2 AEROSPACE AMERICA FEBRUARY 2013

February 2013

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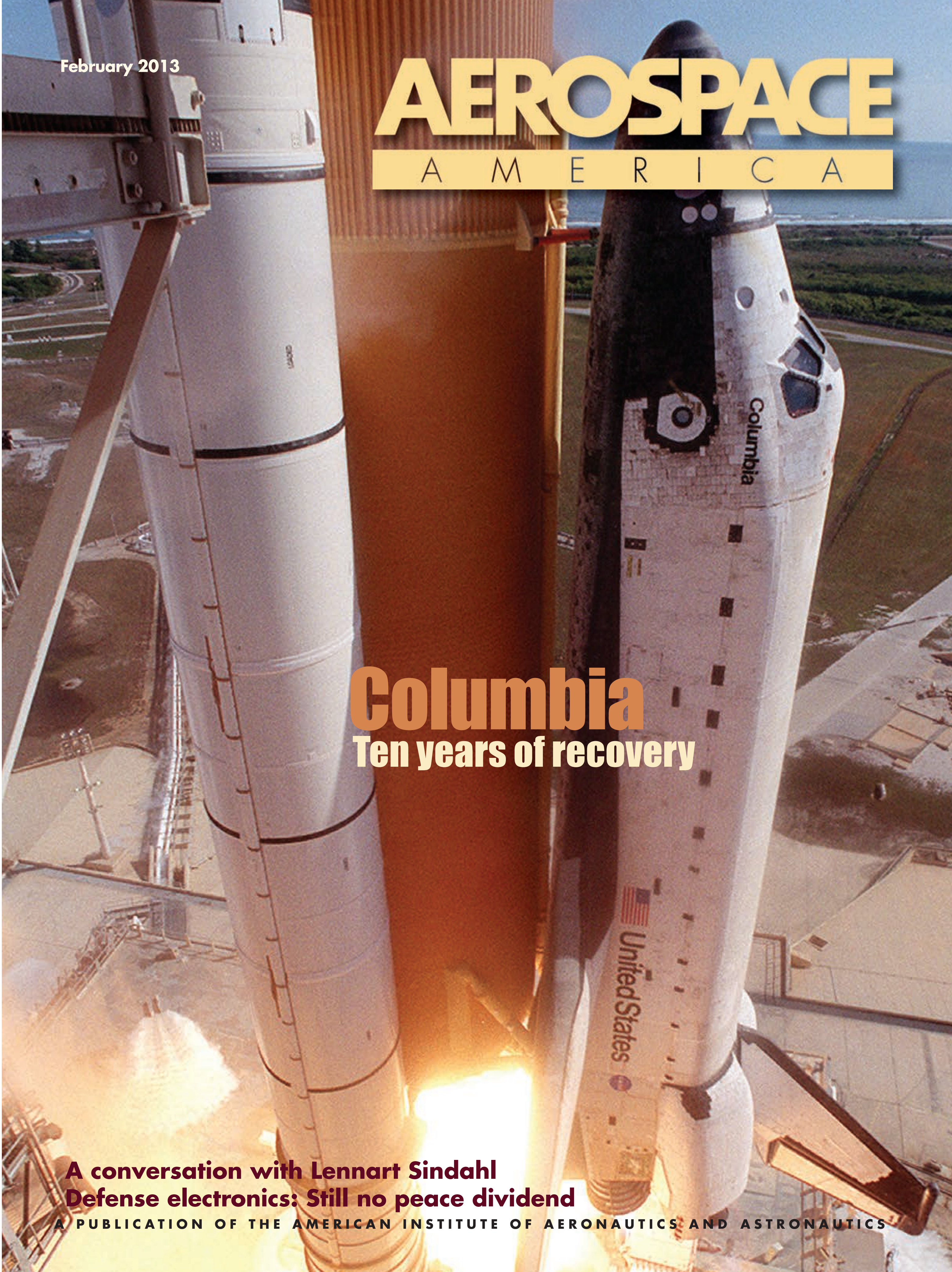

Columbia
Ten years of recovery

A conversation with Lennart Sindahl

Defense electronics: Still no peace dividend

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Engineers Week 2013

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February 2013

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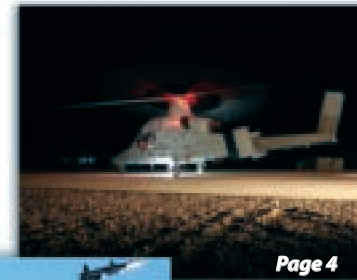
Page 4


Page 18


Page 22


Page 38


Page 32


Page 46

COVER

Ten years after the devastating loss of the space shuttle Columbia and her crew, researchers are still piecing together not just the orbiteritself , but the causes of her tragic destruction. See the story beginning on page 26. NASA photo.

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Editorial

Cliffs, ceilings, and slippery slopes

Historically, the U.S. economy has moved in a forward, positive direction. Yes, we have faced recessions, a depression, and serious, painful stumbles. But we regrouped, often facing drastic measures, and forged ahead. And when things looked their bleakest, the government pulled together and pushed ahead. There was often anger and rancor, but there also needed to be an understanding that the greater good had to prevail over party or personal, even if deeply felt, preferences.

Often, when the economy did falter, it was because of unpredictable, uncontrollable, or external events. Foreign conflicts, drought and other nightmare weather events, and sometimes just bad miscalculations all played roles in sending us into a tailspin.

Today, to a greater or lesser extent, all of those factors are present—at the same time. And unfortunately, they are accompanied by a factor even more difficult to overcome.

We are at a point in this country where scoring notches on our fiscal belts seems to be more important than holding our pants up. Right now, having just barely escaped falling over the 'fiscal cliff,' we are about to hit our heads on the debt ceiling. And should we somehow figure out a way to avoid that concussion, sequestration is staring us in the face.

This would be a difficult enough series of problems to have to wrestle with if the government were working together—or just working at all. Yes, we elect our congressmen and women to represent our local interests, but it is also in our interest that the nation as a whole remain fiscally healthy. But warring political positions in many cases have given way to pure recalcitrance.

The economic problems we are facing are deep and complex, and solving them will mean inflicting pain. But to solve them, the players cannot choose to protect their favorites in hopes of scoring points, and refuse to negotiate. Our legislators may discover that, if they choose to just take their toys and go home, that home may be foreclosed.

Can we only afford to keep the F-35 flying at the expense of Social Security? Is shutting down NASA's next three or five space missions or research projects the only way to keep Medicare viable? Can we not find a compromise where everything bleeds a little, but nothing hemorrhages? And no, not every local project needs to survive.

Sharing the pain, compromise, give and take are what our way of governing is meant to be about. But to begin with, talking must replace shouting and posturing must cede to finding common ground. We seem to have reached grudging agreements on several highly controversial aerospace issues, such as the new Space Launch System, the Orion capsule, completing the James Webb space telescope, commercial launches of NASA payloads, and even export reform. Could these successful compromises help point the way to the much more important overall fiscal agreements?

The partisan rancor of the last few years seems to be escalating, as difficult as that may be to believe. But there will ultimately be no winners in this clash of wills until the people we have elected to protect our interests show up, stop phoning it in, and get to work. Then we can mint them each one of those commemorative trillion-dollar coins as a keepsake.

Elaine Camhi
Editor-in-Chief

Europe falls behind in race to build unmanned cargo aircraft

At the end of 2012 the European Commission (EC) published its staff working paper, "Towards a European strategy for the development of civil applications of Remotely Piloted Aircraft Systems (RPAS)." One of its key conclusions was that "The current market for commercial RPAS services is practically nonexistent due to difficulties for RPAS to obtain flight permissions and their restriction to segregated airspace. It is expected that once the barriers limiting RPAS flight will be removed the understanding of the RPAS potential will quickly spread amongst potential users, creating new markets of aerial services, in the same way that the iPad created an entirely new and unpredicted market for mobile data services."

Hopes for growing markets

One of the most important potential roles for civil RPASs could be as air freight carriers. Back in 2009 FedEx founder Fred Smith gave a number of interviews in which he said he would like to switch to RPAS platforms as soon as the FAA rules for integrating these aircraft into the National Airspace System became applicable. In particular he liked the idea of a 'blended wing' cargo UAV design, which would be safer and cheaper, with more carrying capacity than the current fleet, and could potentially lower freight prices by factors of 2-10.

But since then, notions of huge cargo-carrying civil RPAS crossing the skies around the globe have faded, and the airworthiness and airspace integration regulations that would allow for such operations still look somewhat distant, despite the numerous roadmaps and regulatory goals that have been put in place.

Without these, air cargo operators have been reluctant to invest in any of the expensive new technologies and procedures that would be needed to create a new type of aircraft. "This is not on the agenda for the next few years," says Peter van Blyenburgh, president of the Paris-based RPAS trade association Unmanned Vehicle Systems International. "For the authorities to act, the operators will have to make a business case, and they are the one group which is missing right now from the process."

However, the idea has never quite gone away. Over the past 12 months some of the key prerequisites for this new class of aircraft have started to reach maturity, although the first examples of civil RPAS platforms are likely to be small, maneuverable, tactical supply aircraft rather than 100-tonne-payload long-distance freighters.

For the moment it is a potential market that most probably will be dominated by U.S. and Israeli companies. But in its Flightpath 2050 study (see "Europe's new plans for research and funding," January 2013, page 4), announced by the EC in March 2011, the concept of large unmanned air cargo freighters features prominently.

"Freight forwarders and shippers have similar choices to passengers regarding price, service level, and journey time," said the EC in its strategic vision for European aviation in the middle of this century. "Cargo remains an important component of the payload on passenger aircraft, and unmanned air vehicles are playing an increasing role as freighters. Non-transport aviation missions have increased significantly. These missions are undertaken by a mix of fixed-wing, rotorcraft, and unmanned aircraft. UAVs are used especially for predictable and repetitive, dangerous, and long-endurance tasks."

According to the EC's staff working paper on the development of civil applications of RPAS: "The production of European countries, all together, does not represent more than 10% [of the current total market]. Teal Group estimates that the worldwide RPAS market will double over the next decade to represent an annual procurement and R&D market of $11.3 billion in 2020, with European and Asian manufacturers falling behind. Overall, it is estimated that 35,000 RPAS will be produced worldwide in the next 10 years. The European market should experience the same growth trend but at lower scale. If Europe's ambition is maintained at current levels, the United States together with Israel will remain, in the foreseeable future, the dominant players in a growing RPAS market. This is why it is imperative for the EU to take action now."

Urban Aeronautics has introduced its AirMule, an experimental single-engine VTOL cargo and MedEvac UAS.

