate Division

- First place: Scott Wingate, UMD, for “Graphene-Silicon Composite Lithium Ion Batteries for Micro Air Vehicles”
- Second place: Joseph Tore Mullins, UMD, for “Design and Development of a Flying Cyclocopter”
- Third place: Jose Mondragon, UMD, for “Drag Reduction for Ground Vehicles Upon Vortex Generators Implementation”

Team Division

- First place: Adam Pranaitis, Steven Ericson, Melissa Kelly, Jeffrey Parkhurst, and Robert Waldron, Daniel Webster College, Nashua, NH, for “Autonomous Unmanned Aerial Vehicle”
- Second place: Lauren Min, Rehan Kaluarachchi, Eileen Kim, and Daniel Rocio, Cornell University (CU), Ithaca, NY, for “Little Gull Ornithopter”
- Third place: Al Jean-Francois, Henry Ekwaro-Osire, Peter Ingato, Oliver Kliewe, Nik Lal, and Yan Li, for “Wingmill Energy Harvesting”

Community Outreach Division:

- First place: Kaitlynn Mosier and Joshua Jenkins, The Virginia Polytechnic Institute and State University, Blacksburg, VA, for “Atmospheric Teaching Experiment at Virginia Tech.”
- Second place: Yan Li and Wendy Zhao, CU, for “2013 Wind Turbine Competition: Aeronautics and Alternative Energy Intersect”

Other schools taking part were: Old Dominion University, Rutgers University, Syracuse University, the University of Virginia, and Virginia Commonwealth University. Visit the AIAA Foundation Student Paper Conferences for more information.

TEN YEARS OF EXCELLENCE AT THE UT SPACE INSTITUTE

In his tenth year at the UT Space Institute, **Prof. Joseph C. (Joe) Majdalani** was honored with the Abe M. Zarem Educator Award at the 51st Aerospace Sciences Meeting. The Zarem Educator Award is conferred by the AIAA Foundation to faculty members who showcase a remarkable degree of effectiveness in their mentorship and guidance efforts toward advising graduate students as demonstrated by the graduate students receiving the Abe M. Zarem Award for Distinguished Achievement..

In the past four years, Dr. Majdalani has advised seven graduate students who became recipients of eight best paper awards. In addition to Charles T. Haddad, who won the Zarem Award for Distinguished Achievement in Astronautics, Dr. Majdalani's group at UTSI has been successful at securing seven Best Papers at the 61st–64th Southeastern Student Conferences. Dr. Majdalani's team so far has entered these conferences with only seven papers, and returned with one national and seven regional awards. Such unprecedented winning streak is a testimony to the exceptional talent of students and faculty that UTSI attracts. The seven papers in question focus on advanced propulsion concepts that pertain to chemical rockets in which the flow is driven by either wall-normal or wall-tangential injection. They are sponsored, in part, by the National Science Foundation and, in part, by the UT Space Institute. "We are truly blessed," Dr. Majdalani added, "because it literally takes an act of God to repeatedly win at these highly contested paper championships."

Dr. Majdalani joined UTSI in 2003 as the Jack D. Whitfield Professor of High Speed Flows. In 2007, he was selected to fill the H. H. Arnold Chair of Excellence in Advanced Propulsion. His interests span the areas of internal aerodynamics, acoustic



Former AIAA President Paul D. Nielson and Professor Joseph Majdalani (right).

instability, high-speed gas dynamics, swirl-augmented engine technology, and singular perturbation theory. Dr. Majdalani's research activities at UTSI have materialized in approximately 145 publications in journals and conference proceedings. These have attracted 14 external awards while contributing to the fulfillment of 14 M.S. and 6 Ph.D. degrees.

AIAA SACRAMENTO SECTION CELEBRATES 50TH ANNIVERSARY

Jim Hornick, AIAA Sacramento Section Chair

May 2013 marked the 50th anniversary of the American Institute of Aeronautics and Astronautics, the combination of the American Rocket Society and the Institute of the Aerospace Sciences. AIAA's Sacramento Section was founded on 15 May 1963. The Sacramento Section has been promoting professionalism among those involved in the art, science and technology of aeronautics and astronautics since its inception.

Among the section's recent activities have been hosting technical seminars and advancing STEM studies from K–12 through the university level. In recent years, with the assistance of the GenCorp Foundation, senior-year engineering projects at both CSUS (Sac State) and UCD have been funded to encourage and advance the engineering skills of the students.

In April, a dinner meeting featuring Dr. Paul Bevilacqua (Chief Engineer of the Lockheed Martin Skunk Works) was held at the Aerospace Museum of California.

Pictured right were two attendees at that event who represent the 50-year span of AIAA in Sacramento. On the left is Donald Eby (Lt. Col., USAF, Retired) and Steven Reiff (Founding President of the AIAA Student Branch at CSUS). Each are hold the founding certificates, issued 50 years apart.

Lt. Col. Eby was a summer intern at Aerojet in 1962 and was a founding member of AIAA in 1963. After graduation from Cal Poly, he went on to join the USAF, flew three tours in Vietnam, was a member of the recovery team for Apollo 11 crew, and served positions with the Lockheed Aircraft Company as aerospace engineer and test pilot. After his military service, he



was an Assistant Program Manager on the A-10 program and worked for SAIC in support of the Air Force Logistics Command. Mr. Reiff, as a senior at Sac State, led a group of students in applying for an AIAA Student Branch charter at his school. He is also involved in STEM study advancement at the Aerospace Museum of California.

AIAA DELAWARE SECTION SPONSORS DELAWARE ROCKET DAY FOR MILITARY FAMILIES

On 4 May 2013, the AIAA Delaware Section sponsored a rocket construction and launch event, or “Rockets at the Outpost,” an event hosted each year by the Delaware AeroSpace Education Foundation (DASEF) in Smyrna, DE. It is a hands-on, learning program developed by DASEF to encourage students in grades K–12 to build and launch their own model rockets.

The purpose of the Rockets at the Outpost program is to educate children on the importance of science and technology, and stimulate academic interest and public awareness in science, technology engineering, and math (STEM); as well as space and environmental sciences. This year, Rockets at the Outpost featured a special focus on military families and their children. The AIAA Delaware Section sponsorship included a DASEF grant to purchase model rocket kits for students participating in Rocket Day activities.

The day began with short presentations given by ATK Missile Defense & Controls and AIAA Delaware Section. Taylor Donaldson, AIAA Delaware Section Education Chair, spoke to both parents and students about the AIAA organization and shared insights on the aerospace industry. Anthony LoRusso, ATK MD&C systems engineer, presented “How Solid Rocket Motors Work,” supplying students with a tangible example of the work performed in the aerospace industry. The students demonstrated genuine interest in the presentations, especially in the topics of the Space Shuttle and future Space Launch System. Parents were pleased to hear about opportunities that AIAA can provide for students interested in the aerospace field.