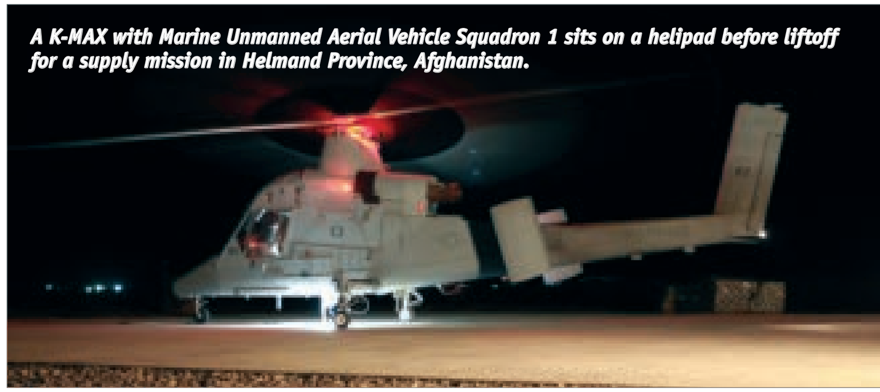
Timeframes and regulatory issues

So when will the first air-freight RPAS take to the European skies? While U.S. regulators were given a deadline of September 2015 by President Barak Obama in February 2012 for the full integration of unmanned air systems into U.S. national airspace, Europeans are working toward a less ambitious deadline. As part of a program to boost civil-military cooperation in research and technology, the European Defense Agency (EDA) and the EC have signed a cooperative agreement that includes developing an RPAS airspace integration roadmap by the start of 2013, targeting an initial capability to fly RPAS platforms in general airspace—with some restrictions—by 2016, achieving full operational capability by 2020. According to the plan the steps along the way will be financed jointly by the EU's civilian Horizon 2020 program and the EDA's joint investment program.

However, this is only the start of the regulatory process. If air cargo carriers want to transport their freight beyond national boundaries, they will need to operate within the International Civil Aviation Organization regulatory framework. Work on this has already started; according to the EC's staff working document, "ICAO is currently developing Guidance Material in a form of a 'Manual' expected around the end of 2013 and Standards and Recommended Practices (SARPs) immediately after. ICAO also plans to organise a world-wide RPAS Symposium in spring 2014."

Up and coming

The next hurdle will be developing suitable civil platforms and related systems, which some manufacturers have forecast to take 15 years to bring to market. However, recent industry developments suggest this timeline could be unduly pessimistic. In 2012 and 2013 the Lockheed Kaman K-MAX UAVs were successfully operated by the Marine Corps in Afghanistan for transporting freight to distant outposts and carrying out intelligence, surveillance, and reconnaissance missions. This has shown that unmanned cargo operations are feasible in even the harshest of operating conditions.



A K-MAX with Marine Unmanned Aerial Vehicle Squadron 1 sits on a helipad before liftoff for a supply mission in Helmand Province, Afghanistan.

The same airframe is used for civil applications such as firefighting and construction, and other manufacturers are also entering this very niche market. In October 2012 the Israeli military put on display its 'Flying Elephant' UAV troop supply aircraft. Developed by Elbit Systems, it can reportedly carry a one-tonne payload. And Israeli company Urban Aeronautics sees civil applications for its AirMule, an experimental single-engine, vertical takeoff and landing cargo and MedEvac UAS, which completed the first phase of a flight test program in January 2010.

Europe's Cassidian ram-air cargo parachute system ParaLander has received Category I certification in Europe under UAV regulations and is approved for deployment in restricted areas, including in peacekeeping flight operations. But essentially it is a highly accurate parachute system—designed to carry a 1,000-kg payload—rather than a ground-launched RPAS. And other European cargo-carrying RPAS projects are also relatively small scale. Geneva-based Flying Robots's SWAN X1 platform has been designed as a cargo-carrying RPAS based on a two-seater microlight configuration.

A new roadmap

These are a long way from Fred Smith's vision of massive cargo-carrying flying-wing and blended-wing-body shaped airliners crossing the globe. And Europe's preliminary research programs into these concepts—such as the EC-funded VELA (Very Efficient Large Aircraft) program and its follow-on research—have concentrated almost entirely on passenger-carrying aircraft.

However, in September 2013 the results of another EC part-funded research program, the Air Cargo Technology Roadmap, are due to be released. This will examine what new type of dedicated air cargo planes will be required in the future.

According to the research program's aims: "Based on business models for such new types of air cargo operations, the need for novel dedicated air cargo planes will be derived and the technologies that will be needed to create these novel airplanes will be identified in a roadmap…. Whilst identifying novel technologies, only those specific to air cargo operations will be shown in the roadmap, assuming that generic technologies in aviation will take place. The roadmap will identify current and planned research and missing elements to enable a new generation of air cargo aircraft to be realised."

Moving ahead…

The roadmap is likely to highlight the growing gulf between North America and Europe in key technologies for the next generation of automated cargo-carrying aircraft.

And U.S. military RPAS cargo-carrying capabilities are due to move a stage further when the winner of the U.S. Office of Naval Research's (ONR) Autonomous Aerial Cargo Utility System (AACUS) program starts operations. At the end of 2012 came the announcement of the two candidates for this program. They are Lockheed Martin Mission Systems and Sensors, with a development of the K-MAX, and Aurora Flight Sciences, with a UAV version of a Sikorsky S-76.

The program will take autonomous operations to a new level. "Key features of AACUS include a vehicle autonomously avoiding obstacles while finding and landing at an unprepared landing site in dynamic conditions, with goal-directed supervisory control by a field operator with no special training," according to the ONR. The two candidates are due to compete in a 'fly-off' competition in 2014 to determine which software architecture offers the best performance in computation speed and sensing.

The development of such technologies should give the U.S. and Israel a major lead when it comes to developing mature RPAS management technologies for large-scale civil UAS applications. And further reinforcing America's market dominance will be the ambitious timescale for granting licenses to civil RPAS operators—according to FAA Administrator Michael Huerta, speaking at the annual conference of the Association for Unmanned Vehicle Systems International in August 2012, the FAA will begin granting personal and commercial licenses to RPAS operators in 2015.

According to Marko Lukovic, principal consultant for aerospace, defense, and security at Frost & Sullivan, in a UAS research paper published in June 2011: "Military UAS operations have now become the norm in almost all important deployments, and military UAVs are leading the way in terms of standards, certification, and pilot training. However, in the long term, the civil and commercial UAS market has the potential to grow larger than its military counterpart. It will take a considerable amount of time for experience and the successful use of UAS in military and a wide range of non-military applications to diffuse across a dispersed customer base."

One perspective

According to Frank Pace, President of General Atomics Aircraft Systems Group: "Remotely piloted and unmanned aviation is a field that is expanding rapidly. With history being a good indicator in aviation trends, the expansion of unmanned aircraft technologies into the commercial sector could eclipse that of DOD within a decade or so. The opening up of national airspace for use by unmanned aircraft is the key factor that will pace this growth. There are significant integration and regulatory issues that first must be accomplished before we realize routine flight of unmanned aircraft for civil aviation. The FAA and the DOD are working in concert to come up with the rules and regulations infrastructure and technologies that are necessary to enable the safe integration of unmanned aviation into the National Airspace System. I don't think that anybody can actually determine what the unmanned aviation landscape will look like in just five to 10 short years from now; but one thing is sure, it is an exciting time to be in unmanned aviation. We have not seen this type of technological evolution in aviation since the introduction of the jet age."

...and catching up

As the recent EC staff working paper on the development of civil applications of RPAS concludes: "European RPAS producers have made significant progress in the development of critical technologies and in the systems integration expertise required to field mature and globally competitive RPAS systems. However, when evaluated against the track record of Israeli and U.S. manufacturers it is clear that European RPAS producers have significant work to do to increase competitiveness in the global market."

While fleets of huge cargo-carryings RPAS may still be many decades away, the base technologies that will be required to fly them safely and autonomously in civil airspace will soon be reaching maturity in the U.S. and Israel. This is a technology race Europe cannot afford to lose—for if the forecasters are right and the civil RPAS market will one day outperform the military sector, Europe's industry will have a great deal of catching up to do in an impossibly short timeframe.

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Correspondence

Congratulations on **A tale of no tail** (November, page 34), and thanks to the author for making the full report leading to his article available to the rest of us design engineers. I'm going to download it myself.

It's been too long since *Aerospace America* has published an article with this much technical 'meat.' I hope this is the start of a trend.

When I started reading the article I found myself saying "it's about time" as his opening paragraphs laid out the technical drawbacks of some alternative airliner configurations that have been explored the last few decades. In the speed range of today's airliners there are diminishing returns from higher and higher aspect ratios to reduce drag due to lift—unless you find a way to also reduce the zero lift drag.

Time will tell if Dan Raymer's suggested approach is the way; but at the least publishing this article should help refocus some design studies and research.

Frank O'Brimski
fjobrimski@aol.com

Doesn't anyone vet these articles? The article **A tale of no tail** is just silliness. All of the tribes that put feathers on the front of their arrows have died out. Apparently, the same can't be said for airplane designers who put tails on the front of airplanes.

Grant Carichner
grant.carichner@lmco.com

Reply by author I do hope that my article sparks a real discussion of the possible merits and problems of this high-risk, high-reward approach.

✈✈✈

I believe there are two errors in Michael Westlake's otherwise interesting article, **A question of leadership** (November, page 7). These errors are in association with Michael's description of the failed Phobos-Grunt mission on p. 8. First, this mission was not launched by a Soyuz rocket but rather by a Zenit. Second, Phobos-Grunt did not fail to reach orbit, at least one about the Earth. The Zenit rocket successfully achieved the desired Earth orbit, but the modified Fregat-MT upper stage named Flagman failed to depart Earth and achieve orbit about Mars according to mission design.

Daniel R. Adamo
adamod@earthlink.net

✈✈✈

With reference to **Troublesome trends in U.S. air transportation** (November, page 20), there is a flaw in NextGen being characterized as "satellite based." Indeed it is actually ground based with satellite augmentation and therefore it requires three streams of communications for a single message rather than only one in the existing system, making it far more vulnerable to atmospheric interference and terror attacks. Furthermore the questionable marginal benefits, if there are any, do not justify the huge multibillion-dollar taxpayer and industry investment.

Karl Kettler
kettler@nac.net

Reply by author We agree with the mischaracterization as a satillite-based system (except that it uses GPS signals). Most communication in NextGen is land line and VHF.

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

Events Calendar

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

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

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

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

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

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

MARCH 25-28
Twenty-second AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar; AIAA Balloon Systems Conference; 20th AIAA Lighter-than-Air Systems Technology Conference. Daytona Beach, Florida.
Contact: 703/264-7500

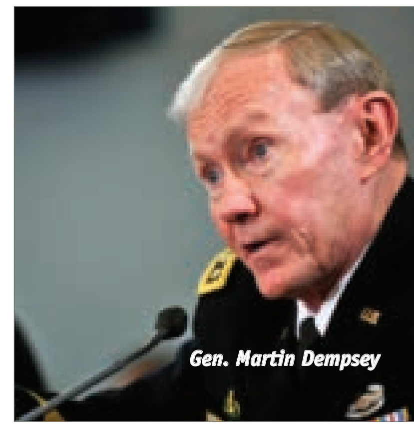
APRIL 8-11
Fifty-fourth AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference; 21st AIAA/ASME/AHS Adaptive Structures Conference; 15th AIAA Nondeterministic Approaches Conference; 14th AIAA Dynamics Specialist Conference; 14th AIAA Gossamer Systems Forum; Ninth AIAA Multidisciplinary Design Optimization Conference. Boston, Massachusetts.
Contact: 703/264-7500.

APRIL 10-12
EuroGNC 2013, 2nd CEAS Specialist Conference on Guidance, Navigation and Control, Delft. The Netherlands.
Contact: Daniel Choukroun, d.choukroun@tudelft.nl; www.lr.tudelft.nl/EuroGNC2013

APRIL 15-19
2013 IAA Planetary Defense Conference, Flagstaff, Arizona.
Contact: William Ailor, william.h.ailor@aero.org; pdc.2013.org

APRIL 23-25
Integrated Communications, Navigation and Surveillance 2013, Herndon, Virginia.
Contact: Denise Ponchak, denise.s.ponchak@nasa.gov; www.i-cns.org

Temporary reprieve in a troubled time


Gen. Martin Dempsey

In the 20 years since we began this monthly feature about events in Washington, government has never seemed so dysfunctional as it is today. Temporary legislation providing a two-month reprieve from widespread spending cuts—called sequestration—was enacted by a lame duck Congress on January 1 but offered little to planners in Washington who must chart a course for the immediate future. Nor did the temporary legislation, which was followed by separate action on a National Defense Authorization Bill (NDAA), make even a small dent in the nation's deficit and debt issues. *Washington Post* columnist Joe Davidson called it "the continuing soap opera that passes for governance" in Washington.

President Barack Obama named key figures for top jobs at the State Dept., DOD, and the CIA. All would have seemed reasonable choices in a less divisive era, but all will face a grind in the Senate before they can be confirmed. Add to that list the expected nominee for Secretary of the Treasury, and all four of Obama's key appointments are white men in a nation that says it values diversity.

The outgoing 112th Congress passed the American Taxpayer Relief Act of 2012, which puts off sequestration until March 1 and gives Congress more time—or creates a further delay—in working out a solution to the nation's financial woes.

The measure postponed draconian federal spending cuts for two months. As a separate issue, the U.S. nudged up against its debt ceiling again, a potential moment for more drama and gridlock.

Defense authorization bill

In a separate move—and with considerable discord—the outgoing Congress passed NDAA and Obama signed it into law on January 3. The NDAA contains elements certain to make everybody unhappy about something. The president opposed language that prevents him from transferring prisoners from Guantanamo Bay or closing the prison at the U.S. naval installation in Cuba. Air Force leaders saw undue, politically driven restrictions on retiring unwanted C-27J tactical airlifters, aging C-5 Galaxy strategic airlift craft, and B-1B Lancers, and they bristled at Congress's prohibition against canceling the Avionics Modernization Program for the C-130 Hercules transport, an effort that is many years behind schedule and seriously above predicted costs.

Missile defense experts noted that the NDAA does not provide for the MEADS (medium extended air defense system) but does include $211 million for Israel's Iron Dome short-range rocket defense system. The bill authorizes the Army to develop a plan to update the Patriot air and missile defense system.

The act acknowledges longstanding tensions between the active duty Air Force and the reserve component, a term that encompasses the Air Force Reserve and the Air National Guard. Although the Joint Chiefs of Staff, led by Army Gen. Martin Dempsey, already have large numbers of staff members and advisors, the NDAA requires one new senior advisor each to the JCS from the Reserve and Guard. Five years ago, the Guard won a seat on the JCS, making the National Guard director, currently Gen. Frank J. Grass, equivalent to the military service chiefs.

Tension between the active duty force and the Guard is no small matter. Almost every defense analyst seems to agree that the U.S. is being dragged down by having to operate far more military bases and installations than its force structure can inhabit. Complicating the situation is that the Guard is extremely competent, with deep-rooted experience and maturity (in one unit, an aircraft has had the same crew chief for 10 years). Politically it is all but impossible to close a base, especially a base belonging to the Guard, so the military will continue to operate units such as the 179th Airlift Wing in Mansfield, Ohio, which has just four C-27Js—the same, small airlifter the Air Force wanted to get rid of. In the past, an airlift wing would traditionally have operated 45-60 aircraft.

Staffers in the Pentagon are doing their best to conduct business as usual, having issued $4.8 billion in contracts for low-rate initial production of the F-35 Lightning II JSF before year's end. Other major military aerospace programs, including the KC-46 aerial refueling tanker and a new bomber, are protected in the NDAA.

The act kills the Air Force's plan to retire its small fleet of RQ-4B block 32 unmanned aircraft systems and its equally modest inventory of two dozen C-27Js, but it authorizes the Air Force to proceed with a plan to retire about 120 A-10 Thunderbolt II attack aircraft and dismantle five squadrons. Three of the five squadrons belong to the Guard, which considers itself embattled. Gen. Mark Welsh, Air Force chief of staff, is preparing to visit the A-10 units to ease the pain.

Stalling sequestration

The New Year's Day measure aimed at stalling sequestration permanently extends long-standing middle-class tax cuts. It provides a claimed $24 billion in savings equally spread across defense and nondefense accounts, realized through an equal amount in spending cuts and revenue increases—but that amount is minuscule by Washington standards.

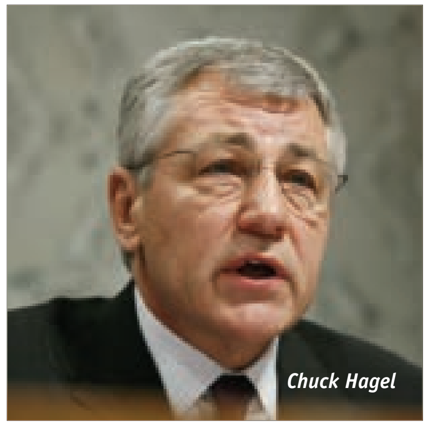
"This will give Congress time to work on a balanced plan to end the sequester permanently," says a White House statement—failing to mention that Congress already had about 18 months to do so and that two more months, until March 1, is not a lot. Even the $24 billion in savings will probably prove elusive. It comes primarily from raising taxes on Americans making $400,000 (for one person) or $450,000 (for a couple) a year.

New faces in the capital

Many incumbents in leadership positions in the nation's capital will remain in place going into the spring: Transportation Secretary Ray LaHood, FAA Administrator Michael Huerta (who belatedly won Senate confirmation for a five-year term on January 1), and NASA Administrator Charles Bolden.

Sen. John Kerry (D-Mass.) is the president's choice to replace Hillary Clinton as secretary of state. Clinton appears to have recovered from a series of acute health issues but says she wants "a good long rest" before discussing her future. As a solidly en-

Sen. John Kerry



Chuck Hagel

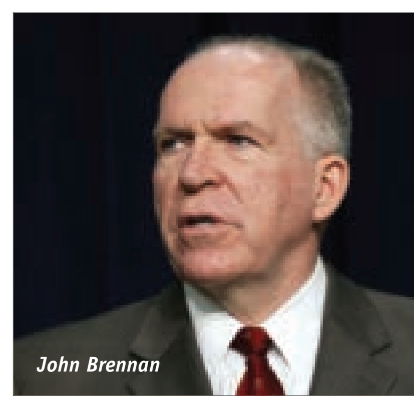
trenched member of the upper house who must confirm every cabinet appointment, Kerry was expected to make it through the Senate and take up the top diplomat's job, but perhaps not easily. Critics are likely to dust off the overwrought criticism of Kerry's Vietnam service that dogged his 2004 presidential campaign and to criticize him further for his anti-Vietnam war testimony on Capitol Hill in his youth.

Not so readily assured of a warm welcome in the Senate is former Sen. Chuck Hagel (R-Neb.), named to be secretary of defense. Hagel has been away from the Senate long enough not to be considered an insider. He draws criticism from the right for allegedly being soft on Iran and weak in support of Israel, and from the left for his disparaging comments in the 1990s about gay Americans. But Hagel, like Kerry, is a combat-wounded Vietnam veteran and, more important, a veteran of Washington's turf battles. On the day Hagel was nominated, Leon Panetta was already packing his bags, eager to get back to his family farm.

White House counterterrorism advisor John Brennan, a long-time intelligence officer, is the nominee to head the CIA. He, too, will draw fire from some quarters for allegedly being too soft on Iran. He is remembered in Washington for an inaccurate account of the May 1, 2011, Navy SEAL assault that killed Osama bin Laden. The two appointments are certain to stir new debate about the CIA's drone strike program in Pakistan.

Also recently announced, Obama has selected his White House Chief of Staff. Jack Lew, to replace Timothy Geithner as Treasury secretary. If confirmed, Lew will immediately be 'up to his ears,' as one observer put it, in critical budget and deficit deliberations.

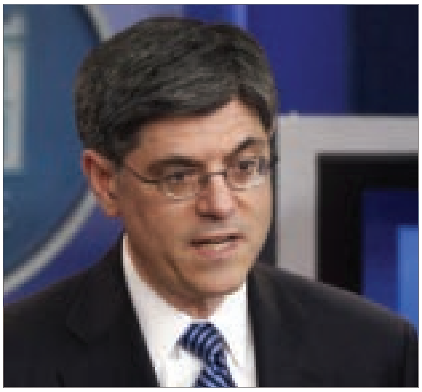
All of the nation's key military officers are recent appointments, including JCS boss Dempsey and the Air Force's Welsh, and are expected to remain. Marine Corps Gen. John Allen, U.S. commander in Afghanistan, was to be replaced this month by Marine Corps Gen. Joseph F. Dunford Jr., but Allen's nomination to become NATO commander in Europe is on hold in the Senate while he remains under investigation for emails he exchanged with a socialite in Florida.