Following the presentations, everyone moved inside to start the model rocket assembly activity. The students and their parents were able to collaborate on the rockets construction as DASEF volunteers guided them through the assembly process. One by one, the rockets were assembled with the motors installed last to prepare for launch. Younger students had the opportunity to decorate canister rockets, whose primary means of propulsion was water and an Alka-Seltzer tablet. During the rocket building activity, DASEF volunteers also provided the children an opportunity to view the sun and its sunspots through a large, filtered telescope, thrilling all who peered into it.

Once the rocket assembly was complete, the students gathered outside to launch their rockets in groups of six from the DASEF-built launch pad. Students took turns launching and retrieving their rockets after flight. A few adventurous participants



changed the configuration of their rocket fins to see how the flight of the rocket would be affected. Many rockets were successfully launched to heights of 100 feet or so, others tracked unusual flight paths, some plummeted to the ground after failure of the parachute, and a few of the rockets suffered a hang-fire. Fortunately, none found any RETs (rocket-eating trees) that the DASEF volunteers had warned them about.

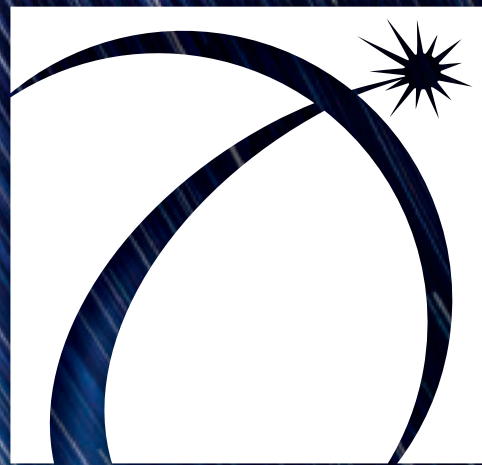
In all, the event was an unqualified success, providing a hands-on opportunity for children of military families to learn about the aerospace industry and pique their interest in STEM education. Parents were very happy to watch their children take a true interest science and technology, and the student enthusiasm was evident as they charged into the field to watch something they created launch into the sky. The Rockets at the

Outpost event clearly nurtured interest in the STEM fields, and hopefully inspired some to pursue careers in our industry!





A I A A



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COLLABORATION**
TO ENABLE
MISSION SUCCESS

10–12 September 2013

San Diego Convention Center
San Diego, California

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Plenary sessions will feature space industry leaders on:

- The evolution of space business paradigms
- Beyond LEO destinations, and cooperation between government and private initiatives
- Sustaining innovation on tight budgets
- Aligning technology roadmaps for sustained progress in space
- The future of space-based weather and climate monitoring

Panel sessions will discuss challenges and progress in:

- Current launch vehicles
- Stimulating innovation
- Mars exploration
- Commercial crew and cargo
- STEM and workforce needs to sustain space leadership
- Hosted payloads and disaggregated architectures
- The future of NASA space science
- Early-stage technology development
- Human spaceflight
- Bringing mature technologies to market
- Satellite services
- Space debris issues and mitigation
- NASA's asteroid retrieval program
- Future opportunities for small sats
- The confluence of space system design and operations

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CALL FOR NOMINATIONS

Nominations are being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 October**. Awards are presented annually, unless indicated. AIAA accepts nomination on a daily basis and applies to the appropriate year.

Any AIAA member in good standing may serve as a nominator and are urged to read award guidelines carefully to view nominee eligibility, page limits, letters of endorsement. AIAA members may submit nominations online after logging into www.aiaa.org. You will be guided 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.

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

Premier Awards & Lectureships

Distinguished Service Award gives unique recognition to an individual member who has provided distinguished service to the Institute over a period of years.

Goddard Astronautics Award, named to honor Robert H. Goddard—rocket visionary, pioneer, bold experimentalist, and superb engineer, is the highest honor AIAA bestows for notable achievement in the field of astronautics.

International Cooperation Award recognizes individuals who have made significant contributions to the initiation, organization, implementation, and/or management of activities with significant U.S. involvement that includes extensive international cooperative activities in space, aeronautics, or both.

Reed Aeronautics Award is the highest award AIAA bestows for notable achievement in the field of aeronautics. The award is named after Dr. Sylvanus Reed, aeronautical engineer, designer, and founding member of the Institute of Aeronautical Sciences.

Dryden Lectureship in Research, named in honor of Dr. Hugh L. Dryden, emphasizes the great importance of basic research to the advancement in aeronautics and astronautics and is a salute to research scientists and engineers.

Durand Lectureship for Public Service is given for notable achievements by a scientific or technical leader whose contributions have led directly to the understanding and application of the science and technology of aeronautics and astronautics for the betterment of mankind.

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

Wright Brothers Lectureship in Aeronautics emphasizes significant advances in aeronautics by recognizing major leaders and contributors. (Presented odd years)

Technical Excellence Awards

Aeroacoustics Award is presented for an outstanding technical or scientific achievement resulting from an individual's contribution to the field of aircraft community noise reduction.

Aerodynamics Award is presented for meritorious achievement in the field of applied aerodynamics, recognizing notable contributions in the development, application, and evaluation of aerodynamic concepts and methods.

Aerodynamic Measurement Technology Award honors continued contributions and achievements toward the advancement of advanced aerodynamic flowfield and surface measurement techniques for research in flight and ground test applications.

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

Chanute Flight Test Award recognizes significant lifetime achievements in the advancement of the art, science, and technology of flight test engineering. (Presented even years)

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

Engineer of the Year is presented to an individual member of AIAA who has made a recent significant contribution that is worthy of national recognition. Nominations should be submitted to your AIAA Regional Director.

Fluid Dynamics Award is presented for outstanding contributions to the understanding of the behavior of liquids and gases in motion as related to need in aeronautics and astronautics.

Ground Testing Award is given for outstanding achievement in the development or effective utilization of technology, procedures, facilities, or modeling techniques or flight simulation, space simulation, propulsion testing, aerodynamic testing, or other ground testing associated with aeronautics and astronautics.

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

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

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

Losey Atmospheric Sciences Award recognizes outstanding contributions to the atmospheric sciences as applied to the advancement of aeronautics and astronautics.

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

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

Plasmadynamics and Lasers Award is presented for outstanding contributions to the understanding of the physical properties and dynamical behavior of matter in the plasma state and lasers as related to need in aeronautics and astronautics.

Jay Hollingsworth Speas Airport Award is presented to the person or persons judged to have contributed most outstandingly

during the recent past toward achieving compatible relationships between airports and/or heliports and adjacent environments. The award consists of a certificate and a \$10,000 honorarium. Cosponsored by AIAA, the American Association of Airport Executives, and the Airport Consultants Council.