John Brennan

At press time, it was far less clear what would happen with Attorney General Eric Holder, who is under fire from several quarters, or FBI Director Robert S. Mueller, who would require special legislation to stay on. The Senate gave the Obama administration special permission to keep Mueller for two additional years beyond the statutory 10-year limit on the job, which for Mueller expired September 2, 2011. What happens to Holder and Mueller will determine whether Homeland Security Secretary Janet Napolitano moves into one of their slots.

Although women and minorities are missing from the White House's top four national security nominees, the Senate now has 20 female members for the first time in its history. Sen. Harry Reid (D-Nev.) will continue



White House Chief of Staff Jack Lew

as majority leader. Rep. John Boehner (R-Ohio), facing near-mutiny by conservative elements in his own party, narrowly squeaked through reelection as speaker of the House of Representatives. Reid and Boehner, of course, will have pivotal roles in the ongoing budget debate. In addition to facing a March 1 deadline for sequestration, they are likely to be drawn imminently into a debate about raising the nation's debt ceiling.

Sen. James Inhofe (R-Okla.) will become minority leader of the Senate Armed Services Committee. He replaces Sen. John McCain (R-Ariz.), who hit a six-year term limit in the Republicans' top defense slot. Both men are pilots and both favor strong defense. Inhofe is seen as more conservative and more ideological, raising questions about whether he can maintain McCain's warm ties with the committee's chairman, Sen. Carl Levin (D-Mich.). Inhofe's home state has many military installations, including Altus AFB and Tinker AFB, where the Air Force's new KC-46 air refueling tanker is likely to be stationed.

Inhofe said he would serve as ranking member on "military readiness, acquisition reform, and preventing the potential hollowing out of our forces." He said he hopes to address wide-ranging military personnel and equipment needs.

Afghan air force

Building a local Afghan air force has long been a U.S. policy goal closely linked to the planned withdrawals of American troops from Afghanistan next year. The effort to equip and train Afghan pilots and maintainers has been mostly the work of a few hundred U.S. airmen and contractors. Their work wins good reports, but their efforts are being stymied by legal, industry, and U.S. domestic political issues.

The Light Air Support (LAS) program for the Afghan air force, the latest in a series of unsuccessful efforts undertaken since the USAF first went shopping for a light combat aircraft in 2007, is dormant and will be difficult to revive. It is essentially a contest between the Brazilian-designed Embraer EMB-314 Super Tucano and Swiss-designed Hawker Beechcraft AT-6 Texan II, either of which would be assembled on U.S. soil if selected.

Sen. James Inhofe

LAS got all the way to the point of an aircraft being selected late last year (the Super Tucano) only to have the Air Force cancel the contract award and begin afresh. An appeals court has since turned away a lawsuit by Sierra Nevada, prime contractor on the Super Tucano, seeking to be given the original award. Air Force officials say a new selection will be made this year.

LAS has prompted strong reaction from lawmakers. The Super Tucano would be assembled in a plant in Jacksonville, Florida, and has support from the local community and congressional delegation. The Texan II is made in Wichita, which has an especially vocal legislative caucus. The Super Tucano, which is larger and more robust, was designed from the outset as a combat aircraft but is plagued with a 'foreign' label because none, so far, has been assembled in the U.S. The Texan II is a converted trainer that performs well with U.S. equipment and ordnance and would enjoy commonality with some 635 trainer versions already built in Wichita.

A separate program would have equipped the Afghan air arm with 20 Italian-built (and, like the whole effort, U.S.-financed) C-27A Spartan airlifters. However, the program is being abandoned after four years and $596 million because the planemaker is facing insurmountable problems with spare parts and maintenance. The C-27A (not to be confused with the C-27J, a newer aircraft) dates to 1970 and has never operated successfully in Afghan hands. Sixteen of the 20 planes are to be scrapped, most without ever having flown a single mission.

As part of the Afghan air force buildup, two Afghan women were brought to the U.S. and trained as helicopter pilots (although one does not know how to drive a car). They returned home with pilot wings, only to be ignored by the brass in their own air force and kept away from helicopter controls because of their gender.

With U.S. support and training, the Afghan air force operates about half a dozen aircraft types without difficulty, including Russian-made Mil Mi-17 helicopters and U.S.-built Cessna C-208B Caravan utility craft and other aircraft. Most of these aircraft types offer little cost-saving commonality with those in the U.S. inventory.

It is unclear what will happen next in the U.S. attempt to build an air force in Afghanistan. The effort appears to have little constituency on Capitol Hill, and there appears to be no way it can be maintained if the U.S. withdrawal proceeds as scheduled. The intent is to have separate combat wings stationed at Shindand and Kandahar, but as recently as January 1, Shindand had an 8,000-ft runway, a gleaming new headquarters building, and no combat aircraft. Some retrenching and consolidation can be expected, and many in Washington doubt that LAS will reach fruition.

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Shooting for the Moon

Various contests worldwide try to entice competitors to join in the space race. In early December, these efforts were overshadowed somewhat by North Korea, which after four unsuccessful attempts—the last miss being in April—managed to loft a satellite into a polar orbit using a three-stage rocket. Whether or not the satellite is performing its stated Earth observation role is a matter of debate, as is the question of whether the launch doubled as a long-range missile test; but the country has joined China and Japan as a space-capable Asian nation.

That said, there is a major capability gap between North Korea and its Asian rivals, whose only similarity is that their space efforts seem to be entirely, or almost entirely, controlled by their governments or related agencies.

This is in stark contrast to private and amateur space R&D activities in other parts of the world. In the U.S., for example, NASA Ames and the National Space Society cosponsor an annual contest open to all students up to the 12th grade (18 years old) from anywhere in the world. With a strictly educational purpose, the contest is also fun and broadens the imagination by asking students to develop designs for space settlements and related materials. But that is at the theoretical level.

Ansari X PRIZE: A critical leap

At a decidedly more practical and monetary level, commercial companies have crossed the suborbital and orbital frontiers that in the West, too, were once the realm only of governments and their contractors, finding new approaches that are often more cost effective and efficient. Spurring this in a significant way was the $10-million Ansari X PRIZE, awarded in 2004 to Scaled Composites (led by Burt Rutan) for the achievement of regular suborbital flight by SpaceShipOne.

The prime mover in this contest was the U.S.-based X PRIZE Foundation, an educational and not-for-profit organization that continues to offer prizes for ventures that stimulate development of knowledge and progress in four areas: education and global development, energy and environment, life sciences, and exploration (ocean and deep space).

Google's search

Now the rewards are potentially even greater, as is the challenge, with the Google Lunar X PRIZE. It is offering a total of $30 million to the first privately (at least 90%) funded teams to land a robot safely on the surface of the Moon, make the robot move 500 m over the lunar surface, and transmit video, pictures, and data back to the Earth. Announced in 2007, the contest was originally set to end this year. In 2010, however, the deadline was pushed back to 2015. In February 2011 a list of 29 teams from around the world was announced, including two from Asia—one from Shanghai in China and another from Malaysia.

The Shanghai team has since pulled out (the field is now 25 teams), but Malaysia's Independence-X Aerospace is still in the contest, which now has a sting in the tail—the prizes diminish if government lunar landers arrive before those of the contestants. China could beat the X PRIZE teams to the lunar surface with its intended first Moon landing next year, or even with a year's delay; at present no other country seems to be in the frame.

Going nano

Offering a smaller reward was NASA's Nano-Satellite Launch Challenge. Its prizes were $1.5 million for the winner, and $1 million and $500,000 for the two runners-up, for placing two cubesats weighing at least 1 kg and measuring 10 cm a side—to remain in space for at least one full orbit—within a week of each other. However, NASA killed the contest in November 2012, having concluded that none of the contestants were likely to achieve its goals—except for two government projects for small satellite launches.

Still further down the scale in reward, and pushing the boundaries of the possible to the utmost, is a worldwide contest started in 2008 by a Cambridge University professor, biologist Paul H. Dear. When the entries closed last September, 53 contestants from around the world were registered. Asia is represented by a selection of seven teams from Australia and New Zealand, though one of the withdrawn entries was from the same Shanghai team that later also withdrew from the Google prize. The vast majority of entries are from Europe and the U.S.

Dear describes himself as the "founder and chief optimist" of the N-Prize, with a purse of £9,999.99 (about $16,000) for launching into orbit a payload weighing between 9.99 and 19.99 g. The N stands for nanosatellite or negligible resources. The deadline for reaching orbit has been put back several times. The prize is closed to new teams, but existing teams have until this September to complete their attempts.

With such small payloads, much effort has gone into the development of 'rockoons'—small rockets launched from high-altitude balloons—that avoid the need for large and expensive booster rockets for a surface launching. It may be only natural that the U.S. and Europe, with long traditions of amateur rocketry, are prominent in this contest, in which the rewards will inevitably be mostly intellectual, while Asia is notable for its near-complete absence. Such science-based individualism shows up much less often in Asia, especially in societies with a history of Confucian influence and strong belief in harmony and hierarchies, such as China and Japan, though such stereotypes contain their own hazards and contradictions.

Is Dear disappointed with the numerous though apparently somewhat muted responses? Not really. As he himself says, "If nothing else, the project succeeded in encouraging advanced amateur rocket development.

"As far as China, Japan, and other far-Eastern countries go, I'm not sure what the problem is. It may be that they just don't get to hear about the N-Prize, or it may be that government regulation is too burdensome. But I wonder also if it reflects a difference in philosophy? Any N-Prize entrant has to have a big ego (who else would attempt such a thing?) and a great willingness to go outside the box. I don't want to stereotype any nation, but I think the West produces more 'nuts' (and I mean that in a good way) than the East.

"I do a little teaching and mentoring in Asia (not China or Japan), and the philosophy I often encounter is one of responsibility and 'team mentality.' This is great for some things, but maybe makes people less likely to try something crazy like the N-Prize."

Waiting for winners

Given the extra time he has now allowed, does Dear believe any of the teams will win the prize?

"I think it's about 50-50. Of all the registered teams, only a minority are really active (there was no bar to entry, so we had lots of people who maybe bit off more than they can chew). Of these, there are perhaps half a dozen who are in with a fair chance. I might mention Team Prometheus [a U.S. team] as an example—they have put in a huge amount of serious effort on this, and I think they have a chance of pulling it off. But there are a handful of other teams who are also in with a chance.

"As to whether it is, fundamentally, possible at all—the answer is yes, even on the N-Prize's shoestring budget. The raw materials needed to deliver a microsatellite to low Earth orbit are not particularly expensive, so if you're ingenious and don't mind a lot of work, there's nothing to stop you apart from the red tape. Space is only 60 miles away. Unfortunately that's 60 *vertical* miles, and you have to be moving sideways at several miles per second to stay there, but still..."

> ***"I want people to have fun, to be creative, and to realize that if a problem cannot be surmounted, then perhaps it can be circumnavigated."***
>
> — Prof. Paul H. Dear

Agency in a shed?

Does Dear believe the self-education that the contest makes necessary is more important than the goal itself?

"Yes and no. In one sense, if even one really good idea comes out of the N-Prize, it won't matter if anyone wins. I want people to have fun, to be creative, and to realize that if a problem cannot be surmounted, then perhaps it can be circumnavigated. To quote the physicist Ernest Rutherford: 'Gentlemen, we haven't got any money, so we will have to think.'

"In another sense, though, an actual N-Prize winner will have a huge impact on how we all think about spaceflight. Imagine picking up a newspaper and reading that a team of amateurs have launched a satellite using a rocket they built in a shed! Immediately, it becomes conceivable for schools, universities, and hobbyists everywhere to do the same, or to do better. A successful N-Prize attempt means that the number of 'space agencies' in the world increases from a handful to thousands overnight.

"By way of comparison, look at computing. For a few decades, computers grew bigger and more expensive, and were the province of major organizations with serious funding. Then, when the technology permitted, enthusiasts in sheds and bedrooms started building their own machines; and it was these enthusiasts who really drove the development in computing since then. Even today, the 'hacker mentality' lies behind many of the major developments in computing. Spaceflight needs hackers!"

But did he perhaps set the limits too tight? "No, not really. The very low budget makes it impossible to do a conventional launch, and demands original thinking. It also means that money alone can't guarantee success, so the amateurs aren't squeezed out."

Is the N-Prize a reasonable competition, given the level of government regulation(s) presumably intended to protect the general public from falling debris from failed attempts to reach orbit?

"The risks are phenomenally low. Every year, several thousand meteorites hit the Earth—we're talking here about ones big enough to make it through the atmosphere, and many of these would be fatal if they hit anyone. But as far as I know, nobody has been killed by a meteorite strike. People are actually pretty thin on the ground, and the odds of dropping something on one of them are very low," he explains.

That thinking seems to be completely in line with Dear's self-proclaimed title of Chief Optimist. But as to the breadth of entries, it seems a shame that his enthusiasm has apparently failed to inspire many budding Asian equivalents of Steven Jobs or Bill Gates, so far at least. They must be out there somewhere.

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Lennart Sindahl

What are the current priorities for Saab's aerospace interests in the near future?

Clearly the Gripen program has a very high focus for us. But another important area is our aerostructures business. We have been in this business as a supplier to Airbus and Boeing since we left the regional aircraft manufacturing sector, and we are developing it as one of the pillars that Saab Aeronautics will lean on in the future. Of course it is impacted by the overall global economy, but even in bad times this market at worst declines rather than disappears. When the world economy struggles, growth is slower for some time; but as the production lead times are very long, the ups and downs of the economic cycle only impact it slightly.

If you had asked me 10 years ago what would have been the fastest growing market for us, I would have said unmanned systems. But this market has not grown, in general, as fast as many would have forecast. There's a vast span of different technologies involved in unmanned systems, and we are part of the Neuron unmanned combat air vehicle demonstrator program with the French, the Italians, Greece, Spain, and Switzerland. It's an important focus for us because it's a clean sheet design. It's also a way of testing new ways of European cooperation. Sometimes collaborative European aeronautical programs have not been that successful, in terms of time and cost slippages. So we are trying to find new ways of working together, and with Neuron we have succeeded.

We have a special focus on unmanned tactical systems, and we delivered such a system for the Swedish armed forces that is now being used in Afghanistan.

Another important area is the maritime patrol/airborne early warning/intelligence, surveillance, and reconnaissance [ISR] markets, where we provide platforms such as the Saab 340 and Saab 2000. We also have a growing business in service and support. We have just signed a performance-based logistics contract with FMV—the Swedish Defence Materiel Organization—on the Gripen.

What is different about Neuron and the way the partners are working together?

There are a number of differences. It starts with the way of managing the program—with a single point of decision, the French Defense Procurement Agency [DGA], and a single point of implementation, Dassault Aviation, as prime contractor. At the very early stages of the program we had some very open discussions with partners about how to split the work. One important step we took is to agree not to have all the partners in all work packages. We have ensured one partner takes the lead on one work package and has responsibility for delivering it, but not everyone is involved in everything.

And we had very challenging discussions about who is best at what—who should lead the ISR, the radar and avionics programs, for example—deciding who has the best skills in certain areas and making them responsible for that work package. That was interesting to see, European companies sitting down together and talking very openly about capabilities. There were, of course, some divergent opinions, but these were openly discussed, because we all knew the success of the program was based on picking the right company for the right job.

So what does Saab bring to the table, not just on Neuron but also in other areas? After all, you have relatively high labor costs and are a relatively small company compared to your larger partners and competitors.

One of our strengths is that we make sure we pick the best suppliers, and we don't pick them because they come from any specific country. Another strength is our productivity—if you look at the hourly rate for blue-collar workers in Sweden, it's relatively high, but we are still able to produce the Gripen at a competitive price. We have relatively low administration costs in Saab, and for several years alongside the traditional cost-cutting measures we have also introduced other efficiencies and improved our systems integration skills.

Lennart Sindahl is head of the aeronautics business segment at Saab Group in Sweden, with responsibility for both commercial and military aircraft development and production. He is also chairman of the Aircraft Sectorial Group within the Aero-Space and Defense Industries Association of Europe, and a board member of Vingtech Saab A/S.

Sindahl has an M.S. in electrical engineering from the KTH Royal Institute of Technology in Stockholm. Prior to his current post he was business unit manager for Saab Aerosystems and a local manager of Saab's operations in Linköping, with responsibility for government and community relations in the region.

Interview by Philip Butterworth-Hayes

One major step taken lately is to introduce model-based system engineering, where, in very broad terms, you skip writing detailed specifications and go straight to building 3D models. This has been a key to our efficiency drive, working in ways beyond traditional aerospace industry production methods.

Where are you putting your main research and technology efforts?

It is important for us to stay in the forefront of the aerostructures business, and that's why we have joined in the Clean Sky research program to work together with Airbus on new wing designs. Another important area is unmanned systems, and we see a growth in the mix of manned and unmanned vehicles, with airworthiness issues being key features of this. This is why we have joined the European Defence Agency's [EDA] Mid Air Collision Avoidance System [MIDCAS] program, where we are leading the work to develop automated sense-and-avoid systems for unmanned air systems.

In terms of Gripen, there are two very important areas of developing technologies in which we are investing—electronic warfare [EW] and radar systems. We are taking all our radar products over to AESA [active electronically scanned array] technology, and the next step is the integration of radar with the EW systems, designing multifunction systems. The focus on sensor and data fusion is very high.

Why is it taking so long to develop UAS technologies and procedures to allow these aircraft to fly in civilian-controlled airspace? We have the technology available, but integrating it seems to be taking forever.

I agree. Many market predictions for UAS have not really changed for the last 10 years—they just move left every year they are published. In general, U.S. military customers have been much more focused on unmanned systems than their European counterparts. I think that once customers start operating the systems they will start to realize their usefulness.

"So the question is, what systems are really unmanned—from an operational, economic, and logistical point of view?"

But I also feel that some so-called unmanned systems are not really unmanned at all. Some need four six-wheeled trucks and 50 people on the ground to keep a single system in the air, whereas the Gripen needs one man in the air but just five to 10 people on the ground. So the question is, what systems are really unmanned—from an operational, economic, and logistical point of view?

In NATO operations over Libya in 2011, we had a problem where manned aircraft could not fly south beyond a certain latitude because the search and rescue helicopters did not have the range to pick up a downed pilot. That tells me that unmanned surveillance aircraft would have made a difference in this instance.

Are you looking at a Gripen replacement now?

The Gripen will be replaced by the Gripen. We are looking now at the Gripen NG [Next Generation] full-scale development early next year with Sweden and Switzerland as customers. I think the difference between this aircraft and the C/D version it will replace is as big a jump as the new generation of fighters that appeared in the 1950s had over the legacy aircraft. It is a major step, with new sensors and new integrated weapons capabilities; the aircraft we supply to our Swedish customer will still be operational in 2040, so there will continue to be further developments.

However, we are also part of the Future Air Systems team, brought together by the EDA, looking at the technical issues of future air power. And we are discussing with our Swedish customer their needs for the future. But I think it's hard now to say what will come after Gripen, Eurofighter, and the Joint Strike Fighter. Will it be unmanned or manned? We don't know, but we are researching it right now.

How do you see the next phase of aerospace consolidation unfolding in Europe? How will it affect Saab?

I think we will probably see some consolidation, but I think it is more likely to be on a global basis than a European basis. I don't foresee any immediate consolidation efforts in the European arena. We saw the attempts with BAE Systems and EADS to get together, but that in a sense became too big a deal. I foresee a number of countries with ambitions in the aeronautics arena, such as Brazil, India, South Korea, and Malaysia, for example, so maybe there will be new partnerships to be formed among and with them. And I am also anxious to see how our American friends will act if and when the U.S. budget is cut. Maybe they will look again at more international collaboration.

Saab has signed an agreement in Brazil, I believe, to work with a potential supplier base there on various Brazilian air force projects.

Two years ago Saab signed a collaborative agreement with Akaer, a partner in the Gripen program, and that's an interesting link. We have also set up a technical center in India as a way of tying together new global aerospace connections.

So how do you rate your prospects of doing more business in the U.S.? It has traditionally been a tough mar-

"We know humans cause errors, but do people really trust fully automated systems?"

ket for European companies.

Historically we have been very successful on the commercial aeronautics side with the Saab 340, and most of these aircraft were sold to U.S. customers. We have been growing quite successfully with Boeing on the commercial side. We made a U.S. acquisition in 2011 of Sensis, which brought us more closely into the U.S. market for radar and air traffic management [ATM]. It has put us in a very interesting position in the ATM market in that it connects to the UAS airspace integration business. We are taking slow, step-by-step moves into this area, but although it is very competitive, I think we will see further steps in the future.

This seems to suggest that there is a common theme to your business development, redesigning aviation networks to change the way pilots, systems operators, and controllers will work in the future. Do you have a vision of how the civil and military aeronautics systems will evolve to include far more automation?