Theodor W. Knacke Aerodynamic Decelerator Systems Award recognizes significant contributions to the effectiveness and/or safety of aeronautical or aerospace systems through development or application of the art and science of aerodynamic decelerator technology. (Presented odd years)

Thermophysics Award is presented for an outstanding singular or sustained technical or scientific contribution by an individual in thermophysics, specifically as related to the study and application of the properties and mechanisms involved in thermal energy transfer and the study of environmental effects on such properties and mechanisms.

James Van Allen Space Environments Award recognizes outstanding contributions to space and planetary environment knowledge and interactions as applied to the advancement of aeronautics and astronautics. 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)

Service Award

Public Service Award honors a person outside the aerospace community who has shown consistent and visible support for national aviation and space goals.

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

THIS SUMMER, DON'T FORGET—ALL AEROSPACE IS LOCAL!

Duane Hyland

AIAA has changed the name of its August is for Aerospace program to "All Aerospace is Local." The name change encourages AIAA sections across the country to reach out to their federal and state legislators all summer and fall in an effort to educate them about the importance of aerospace to their local communities.

Don't worry, the program expectations have not changed—AIAA sections and members will reach out to their congressional, state, and local legislators in an effort to educate them about the importance of aerospace—preferably by having them to a section event, or by giving them a tour of the member's place of business. However, the name change reminds us that aerospace is important and education and advocacy on behalf of the community cannot be constrained to a single month of the year.

The new name also recognizes a key piece of the advocacy that AIAA advances under this program's umbrella—that all aerospace initiatives are comprised of individuals who support families as well as local communities with their work and wages, and that the aerospace industry is a bulwark of good paying jobs that propels our nation forward to ever greater engineering and scientific advancements. By making legislators and other officials realize that all aerospace is local, ideally by involving them in local aerospace happenings, we build a stronger base of support on Capitol Hill and in other legislative venues—as each legislator comes to realize the importance of our industry to the areas they represent.

For program ideas and support for "All Aerospace is Local," please contact Duane Hyland, AIAA Grassroots Public Policy Coordinator at duaneh@aiaa.org or 703.264.7558.

ACHIEVE MORE

THE AIAA CAREER CENTER – With thousands of job postings, it's your best source for finding the ideal job. And now, with its expanded services, it's also your best source for career advice and development. This AIAA member benefit includes professional development tools to help you in your career.

CAREER TIPS – Free access to articles on job hunting, interview and negotiation techniques, networking, work-life balance, and other career-related topics.

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AVIATION AVIATION



2014

16-20 JUNE 2014

ATLANTA, GEORGIA

MARK YOUR CALENDARS TODAY!

Watch for the Call for Papers to open in August 2013.

The complete list of conferences featured at AIAA AVIATION 2014:

- 20th AIAA/CEAS Aeroacoustics Conference
- 30th AIAA Aerodynamic Measurement Technology Conference
- AIAA/3AF Aircraft Noise and Emissions Reduction Symposium
- 32nd AIAA Applied Aerodynamics Conference
- AIAA Atmospheric Flight Mechanics Conference
- 6th AIAA Atmospheric and Space Environments Conference
- 14th AIAA Aviation Technology, Integration, and Operations Conference
- AIAA Balloon Systems Conference
- AIAA Flight Testing Conference
- 7th AIAA Flow Control Conference
- 44th AIAA Fluid Dynamics Conference
- AIAA Ground Testing Conference
- 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference
- 21st AIAA Lighter-Than-Air Systems Technology Conference
- 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference
- AIAA Modeling and Simulation Technologies Conference
- 45th AIAA Plasmadynamics and Lasers Conference
- 7th AIAA Theoretical Fluid Mechanics Conference
- 45th AIAA Thermophysics Conference

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Sign up to be notified when the Abstract Submission site opens at www.aiaa.org/aviation2014





Members of the Northeastern New York section help a group of eager students at the section's Straw Rocket Booth at Niska Day in Niskayuna, New York (Photo by Xiaoqing Zhang and Joyce Zheng).

AIAA DESIGN, BUILD, AND FLY: A STRAW ROCKET BOOTH AT NISKA DAY

On 18 May, an AIAA Design, Build, and Fly a Straw Rocket event was held at NISKA Day in Niskayuna, NY. Five volunteers manned the booth that approximately 100 children visited to design, build, and fly straw rockets. Children won prizes for hitting the target with the rocket.

The children were very excited to see the results of their own work and to see how everyone's rockets were flying. One of the families was so impressed by the activity that they asked a volunteer to autograph their prize. Another mother said, "He had to think, he had to build the rocket, and saw the results in less than minute... The best part of all this is I do not have to pay for this, he is having so much fun, and getting inspired about science." The AIAA members hoped they were able to inspire and generate enthusiasm in a few young minds to be the next generation of engineers.

Thank you to AIAA for providing financial support for this DBF activity, and to the five volunteers: Eric Ruggiero, Neelesh Sarawate, Xiaoqing Zhang, Magdi Azer, and Gulshan Singh. Please visit the AIAA NENY chapter website for more pictures (https://info.aiaa.org/Regions/NE/NE_NY/This%20Week%20in%20Pictures/Forms/AllItems.aspx).

CALL FOR PAPERS

ICNPAA 2014 World Congress:
Mathematical Problems in Engineering,
Sciences and Aerospace
Narvik University, Norway, 15–18 July 2014

On behalf of the International Organizing Committee, it gives us great pleasure to invite you to the ICNPAA 2014 World Congress: 10th International Conference on Mathematical Problems in Engineering, Aerospace and Sciences, which will be held at Narvik University, Narvik, Norway.

Please visit the website, <http://www.icnpaa.com>, for all the details. This is an AIAA, Narvik University (Norway), Norut Narvik (Norway), Luleå University of Technology (Sweden), etc., cosponsored event. Proceedings will be published by AIP, USA.

CALL FOR PAPERS FOR JOURNAL OF AEROSPACE INFORMATION SYSTEMS

SPECIAL ISSUE ON “SOFTWARE CHALLENGES IN AEROSPACE”

SPECIAL ISSUE ON “AEROSPACE AND MECHANICAL APPLICATIONS OF REINFORCEMENT LEARNING AND ADAPTIVE LEARNING BASED CONTROL”

The *Journal of Aerospace Information Systems* (formerly the *Journal of Aerospace Computing, Information, and Communication (JACIC)*) is devoted to the applied science and engineering of aerospace computing, information, and communication. Original archival research papers are sought that include significant scientific and technical knowledge and concepts. In particular, articles are sought that demonstrate the application of recent research in computing, information, and communications technology to a wide range of practical aerospace problems in the analysis and design of vehicles, onboard avionics, ground-based processing and control systems, flight simulation, and air transportation systems.