Let's look at products we already have, such as the Gripen. I'm not a pilot, I'm an electronic engineer by background, but I still can land the Gripen pretty well. That's not because I can fly, but because I can put an arrow on a specific point on the runway image that appears on the display. The Gripen can land itself—once you have chosen where you want to have the wheels touch the runway.

With our Skeldar unmanned rotary wing vehicle there is no throttle or stick in the ground control system, in contrast to many other unmanned systems. There's no pilot on the ground, it flies itself. The controller tells it where to fly and what to do and the aircraft does the rest.

So to a certain extent we already have fixed and rotary wing aircraft that fly themselves, which suggests to me that for many operations you don't need a person in the cockpit. We think in 10 years' time this will be a feature of our military products, so why shouldn't this be the case on the commercial side?

We have been working on automatic takeoffs and landings for at least 10 years; we have acquired Sensis within the ATM sector, and we are leading MIDCAS research in Europe. We are starting to put in place the building blocks that will form the availability of systems for fully automated civil and military flights.

When do you think that we will see fully automated flights in day-to-day operations?

Maybe the limitation is psychological rather than technical—we have to take account of how our citizens, with no knowledge of the aerospace sector, will accept a reliance on automated technology in this respect. We know humans cause errors, but do people really trust fully automated systems? Their mindset will probably be the overriding factor as to how fast we will let ourselves introduce this technology. We have a younger generation growing up with a very different view of technology and automation to their parents', and that might speed up the process.

In the civil sphere, where do you see the major efficiency gains coming from in the near future?

It will start with the structural design and the ability to produce structures much more precisely. One of the areas we are looking at in the Clean Sky program is the ability to make very precisely defined wing structures so you can get laminar flow across a much higher percentage of the wing than has been possible in the past. Then it goes into the type of materials you use in the structure, especially materials such as carbon fiber, which has a major benefit in that carbon structures do not corrode, so you can allow the aircraft to have higher humidity levels than legacy aircraft; this means you have better levels of passenger comfort.

The next thing we will see will be leaner engines, with better fuel consumption and lower emissions performance, along with new configurations for integrating the engines into the airframe. The ATM system needs to be developed to plan for new routing and reroutings to reduce fuel consumption. There's still a lot to do.

In five or six years' time, what will Saab Aeronautics look like? How will it have grown?

In five or six years' time we will be busy delivering Gripen NGs to three or four customers. We will have succeeded in the market with the Skeldar system, and I think we will be involved in at least one large-scale international aeronautical program on the defense side. I think we will have evolved the support side, taking much more responsibility for Gripen and other customer aircraft. And we will have grown in size by around 30%.

Defense electronics: Still no peace dividend

LOOKING AT TRENDS, STRENGTHS, AND weaknesses in the overall defense electronics market over the next 10 years, including growth by market segment and key new technologies, Teal Group's cumulative program forecasts indicate that defense electronics funding available to U.S. manufacturers will continue to rise slowly even as many other defense market segments decline.

New-platform hardware procurements began shrinking as long ago as the 1990s—remember the Cold War? The peace dividend? Backfire bombers, SS-20 MIRVs, nuclear winter?—and have declined again recently. The reductions follow a surge for Iraq and Afghanistan war buys and then for after-action refits (especially of Iraq ground systems such as armored vehicles and base security).

The lull in ship, armor, and aircraft buys will likely continue through this decade because of a slumping economy and tightening defense budgets. So far, the massively overbudget JSF continues to lend strength—or at least government money—to a weakened traditional defense industry, but this may or may not continue. Ship procurements trickle on at a very slow pace, with only the Littoral Combat Ship offering a possible ramp-up in numbers. And the Army wants no more tanks, to preserve funding for other expenses, despite what politicians in iron-bending states are trying to force upon them.

However, electronics funding will likely not decline at all, and our cumulative funding forecast shows slow growth almost every year this decade. Five-year funding plans in recent DOD budgets continue to show increases.

A few midlevel electronics programs have been cut (some unexpectedly, like the Army's EMARSS manned surveillance aircraft), but there is still no downturn on the books once electronics is separated out, and few key programs have been canceled rather than restructured, replaced, or renamed. EMARSS losses pale in comparison with increased UAV sensor funding. Even sequestration hints at cutting platform, personnel, and base funding much more than electronics.

Sniper pod

Updating legacy platforms will take over from all-new procurements, with F-15, F-16, and F-22 production lines still cold for U.S. military services. After a few years of hopeful expectation regarding JSF, reality seems to have set in, and several major legacy fighter electronic warfare (EW) and radar upgrades have finally been contracted in the past year. And although the military's desire for modular open system architectures used to be seen as a cheaper solution for buys and upgrades, in practice this rarely has been the case; defense companies no longer even advertise a pretense in this regard. Teal Group predicts continually improving aerospace electronics capabilities at ever-increasing unit costs, overbalancing a persistent slow shrinkage in legacy air platform numbers and likely cuts (or at least long delays) in numbers of new platforms such as the F-35.

Markets and technology

The largest defense electronics market sector over the next 10 years will be command, control, communications, computers, and intelligence (C4I), followed by radar, EW, and electrooptics (EO).

Despite its size (we include most avionics in our C4I segment), this year our CAGR (compound annual growth rate) forecasts have declined for C4I, because it will be easier to trim future budgets here, with or without sequestration. Though network-centric warfare and U.S. doctrine focus increasingly on making sensor and other data available to all, much C4I funding goes to relatively unseen (and politically invisible) software and hardware development, or is hidden within other program lines; these will be easier to cut than big-name programs familiar to the public (and the press).

The two biggest coherent C4I market segments should remain data links (mainly airborne) and—at least for the moment, with smart phones giving them a run for their money—tactical radios, primarily ground.

Data links have grown to include a virtual octopus of data, imagery, and voice transmission, with ever-increasing interoperability and management issues. New forms of communications nodes are continually being developed. One example is Northrop Grumman's aircraft-mounted battlefield airborne communications node, which assembles and manages ad-hoc Internet protocol networks to bridge a gamut of heterogeneous data and voice networks. Increased UAV use has also added to the complexity of necessary data links, for sensor communications as well as secure air vehicle operation; this trend will continue and accelerate.

EW, increasingly vital for America's wars, will keep expanding steadily, with the highest real segment growth rates. Still, some important programs will likely be cut or delayed here, as is traditional for EW's underappreciated role. However, EW will offer many of the best new programs for both value and growth.

Recently begun production programs will lead continued growth in signals intelligence. SIGINT has become essential for radio frequency ISR (intelligence, surveillance, and reconnaissance) of nontraditional opponents without tanks, planes, or heavy weapons, previously detectable with EO and synthetic aperture radars. A decade of U.S. attacks on enemy civilians from low altitudes is also shifting the airborne IR countermeasures market vs. IR-guided missiles, which grew after the Cold War to reduce losses over Iraq. With today's targeted assassinations occurring from even lower levels (when not carried out by drones), many new programs are now developing airborne shot-detection systems to counter unguided bullets and rocket-propelled grenades.

Traditional radar warning receivers, missile warning systems, and electronic attack will continue as mature market segments, especially for fighter upgrades. This is because the U.S. will shift its military focus again, to countering Chinese defenses and controlling Chinese sea lanes. Expect new starts in the next decade to allow a first strike against near-peer nations. These initiatives will likely include systems for a next-generation bomber, as well as improved stealth and EW to collect ISR over Chinese and Iranian territory, not just a relatively defenseless Libya or Afghanistan.


Battlefield airborne communications node (BD700)


F-16 with AESA

The $2-billion next generation jammer (NGJ) should continue as a major RDT&E program (not fielded until after 2020) as the Navy seeks to defend its presence in the South China Sea. NGJ is to advance electronic attack technologies with active electronically scanned array (AESA) antennas, which double power output and range, and will allow continuing software-driven attack modes and techniques.

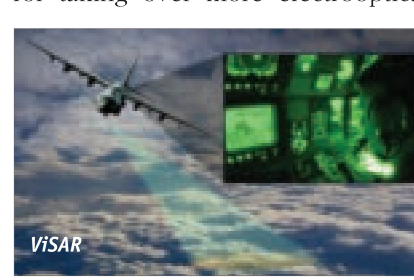
Still more market growth will be seen in countering cyber attack, already used effectively to capture a 'stealthy' UAV intruding in Iranian airspace. According to Mark Maybury, Air Force chief scientist, cyber-based functionalities have increased greatly in USAF aircraft, from 20% in the F-15 to 60% in the B-2, 70% in the F-22, and 90% in the JSF. GPS spoofing (with counterfeit signals) is also a major area of concern, especially with the continuing UAV growth forecast by Teal Group.

The mature radar market will see declines in many segments, with substantial shrinkage in both ground and naval markets. Some airborne radar segments have already shrunk, including fighters and airborne early warning and control (think AWACS), but new programs suddenly promise solid growth again. A coming surge of AESA antenna retrofits, with many programs just contracted this year, should bridge the fighter radar lull until JSF production ramps up.

In June the USAF finally approved an acquisition strategy to "mitigate [JSF] fielding delays" with its F-16 CAPES (combat avionics programmed extension suite), the heart of which will be a new AESA radar. Plans are for a five-year, $330-million development program, with $1.64 billion allotted for an initial procurement of 300 aircraft. Saudi Arabia, Taiwan, and other nations also contracted this year to buy major AESA radars for F-15s and F-16s, beginning a decades-long period of upgrades for thousands of fighters worldwide.

And following the past decade's concentration on ISR and prosecution of ground-based targets, the U.S. looks increasingly intent on funding a cold war with China: "We are looking at refocusing on operations in a contested environment," according to the chief of the command, control, and ISR requirements division of the USAF Air Combat Command. We all know what that means—providing new justifications for improved fighter sensors, long-range detection, and airborne command and control. Iran may provide a 'contested environment,' but only versus sneak attacks by the U.S. or its allies; much like Libya and earlier Iraq, it is no near-peer, and its defenses would be easily overcome by existing U.S. forces in any conventional conflict.

Radar also offers new possibilities for taking over more electrooptical


ViSAR

sensor market share, with extremely high-frequency or millimeter-wave (MMW) systems now in development to overcome the inability of EO to see through clouds, dust, and smoke. Early this year the Army announced plans to spend $226 million over five years to develop a 94-GHz MMW degraded-environment sensor for helicopter brownout conditions. DARPA is also funding MMW research, under its multi-function radio frequency sensor program.

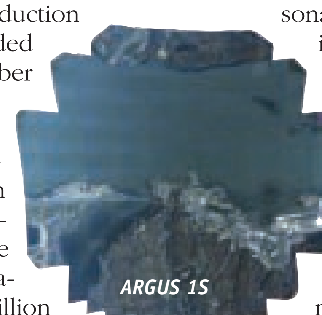
Other developments threaten EO ISR sensors directly, with DARPA's 230-GHz ViSAR (video SAR) sensor intended to fit a standard gimbaled EO turret and provide a 0.2-m resolution all-weather sensor at a range of 5 km and frame rate better than 5 Hz, fast enough to track moving people. Multiple companies are involved in this research.

EO sensor markets rose steadily through the last decade, but with supplemental procurements for the wars in Iraq and Afghanistan now ending, the biggest market surge is over. Teal Group's earlier forecast of a short-term lull in growth has been realized. EO's high CAGRs are thus somewhat deceptive, with FY12 the low point in funding for a decade past and future. If JSF funding is cut back or production stretched out further, the overall market uptick could also be delayed, resulting in a further decline, especially if EO is increasingly supplanted by RF systems.

Continuing steady growth in UAV EO will probably make it the hottest market (aside from the potential of the Joint Strike Fighter), with a CAGR of nearly 10% through the decade, as even legacy Predators will likely receive all-new sensors.

However, despite fast growth, the UAV market will remain small compared to fighter targeting systems—even without JSF. In September 2010, the Air Force dropped something of a bombshell with its $2.3-billion, 670-pod ATP-SE (advanced targeting pod–sensor enhancement) contract, split between Lockheed Martin's Sniper and Northrop Grumman's Litening.

This will be in addition to an $842-million Sniper postproduction support contract awarded to Lockheed in November 2011, and a $690-million Litening postproduction support contract with Northrop in December 2011. International sales continue as well, with Saudi Arabia awarding a $410-million contract to Lockheed Martin in April for Sniper and IR search and track pods, to upgrade 70 F-15Ss to F-15SA configuration; Saudi Arabia is also buying 84 new F-15SAs for $11.4 billion. Thus, fighter targeting should remain the biggest EO market segment indefinitely.



In terms of new technology, hyperspectral systems have still not seen massive funding increases, and we do not forecast them. However, military systems are finally in frontline service, both on Earth and in space. The next 10 years will see continuing technological advancements, especially in producibility.

Wide field-of-view EO sensor development also continues, with the majors—BAE Systems (ARGUS-IS) and Lockheed Martin (ARGUS-IR)—now involved. ARGUS-IR will have a new 'nBn' detector, with a barrier layer sandwiched between two n-type semiconductors, to minimize 'dark current' noise that flows even when there are no photons present, allowing the detector to operate at higher temperatures with less cooling. This is a real benefit with ARGUS-IR's 130 full-motion video 'chip-outs,' each with a resolution reportedly comparable to the single narrow field-of-view sensor on a Predator UAV. ARGUS-IR is to enter service this year.

Prime market shares

Raytheon, Lockheed, and Northrop Grumman will dominate the defense electronics market through FY21, with nearly 40% of prime contracts.

Lockheed Martin will lead with $57 billion in total funding, based on leadership in C4I, EO (especially dominating airborne fighter and attack helicopter targeting system markets), and sonar, and will be a strong third in radar (based on the dominant AN/SPY-1 Aegis ship radar). The company has strengthened its future in many markets where it had previously been a minor player, recently rising above Northrop Grumman in the overall electronics market, and now Raytheon.

Raytheon will place a very close second overall with $56.3 billion, will be number one in radar and second in EO, C4I, and sonar. A weakening of its future position in EO (from a virtual tie with Lockheed last year) has led to Raytheon slipping (barely) to second place in the overall electronics market.

Northrop Grumman fell to third in our forecast last year, but the gap has decreased slightly this year, with $50.4 billion in prime funding over the next decade, placing it well ahead of second-tier firms such as BAE Systems and General Dynamics. Northrop will lead the EW market with important systems including the advanced signals intelligence payload, will come in a close second in radars, and will show third in EO, largely because of JSF.

Note that our funding forecasts are allotted 100% to the prime contractors, with $135.9 billion still available for new primes. A much higher share than this 32.5% 'available' will in fact be available for subcontractors.

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Communicating with a Dragon

THE DRAGON CAPSULE'S RENDEZVOUS with the space station in May showed that computer analysis and modeling have found increasing acceptance in NASA and industry for verifying communications on even the most delicate missions.

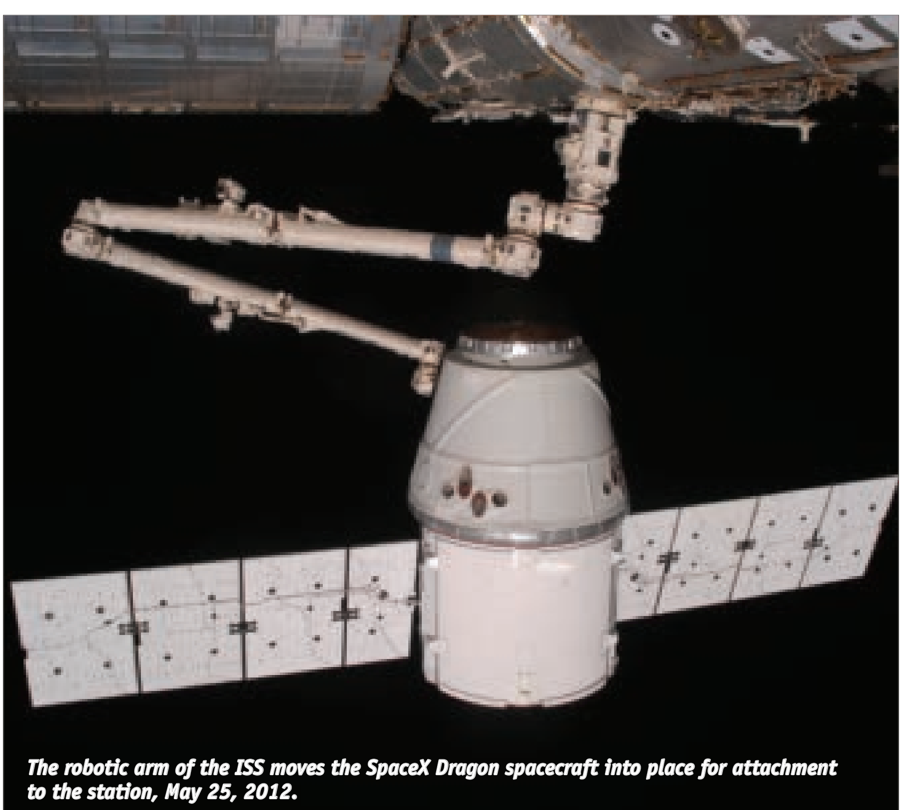
The 6,000-kg Dragon capsule featured 30 conformal antennas as it closed in on the station. The antennas kept Dragon in contact with mission controllers either directly, when the craft was in range, or indirectly via orbiting Tracking and Data Relay Satellites (TDRS). Other antennas provided GPS coordinates and linked the Dragon to the ISS during a confidence-building flyby beneath the station and, shortly after that, during the rendezvous itself.

During development, Dragon's designer and builder, SpaceX, relied entirely on subsystem hardware tests, computer modeling, and analysis to gain confidence in the complex communications system.

"I would prefer to put the whole vehicle in an anechoic chamber if I were going to be really conservative," acknowledges Steve Pollmann, manager of SpaceX's radio frequency (RF) work. "But in this case we didn't have a chamber big enough," he says.

NASA was responsible for the safety of the mission and was satisfied with the preparations even without a chamber test.

"There were quite a bit of tests done along the way," says systems engineer Mike Horkachuck, project executive for NASA's work with SpaceX. There were "RF checkouts of the basic antenna as a piece part; and then after it was installed in the vehicle there were more RF checks. So it wasn't done completely by analysis," he says. As for full-up tests, Dragon communicated before launch via TDRS through the atmosphere, Horkachuck says.



The robotic arm of the ISS moves the SpaceX Dragon spacecraft into place for attachment to the station, May 25, 2012.

'Next level'

The antennas for Dragon and its Falcon 9 carrier rocket were built by Haigh-Farr of Bedford, N.H., as a vendor to SpaceX. Haigh-Farr has made antennas for other space missions, including the Mars Science Lab now studying the red planet, but Dragon was different because of the human element.

"This was definitely taking it to the next level," says CEO David Farr, whose father, George, founded the company in 1968 with Bill Haigh. Last year, Vitec Group purchased the company, making it a business unit.

In addition to building Dragon's antennas, Haigh-Farr was responsible for accurately modeling the antenna RF patterns for SpaceX, which needed them for larger system-level analyses.

The big challenge for Haigh-Farr was to depict digitally how the radiation emitted by one antenna would interact with the surface of the capsule and with signals from other antennas.

Haigh-Farr engineers applied powerful computers and CAD tools. They developed finite-element models of Dragon and Falcon 9 so that the structures' physical characteristics—such as electromagnetism—could be represented in each cell of the models.

"What we have done is increase our computer capability to get these very large objects, such as a whole Falcon 9 or Dragon capsule, in the computer in a finite-element model, so that we can calculate these patterns," Farr explains.

There would be no anechoic chamber test of the entire vehicle.

Haigh-Farr's reliance on computer analysis is not an approach that arose from nowhere. It was the culmination of 20 years of investment in computing innovations, modeling, and anechoic chamber tests on flight articles for other missions, Farr says.

Avoiding outages

Farr does not recommend taking shortcuts when it comes to understanding antenna patterns.

"We have seen in the past, especially in a lot of satellite applications, that companies have not considered the radiation characteristics [that are] actually on their satellite or on their vehicle," Farr says. "They've taken the basic characteristics of their antenna when mounted on an ideal ground plane and assumed that's what it's going to be when they use it. That's not necessarily the case."

A lot can go wrong. Consider a conformal, omnidirectional antenna—Haigh-Farr's are made of a glass-impregnated teflon/ceramic material. Imagine it is wrapped around a cylindrical spacecraft. The antenna's energy does not only radiate into space.

"You will launch surface currents around the outside of the cylinder," Farr says. "So now you have another source, another amplitude and phase off both ends, plus the main amplitude and phase from the antenna itself," he explains.

Engineers must know exactly how the signals from that antenna and spacecraft surface will interact. If the phases are 180 deg apart from each other, they could cancel or null each other. "If you are looking from your receiving site or transmission site to the spacecraft, and you have a null right there, you're going to lose contact," says Farr.

The challenges are even bigger when complex shapes are considered, such as Dragon or the missiles for which Haigh-Farr also designs antennas. "You can imagine that if you add a wing or a fin or some other protrusion, you can wind up with energy scattering from the well," he cautions. Engineers need to establish the radiating characteristics, and plug that into software that conducts a full, dynamic link analysis under various conditions. This is what SpaceX did for Dragon.