Information about the organizers of these special issues as well as guidelines for preparing your manuscript can be found in the full Call for Papers under Featured Content in Aerospace Research Central; arc.aiaa.org. The journal website is <http://arc.aiaa.org/loi/jais>.

Special Issue on “Software Challenges in Aerospace”

Deadline: Submissions are due by **15 August 2013**.

Anticipated Publication Date: **November 2013**.

Contact Email: Misty Davies, misty.d.davies@nasa.gov or Lyle Long, lnl@psu.edu

Key research areas included in the special issue are:

- *Software Synthesis for Aerospace:* including model-based approaches to software and software-intensive system design, compositional and hierarchical design approaches for reducing and managing complexity, approaches to building intelligent and adaptive systems within a safety-critical framework, the generation of code that is correct-by-construction, and the design of maintainable systems.
- *Software Analysis for Aerospace:* including verification and validation for safety-critical software systems, security analysis for aerospace communications, compositional analysis of code for scalability, automated testing techniques, and statistical techniques (including data mining and learning) for program and software behavior analysis.
- *Aerospace System Integration:* including architectures for safety-critical aerospace systems containing software, hardware, and people; approaches to, benefits of, and limitations of Integrated Modular Avionics frameworks; human-computer interaction including intelligent cockpits/control towers; and adaptive airspace implementations.
- *Aerospace Software Policy and Implementation:* including the certification of software systems using traditional or safety-case based approaches and decision-making in air systems (including both autonomy and human factors issues).
- Creating and maintaining a skilled workforce for aerospace software, college curricula, and certification of software engineers.
- Intelligent systems software for aerospace systems.
- Software issues in cybersecurity related to aerospace systems.
- Use of COTS software in critical systems.

These areas are only indicative. The special issue is also open to manuscripts that are relevant to the applied science and engineering of aerospace computing, information, and communication but do not fit neatly into any of the above areas. We do envisage, however, that successful manuscripts will include

experimental results, sophisticated simulations of aerospace systems, or (in the case of a paper in the areas of education or policy) well-researched and thorough arguments for policies and their implementations.

Special Issue on “Aerospace and Mechanical Applications of Reinforcement Learning and Adaptive Learning Based Control”

Deadline: Submissions are due by **15 August 2013**.

Anticipated Publication Date: **January 2014**.

Contact Email: Jonathan How, jhow@mit.edu

Key research areas included in the special issue are:

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

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

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

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

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

CALL FOR BOARD OF DIRECTORS NOMINATIONS

The 2013–2014 AIAA Nominating Committee will meet on 15 August 2013 to review nominees and select candidates to participate in the Board of Directors election to fill the following vacancies by election in 2014:

- Vice President-Elect, Finance
- Vice President-Elect, Publications
- Vice President-Elect, International
- Vice President-Elect, Standards
- Director—Aircraft & Atmospheric Sciences Group
- Director—Engineering & Technology Management Group
- Director—Space and Missile Systems Group
- Director—Region 1
- Director-at-Large
- Director-at-Large International

AIAA members may submit themselves or other members qualified for the chosen position as nominees by submitting a nomination through the AIAA website (go to www.aiaa.org, log in, and select Board of Director Nomination from the left-hand navigation bar) no later than **9 August 2013**. Nominations will open 14 June.

Bill Seymore
AIAA Corporate Secretary



**Register
TODAY!**

[www.aiaa.org/
av13aa](http://www.aiaa.org/av13aa)



AIAA AVIATION 2013

12–14 August 2013 • Hyatt Regency Century Plaza • Los Angeles, California

Continuing Education Short Courses

Guidance of Unmanned Aerial Vehicles

Saturday–Sunday • 10–11 August 2013 • 0800–1630 hrs

Instructor: Rafael Yanushevsky

Summary: This course presents a rigorous guidance theory for unmanned aerial vehicles. It can be considered as the further development and generalization of the missile guidance theory presented in the author's 2007 book *"Modern Missile Guidance."*

Systems Engineering Verification and Validation

Saturday–Sunday • 10–11 August 2013 • 0800–1630 hrs

Instructor: John C. Hsu

Summary: This course will focus on the role of verification and validation, from the beginning through the final stages of the systems engineering for a program or project. It will clarify the confusing use of the terms verification and validation, and explain the process of validating requirements and generating verification requirements.

**Register for either course and attend the Conference for FREE! Registration fee includes full conference participation: admittance to technical and plenary sessions; receptions and luncheons; and online proceedings.*



OBITUARIES

AIAA Senior Member Mole Died in April

Philip J. Mole, 82, died on 17 April.

Mr. Mole completed a four-year course in two years at Northrop Aeronautical School in 1950. Upon graduation he entered the Air Force and was stationed at Wright Patterson AFB in Dayton, OH, until 1953. Upon his separation, he worked in Civil Service at WPAFB as an engineer until 1957, when he accepted a position at General Dynamics/Convair. He retired from General Dynamics in 1992 and started his own consulting business, where he worked until 2012.

Mr. Mole built model airplanes all throughout his teen years, some with a six-foot wing span and motorized models also. He always wanted to be a pilot, which was why he enrolled at Northrop Aeronautical School right after high school. Mr. Mole held many patents for inventions ranging from wind tunnel balances and load cells, to emission systems. He was a Senior Member of the AIAA with over a half century of membership.



AIAA Senior Member Moorehouse Died in May

Jeffrey A. Moorehouse, 52, passed away on 12 May 2013.

Mr. Moorehouse earned a bachelor's degree in civil engineering from the University of Missouri. He went on to obtain his master's in mechanical engineering from the University of Illinois, followed by an MBA from the University of Texas at Arlington.

Mr. Moorehouse worked at Lockheed Martin and its former legacy companies for over 26 years. He worked on many Lockheed Martin programs, ranging from the National Aerospace Plane to the F-35 Joint Strike Fighter. He served as senior manager of the Propulsion Systems Group, supervising over 100 engineers across three company sites. Jeff was a senior member of AIAA, a member of the AIAA Gas Turbine Engines Technical Committee, and co-inventor of technologies incorporated in the Lockheed Martin F-35. He served on the Department of Defense science and technology panels, authored technical papers for professional societies, and NATO conferences.




Register TODAY!

www.aiaa.org/gnc13aa




AIAA Guidance, Navigation, and Control Conference and Co-located Conferences

19–22 August 2013 • Marriott Boston Copley Place • Boston, Massachusetts

Continuing Education Short Courses

Emerging Principles in Fast Trajectory Optimization

Saturday–Sunday • 17–18 August 2013 • 0815–1700 hrs

Instructors: I. Michael Ross and Qi Gong
Summary: This course will introduce the student to the major advancements that have taken place over the last decade in both theory and algorithms for fast trajectory optimization. The overall objective is to outline the new foundations related to convergence of solutions that have emerged in recent years and the accompanying breakthroughs in general techniques for problem solving.

Recent Advances in Adaptive Control: Theory and Applications

Saturday–Sunday • 17–18 August 2013 • 0815–1700 hrs

Instructors: Tansel Yucelen, Eric Johnson, Anthony Calise, and Girish Chowdhary
Summary: The course will provide the tools needed for real-world adaptive control applications, and will be relevant to practicing professionals from electrical, mechanical, and aerospace industries.

**Register for either course and attend the Conference for FREE! Registration fee includes full conference participation: admittance to technical and plenary sessions; receptions and luncheons; and online proceedings.*



Fundamentals of Aircraft and Airship Design, Volume 2 – Airship Design and Case Studies

Grant E. Carichner and Leland M. Nicolai

April 2013, 984 pages, Hardback

ISBN: 978-1-60086-898-6

List Price: \$119.95

AIAA Member Price: \$89.95

About the Book

Fundamentals of Aircraft and Airship Design, Volume 2 – Airship Design and Case Studies examines a modern conceptual design of both airships and hybrids and features nine behind-the-scenes case studies. It will benefit graduate and upper-level undergraduate students as well as practicing engineers.

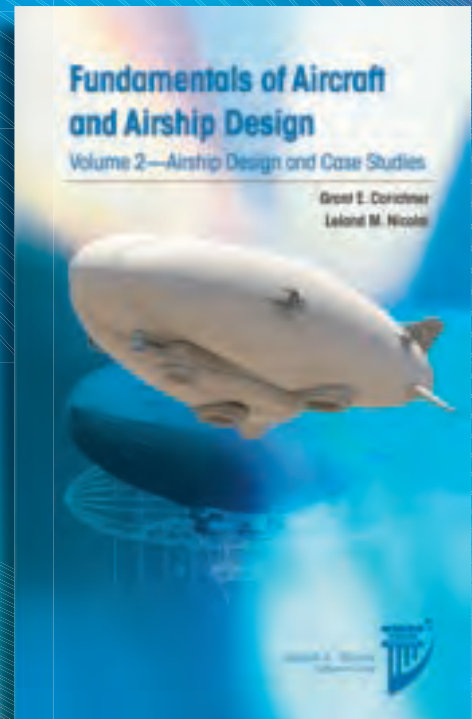
The authors address the conceptual design phase comprehensively, for both civil and military airships, from initial consideration of user needs, material selection, and structural arrangement to the decision to iterate the design one more time. The book is the only available source of design instruction on single-lobe airships, multiple-lobe hybrid airships, and balloon configurations; on solar- and gasoline-powered airship systems, human-powered aircraft, and no-power aircraft; and on estimates of airship/hybrid aerodynamics, performance, propeller selection, S&C, and empty weight.

The book features numerous examples, including designs for airships, hybrid airships, and a high-altitude balloon; nine case studies, including SR-71, X-35B, B-777, HondaJet, Hybrid Airship, Daedalus, Cessna 172, T-46A, and hang gliders; and full-color photographs of many airships and aircraft.

About the Authors

GRANT E. CARICHNER'S 48-year career at the Lockheed Martin Skunk Works includes work on SR-71, M-21, L-1011 Transport, Black ASTOVL, JASSM missile, stealth targets, Quiet Supersonic Platform, ISIS high-altitude airship, and hybrid airships. He was named "Inventor of the Year" in 1999 for the JASSM missile vehicle patent. He also holds design patents for hybrid airship configurations. He is an AIAA Associate Fellow.

LELAND M. NICOLAI received his aerospace engineering degrees from the University of Washington (BS), the University of Oklahoma (MS), and the University of Michigan (PhD). His aircraft design experience includes 23 years in the U.S. Air Force, retiring as a Colonel, and 32 years in industry. He is an AIAA Fellow and recipient of the AIAA Aircraft Design Award and the Lockheed Martin Aero Star President's Award. He is currently a Lockheed Martin Fellow at the Skunk Works.



"Leland Nicolai and Grant Carichner have succeeded in providing a cutting-edge two-volume aircraft design text and reference addressing probably the most productive modes of air transportation: fixed-wing aircraft and the promising low-speed hybrid cargo airship."

— *Dr. Bernd Chudoba, The University of Texas at Arlington*

"This volume combines science and engineering covering the steps required to achieve a successful airship design. It represents an excellent effort to consider every aspect of the design process."

— *Norman Mayer, LTA Consultant, AIAA Associate Fellow and Lifetime Member*

"Carichner and Nicolai have created the definitive work on modern airship design containing many techniques, ideas, and lessons learned never before published. In addition, they have collected a set of case studies that will enable tomorrow's designers to learn from the experience of many who have gone before them."

— *Dr. Rob McDonald, California Polytechnic State University at San Luis Obispo*



Order 24 hours a day at arc.aiaa.org

Standard Information for all AIAA Conferences

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

On-Site Check-In

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

Photo ID Needed at Registration

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

Certificate of Attendance

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

Conference Proceedings

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

Young Professional Guide for Gaining Management Support

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

Journal Publication

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

Timing of Presentations

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

Committee Meetings

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

Audiovisual

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

Employment Opportunities

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

Messages and Information

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

Membership

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

Nondiscriminatory Practices

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

Restrictions

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

International Traffic in Arms Regulations (ITAR)

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

Technical Committee Nominations

Membership nominations are now open for AIAA Technical Committees (TC) for 2014/2015. Our TCs have between 30 and 35 members each. Nearly one-third of the members rotate off the committees each year, leaving six to ten openings per TC.

The TC chairs and the Technical Activities Committee (TAC) work diligently to maintain a reasonable balance in (1) appropriate representation to the field from industry, research, education, and government; (2) the specialties covered in the specific TC scopes; and (3) geographical distribution relative to the area's technical activity. TAC encourages the nomination of young professionals, and has instituted a TC associate member category (see associate membership guidelines). Associate members,

with identified restrictions, are included on TCs in addition to the 35 regular member limit.

If you currently serve on a TC, do not nominate yourself. You will automatically be considered for the 2014/2015 TC year.

Enclosed are instructions for nominations. Nominations are submitted online. The TC nomination form can be found on the AIAA Web site at www.aiaa.org, under My AIAA, Nominations and Voting, Technical Committee. We look forward to receiving your nominations. If you have any questions, please call Betty Guillie at 703.264.7573.

Nominations are due by **1 November 2013**.

Current AIAA Technical Committees

Adaptive Structures	General Aviation	Plasmadynamics & Lasers
Aeroacoustics	Ground Testing	Product Support
Aerodynamic Decelerator Systems	Guidance, Navigation & Control	Propellants & Combustion
Aerodynamic Measurement Technology	High Speed Air Breathing Propulsion	Sensor Systems
Aerospace Power Systems	History	Small Satellite
Air Breathing Propulsion Systems Integration	Hybrid Rockets	Society & Aerospace Technology
Air Transportation Systems	Information and Command & Control Systems	Software
Aircraft Design	Intelligent Systems	Solid Rockets
Aircraft Operations	Legal Aspects of Aeronautics & Astronautics	Space Architecture
Applied Aerodynamics	Life Sciences & Systems	Space Automation & Robotics
Astrodynamics	Lighter-Than-Air Systems	Space Colonization
Atmospheric & Space Environments	Liquid Propulsion	Space Logistics
Atmospheric Flight Mechanics	Management	Space Operations & Support
Balloon Systems	Materials	Space Resources
Communications Systems	Meshing, Visualization & Computational Environments	Space Systems
Computer Systems	Microgravity & Space Processes	Space Tethers
Design Engineering	Missile Systems	Space Transportation
Digital Avionics	Modeling & Simulation	Spacecraft Structures
Economics	Multidisciplinary Design Optimization	Structural Dynamics
Electric Propulsion	Non-Deterministic Approaches	Structures
Energetic Components & Systems	Nuclear & Future Flight Propulsion	Survivability
Flight Testing		Systems Engineering
Fluid Dynamics		Terrestrial Energy Systems
Gas Turbine Engines		Thermophysics
		V/STOL Aircraft Systems
		Weapon System Effectiveness

Instructions for Completing Technical Committee Nomination Forms

1. Nominations are submitted online via www.aiaa.org, My AIAA, Nominations and Voting, Technical Committee. Nominees who are not selected for committee membership for 2014 will automatically be considered for membership in 2015. As the nomination forms are held for an additional year, it is not necessary to resubmit a form for someone not selected for the 2013/2014 term. You may send updated information to be attached to an existing nomination form.
2. You do not have to be nominated by someone else; you may submit an application for yourself.
3. A resume or biographical data can be attached and submitted with the nomination form.
4. Membership is usually restricted to one technical committee (TC) at a time. Please list the TCs in order of preference if applying to two TCs. If accepted to the 1st priority, the nominee will be added to that TC. All information should be detailed and complete.
5. The Technical Activities Committee (TAC) strongly suggests that special consideration be given to members 34 years of age and under or who obtained their professional degree less than 10 years ago. See attached Technical Committee Associate Membership Guidelines.
6. All TC members must join AIAA (if they are not already members) within 45 days of their appointment to a technical committee.
7. TC membership is generally for one year with two additional years possible, but contingent upon committee participation, ongoing projects, and AIAA membership. It is not necessary to send a new nomination form for someone who is already on a committee. All committee members are automatically considered for a second and third year of membership.
8. Deadline for receipt of nominations is **1 November 2013**. Nominations received after this date will be held for consideration until the next year.

Technical Committee Associate Membership Guidelines

1. Associate membership is restricted to those who have not yet reached their 35th birthday, or who obtained their professional degrees less than 10 years ago.
2. Associate membership is a one-year term renewable to three years.
3. Associate membership is restricted to current AIAA members.
4. Selection to associate membership is based on technical merit. The associate members should show promise within the field of the technical committee.
5. Associate members may attend TC or subcommittee meetings and will assist in carrying out committee work.
6. At the discretion of the TC, associate members may be assigned a volunteer full member as a counselor. The counselor will advise and guide the associate member on TC procedures and activities.
7. Associate members will have no voting privileges on the TC, but may (with consent) act as a substitute for their counselor.
8. Associate members will not count toward the TC membership limit.
9. Application forms for associate membership are the same as those of full membership, but a resume is a required attachment. Applicants for full membership who were not selected may be considered associate members provided they meet the age restriction.
10. At least two associate members should be appointed to each TC. At no time should the number of associate members exceed that of full members.
11. An endorsement statement from the nominee's department head, indicating that the nominee may travel to two meetings per year and have some time to devote to committee business, must be completed during the online process.

Upcoming AIAA Professional Development Courses

18–19 July 2013

The following Continuing Education courses are being held at the 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and the 11th International Energy Conversion Engineering Conference in San Jose, CA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

Liquid Propulsion Systems—Evolution and

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

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

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

The course presents an overview of the preliminary design of air-breathing engine systems that is determined primarily by the aircraft mission, which defines the engine cycle—and different types of cycle are investigated. Preliminary design activities are defined and discussed in the context of the overall engine development process and placed in perspective. Some basic knowledge of aerodynamics and thermodynamics is assumed so the mathematical material that appears in many good textbooks is minimized and the question “What do you actually do as an engine designer?” is addressed. The practical means and processes by which thermodynamic concepts are turned into hardware are covered and some design techniques are demonstrated. The fact that an air breathing engine is much more than the flowpath component is discussed and the future of engine design methods is raised. Class participation is encouraged throughout.

Missile Propulsion Design and System Engineering (Instructor: Eugene L. Fleeman, International Lecturer on Missiles)

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

29–30 July 2013

The following standalone courses are being held at the National Aerospace Institute in Hampton, Virginia.

Introduction to Space Systems (Instructor: Mike Gruntman)

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

Phased Array Beamforming for Aeroacoustics

(Instructor: Robert Dougherty)

This course presents physical, mathematical, and some practical aspects of acoustic testing with the present generation of arrays and processing methods. The students will understand the capabilities and limitations of the technique, along with practical details. They will learn to design and calibrate arrays and run beamforming software, including several algorithms

To register for one of the JPC 2013 courses, go to www.aiaa.org/JPC2013.

	Early Bird by 17 Jun	Standard (18 Jun–12 Jul)	On-site (14–18 Jul)
AIAA Member	\$1255	\$1355	\$1455
Nonmember*	\$1365	\$1465	\$1565

*Includes a one-year AIAA membership

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

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

*Includes a one-year AIAA membership

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

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

*Includes a one-year AIAA membership

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.

Turbulence Modeling for CFD (Instructor: David Wilcox)

The course begins with a discussion of turbulence physics in the context of modeling. The exact equations governing the Reynolds stresses, and the ways in which these equations can be closed, is outlined. Starting with the simplest turbulence models this course charts a course leading to some of the complex models that have been applied to a nontrivial turbulent flow problem. It stresses the need to achieve a balance among the physics of turbulence, mathematical tools required to solve turbulence-model equations, and common numerical problems attending use of such equations.

10–11 August 2013

The following Continuing Education courses are being held at the AVIATION 2013 Conference in Los Angeles, CA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

Guidance of Unmanned Aerial Vehicles

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

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

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

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

17–18 August 2013

The following Continuing Education courses are being held at the Guidance, Navigation, and Control and collocated conferences in Boston, MA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

Emerging Principles in Fast Trajectory Optimization

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

The confluence of major breakthroughs in optimal control theory and new algorithms has made possible the real-time computation of optimal trajectories. This implies that mission analysis can be carried out rapidly with the only limitation being the designer's imagination. This course will introduce the student to the major advancements that have taken place over the last decade in both theory and algorithms for fast trajectory optimization. Students will acquire a broad perspective on recent developments in the mathematical foundations of trajectory optimization; "old hats" will also acquire a new perspective to some old ideas. The overall objective of this course is to outline the new foundations related to convergence of solutions that have emerged in recent years and the accompanying breakthroughs in

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

	<i>Early Bird by 1 Jul</i>	<i>Standard (2–22 Jul)</i>	<i>On-site (23–29 Jul)</i>
AIAA Member	\$950	\$1075	\$1175
Nonmember*	\$1070	\$1195	\$1295
*Includes a one-year AIAA membership			

To register for one of the AVIATION 2013 courses, go to www.aiaa.org/aviation2013.

	<i>Early Bird by 15 Jul</i>	<i>Standard (16 Jul–9 Aug)</i>	<i>On-site (10 Aug)</i>
AIAA Member	\$1320	\$1420	\$1520
Nonmember*	\$1430	\$1530	\$1630
*Includes a one-year AIAA membership			

To register for one of the GNC 2013 courses, go to www.aiaa.org/boston2013.

	<i>Early Bird by 22 Jul</i>	<i>Standard (23 Jul–16 Aug)</i>	<i>On-site (17 Aug)</i>
AIAA Member	\$1255	\$1355	\$1455
Nonmember*	\$1365	\$1465	\$1565
*Includes a one-year AIAA membership			

general techniques for problem solving. These techniques are intended to enhance, not replace, special techniques that are in common use. Anyone involved in aerospace research will benefit from this course.

Recent Advances in Adaptive Control: Theory and Applications (Instructors: Tansel Yucelen, Research Engineer, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Eric Johnson, Professor, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Anthony Calise, Professor of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA; Girish Chowdhary, Research Engineer, Georgia Institute of Technology, Atlanta, GA)

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

This course will present a review of a number of well-established methods in MRAC. Starting with MRAC problem formulation and an overview of classical robustness and stability modifications, this course will continue to introduce the adaptive loop recovery approach that allows the approximate retention of reference model loop properties such as relative stability margins. The course will also present Kalman filtering in adaptive control, in which a Kalman Filter framework is used to update adaptation gains that enables meeting a given performance criteria without excessive tuning.

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

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

8–9 September 2013

The following Continuing Education courses are being held at the SPACE 2013 Conference in San Diego, CA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

Introduction to Space Systems (Instructor: Dr. Mike Gruntman, Professor of Astronautics at the University of Southern California)

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

Satellite Communications, Today and Tomorrow: Technical Basics and Market and Technology Trends

(Instructors: Edward Ashford, former Vice President, Technology Development, SES of Luxembourg and former Vice President, Broadcast Satellite Development at a subsidiary of Lockheed Martin; Joseph N. Pelton, Ph.D., former Dean, International Space University and Director Emeritus, Space and Advanced Communications Research Institute (SACRI) at George Washington University)

This course provides and introduction to those aspects of RF transmission technology that are important to and govern the design of satellite communication systems. The physics underlying relevant RF communications topics concerning establishment of RF links between Earth and a satellite (and vice versa) will be presented and explained, as well as the mathematical concepts governing the digitization and transmission of information over these links. Easily grasped intuitive explanations of the need for and methods of coding and decoding of information sent over satellite links will be presented.

Once the basics of the communications technology have been presented, the course will then provide an introduction to the types of communication satellite now in use and of the technologies used on these satellites and in their ground terminals to implement the RF transmission technologies. A subsystem by subsystem breakdown will be given of a typical communications satellite.

It covers on-board processing, coding systems, shared payloads, new systems for coping with precipitation attenuation, beam hopping, lifetime extension techniques including on-orbit refueling and battery replacement, mobile satellite systems with ancillary terrestrial component, latest developments in ground terminal equipment, frequency coordination issues, and advanced launch systems. New strategies for implementing military systems, dual-use systems, and potential new strategies for defense-related systems (in space and on the ground) will be examined as well as new standards that allow seamless connection of commercial and military systems. Other

To register for one of the SPACE 2013 courses, go to www.aiaa.org/space2013 .			
	<i>Early Bird by 12 Aug</i>	<i>Standard (13 Aug–7 Sep)</i>	<i>On-site (8 Sep)</i>
AIAA Member	\$1350	\$1450	\$1550
Nonmember*	\$1460	\$1560	\$1660
*Includes a one-year AIAA membership			

relevant issues such as orbital debris, the sustainability of space, space situational awareness, the International Data Association, and new international requirements, and "confidence building measures" will also be addressed.

11 September 2013

This 90-minute webinar will take place at 1300–1430 EST

Missile Defense: Past, Present and Future

Missile defense, especially national missile defense, has changed drastically from the air and missile defense systems once in place in the 1960s to the current strategic missile defense planned for the United States today and for NATO Europe in the coming decade to 2020. The nature of the air and missile threat has changed rapidly over the intervening years including new forms of both strategic and theatre ballistic missiles, the new forms of cruise missiles, and now drones. The changing guidance systems of these missiles have changed the targeting and kill probability challenging the defenders against such new missile forms. Unfortunately, the development times of today's defensive missile systems are much slower than the time taken to introduce these radically new threats. This webinar reviews the historical threats and attacks against the United States together with the past and present proposed national missile defense systems with their shortcomings. The technology of new defense systems currently in the laboratories is reviewed to postulate possible new air and missile defense systems for the future. The webinar is liberally filled with actual historical and technical data on all aspects of the threat and the necessary defense.

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

AIAA Member	\$149
Nonmember*	\$189
AIAA Student Member	\$60
Full-Time Student (Nonmember)*	\$70

*Nonmember fee does not include AIAA membership

23–24 September 2013

The following standalone courses are being held at The AERO Institute in Palmdale, California.

Gossamer Systems: Analysis and Design

An evolving trend in spacecraft is to exploit very small (micro- and nano-sats) or very large (solar sails, antenna, etc.) configurations. In either case, success will depend greatly on of ultra-lightweight technology, i.e., "gossamer systems technology." Areal densities of less than 1 kg/m² (perhaps even down to 1 g/m²!) will need to be achieved. This course will provide the engineer, project manager, and mission planner with the basic knowledge necessary to understand and successfully utilize this emerging technology. Definitions, terminology, basic mechanics and materials issues, testing, design guidelines, and mission applications will be discussed. A textbook and course notes will be provided.

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

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

*Includes a one-year AIAA membership

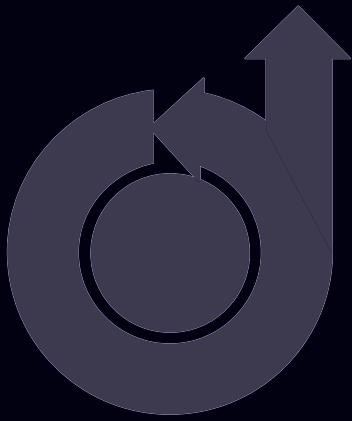
Sensor Systems and Microsystems: From Fabrication to Application

The introduction of sensor technology, including smart micro-sensor systems, into aerospace applications is expanding rapidly to allow improved system monitoring and provide gains in efficiency, performance, critical data, and safety. This short course is taught by three experts in sensor technology and its application to provide not only an overview of microsensor fabrication and development, but also a practical discussion of the implementation of sensor systems in space applications. The first half day of the course will concentrate on micro/nano-fabrication techniques and processes taught by Prof. Peter Hesketh of Georgia Institute of Technology. The second half day of the course will discuss case studies in sensor development taught by Dr. Gary Hunter of NASA Glenn Research Center. The last half day of the course will discuss sensor system implementation ranging from Payloads such as Mars Pathfinder to Launch Vehicle Sensor Implementation such as The Ares I Launch Vehicle; taught by Mr. Larry Oberle of NASA Glenn Research Center.

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

	<i>Early Bird by 23 Aug</i>	<i>Standard (24 Aug–15 Sep)</i>	<i>On-site (16–23 Sep)</i>
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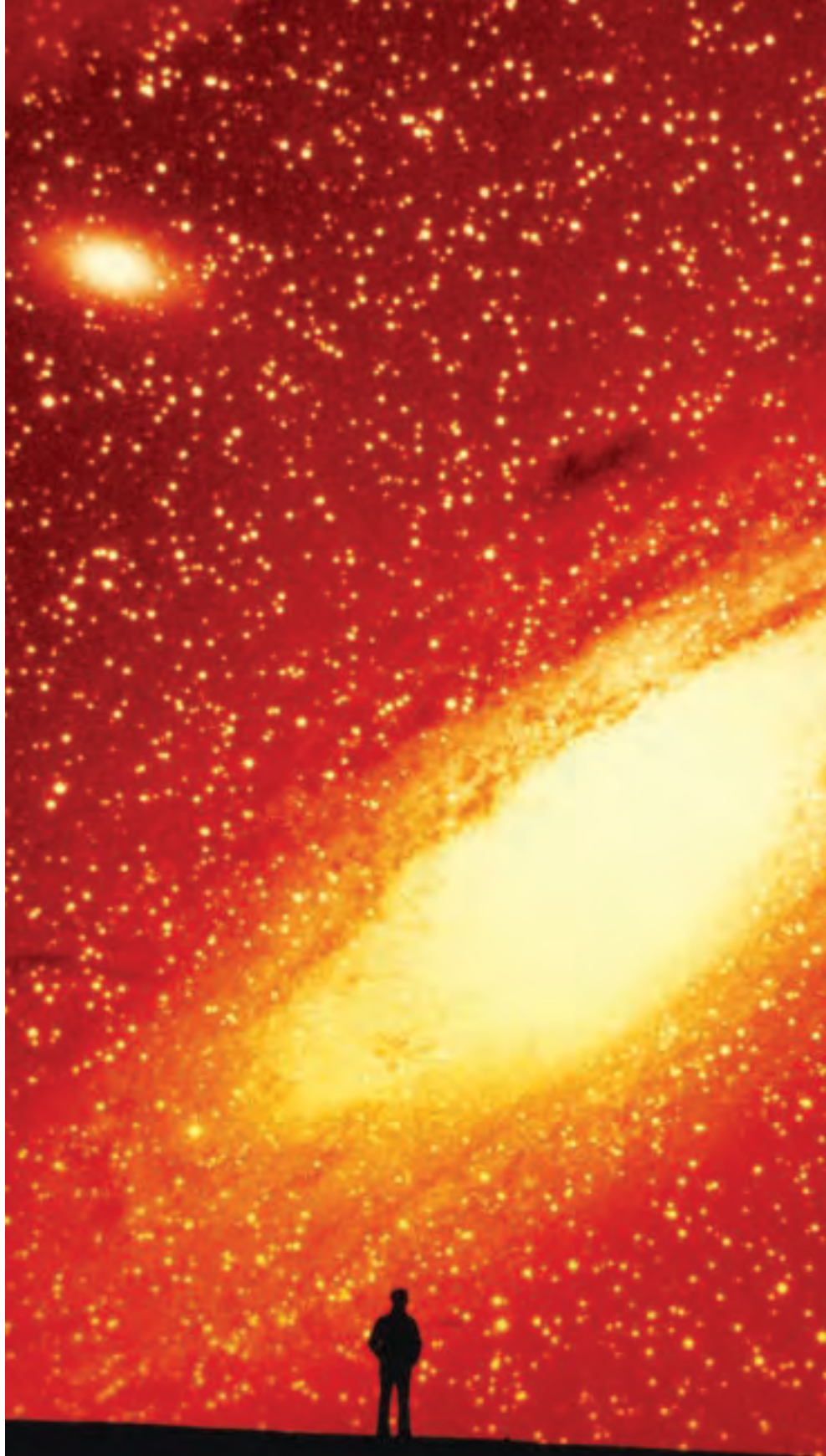
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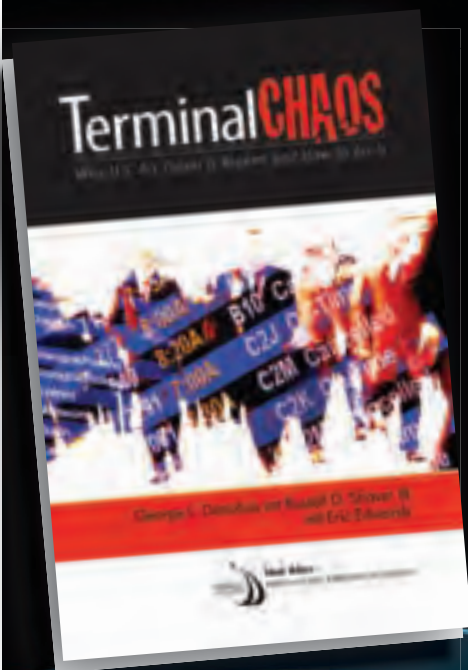
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TerminalCHAOS

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

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



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

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

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

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

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

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

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

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

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

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