Matters were complicated when all the different bands and temperature ranges were taken into account. On Dragon, S Band was used for telemetry and video. There were also C band transponders and antennas for GPS positioning. Dragon needed both omnidirectional antennas and directional antennas for communications via the TDRSs.

On Dragon, or any mission, engineers must be confident the antennas will keep working through the required range of temperatures. Heating or cooling of a material can impact the amplitude and frequency of the signals. "If the resident frequency was shifting because we were down very cold or up very high in temperature, then you could wind up with a serious mismatch, a transmission loss," explains Farr.

Engineers needed to make sure this would not happen during the Dragon mission. "You may lose signal due to this, and of course, the antennas that we're doing for Falcon 9 and a lot of other launch vehicles are for flight termination. So that's critical," Farr says.

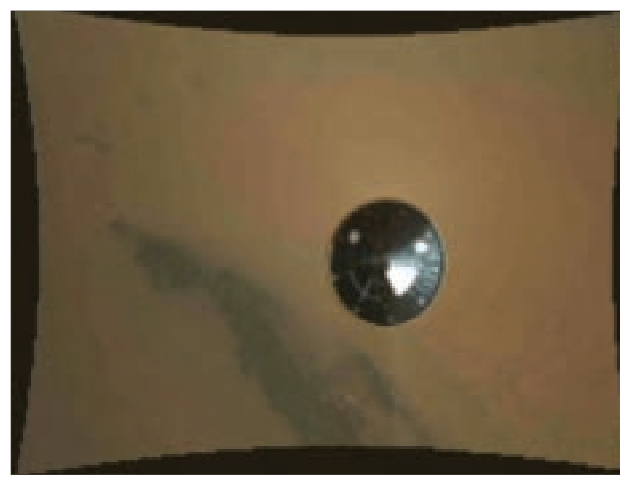
Confidence builder

Dragon was not Haigh-Farr's first space foray. NASA's Phoenix Lander communicated through eight Haigh-Farr conformal antennas during its landing on Mars in May 2008. The Mars Science Lab (MSL) used a similar antenna system to close in on the red planet in August.

Farr says that because of the company's history of modeling, he was confident of the antenna performance as he monitored the Dragon mission on Spaceflight Now and exchanged emails with SpaceX engineers.

Providing a big boost was a series of ground tests on the antennas aboard the Mars Science Lab. The tests were described in the undated paper, "Radiation Pattern Measurements of the NASA Mars Science Laboratory UHF Entry Antenna Using a Spherical Near-field Range." Farr and two coauthors wrote it to explain how the MSL team assessed antenna performance without placing the entire spacecraft in a chamber.

As with Dragon, that was not considered feasible because of the spacecraft's size. The team elected to conduct chamber tests on a fifth-scale model of the entire assembly, plus separate chamber tests on the actual flight nosecone. Those tests took place at Nearfield System in Torrance, California, in the company's spherical near-field test facility, which is lined with 1-m-thick, pyramid-shaped, anechoic absorbing material.



The MSL used antennas from Haigh-Farr as it approached Mars.

The team made radiation pattern measurements before and after application of the thermal protection system materials. That was important, because the choice of such materials can affect the reliability of communications signals.

"It's important that we know the characteristics of the material at elevated temperatures," Farr explains. "There are some materials out there that will char, for example…some of them char into carbon, and carbon can be a very bad thing to have over an antenna. It can prevent you from radiating."

Because the antenna must transmit through the thermal protective material, engineers must choose one with electrical parameters that are as consistent as possible over a range of temperatures. "If you have a material that radically changes, that can perturb the radiation characteristics of the antenna. And if it changes enough it could actually degrade them to the point where it's an issue," Farr says.

On MSL, the team compared their computer model predictions to the patterns measured before and after application of the thermal protection materials. "Good agreement between the patterns indicated that the fifth-scale-model measurements and the calculated patterns on the entire entry vehicle were valid," they concluded.

Both the subscale tests and nosecone tests gave the MSL engineers enough confidence to rely on modeling in assessing the antenna performance for the entire lander system.

Off-the-shelf tools

For Haigh-Farr, the breakthrough in digital analysis started about 12 years ago. The company's engineers were developing their own code for analyzing structures, but they realized there was a burgeoning industry dedicated to developing 3D modeling tools. So they decided to tap into it.

"There were a couple of companies out there that were really taking this to a new level," Farr says. "We were able to interface with AutoCAD and other solid models that make importation of these kinds of structures a lot simpler."

The resulting 3D computer models turned out to be game changers.

"Before, you had to describe [a structure] in a numerical fashion. It wasn't an object you could look at on the screen; you would have to look at a series of numbers," Farr says.

The transition to commercial 3D tools freed the company's engineers to work on bigger problems—namely, how to scale up the modeling and RF pattern analysis technique to larger objects.

"I like to say what we have pioneered—or worked on very diligently—is becoming very good at using these tools to calculate the [radio frequency] pattern," Farr explains. "We also developed the computer horsepower necessary to take [a] whole object and create a finite-element model, because it takes a tremendous amount of memory," Farr adds.

The cost savings challenge

Although known for its cost-cutting derring-do, SpaceX did not use that approach with the first two Dragon vehicles, which had more antennas and radios than the company, ultimately, would like.

"Our main objective was to meet all the safety and contractual agreements we have with NASA in order to do the cargo delivery," says Pollmann of SpaceX. "Cost was definitely a factor in, say, some of our component choices, but the main objective wasn't necessarily cost savings."

SpaceX is beginning to look at how it can reduce the cost of future capsules, however. "We're looking at seeing if we can reduce the number of antennas and the number of radios," Pollmann says. They want to do this while maintaining "two-fault tolerance," which means that if two radios failed, controllers could still communicate with the capsule.

"We've got to look at it and be a little bit more intelligent on how we design the next version of the comms system," Pollmann explains. "We don't have to be as conservative, because we have actual data from the missions we've flown."

In other words, Dragon's success will mean new challenges for antenna designers like Haigh-Farr. Mission engineers throughout the industry are demanding higher bandwidth, multiple channels, and the ability to withstand even greater extremes of temperature, shock, and vibration, particularly for missile applications, Farr says.

Trustworthy modeling will be more important than ever.

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Although a decade has passed since the tragic loss of the space shuttle Columbia and her crew, the recovery effort has not ended. Fragments of the orbiter continue to be found and returned to NASA, whose experts painstakingly catalogue and study them to learn as much as possible from the accident and pass along its sobering lessons to those who design and build vehicles for spacefarers of the future.

by Leonard David
Contributing writer

It has been 10 years since the Columbia shuttle orbiter and its seven-person crew ended their journey in catastrophe. On February 1, 2003, after a nearly 16-day flight, tragedy struck as the spacecraft faced fierce heat on reentering Earth's atmosphere. Columbia broke apart and fell across a 120-mile swath of East Texas and western Louisiana.

A detailed, soul-searching investigation into the accident found that the physical cause was damage by a piece of insulating foam that separated from the left 'bipod ramp' (which connected the shuttle to the external tank), striking Columbia's left wing 81.9 seconds after launch. That foam strike made a hole in a reinforced carbon-carbon (RCC) panel on the wing's leading edge, allowing a torrent of superheated air to sweep inside the internal wing structure during reentry. This led to the structural failure of the wing, destruction of the orbiter, and loss of the crew.

"I'm sure that Columbia, which had traveled millions of

Contact with Columbia is lost. Credit: NASA.

COLUMBIA
Ten years of recovery

miles and made that fiery reentry 27 times before, struggled mightily in those last moments to bring her crew home safely once again. She wasn't successful…," said Robert Crippen at the astronauts' memorial service. Crippen, along with John Young, had flown the orbiter on its maiden voyage in April 1981.

Now, a decade after that terrible day, the recovered and inspected components of the ill-fated orbiter remain as powerful and timeless messages bearing witness to technical errors, lack of effective communication, and a broken safety culture.

Solemn resting place

Michael Ciannilli is the project manager for the Columbia Research and Preservation (CR&P) Office at the Kennedy Space Center in Florida.

The CR&P Office is a nearly 7,000-ft^2 room located on the 16th floor of the 'A' Tower at KSC's Vehicle Assembly Building. A visitor to the site cannot help being overwhelmed by emotion when scanning the recovered wreckage at the center, a solemn resting place for over 80,000 large and small pieces. In total, about 80,000 lb of Columbia have been retrieved.

"We have 40% of the vehicle in," Ciannilli tells *Aerospace America*, "and we know some things will never be recovered. But we do continue to recover items, and have steadily done so since the accident."

Because of this, he says he "is of the strong opinion that we still have pieces out there." Indeed, a piece of debris from Columbia was discovered eight years after the 2003 disaster. The object—a round aluminum power reactant storage and distribution tank—was found in July 2011 in Texas. The tank, 40 in. in diameter, was discovered in an exposed area of Lake Nacogdoches, about 160 mi. northeast of Houston. Lower lake water levels resulting from local drought conditions led to exposure of the hardware. The piece was one of 18 tanks on the shuttle that stored supercold liquid oxygen and liquid hydrogen.

Ciannilli says finding Columbia elements becomes more difficult with time because of changing conditions. Still, hikers may find pieces, as might hunters in the woods. Various construction projects could unearth orbiter parts as well. "I would estimate that about 95% of the calls we get turn out not to be Columbia. But we appreciate the calls. Some of the items are really hard for us to identify…and it takes extra meth-

Columbia's main engine power head was recovered from Fort Polk in Louisiana. Credit: NASA/CAIB.

Columbia Accident Investigation Board members and a FEMA official survey shuttle debris near Nacogdoches, Texas. Credit: Mark Wolfe/FEMA.

ods to go into a laboratory and find out. I'd rather err on the side of caution," he adds.

Even though NASA and its contractors are no longer in the field searching, the agency maintains a telephone hotline and e-mail address that the public may use for reporting information that might help recover as much of Columbia as possible and aid others studying the mishap.

Reconstruction database

The vast majority of people who find Columbia components do the right thing by contacting NASA, Ciannilli emphasizes. But for those itching to cash in on debris (by use of eBay, for example), personally retaining or selling such an item is against federal law. All the material is U.S. government property; unauthorized persons in possession of accident material will be prosecuted. "We don't want anybody getting in trouble or having any issues. We are happy to facilitate getting items back to us," he points out.

Typically, a call comes into the CR&P Office and starts the process for ascertaining that a Columbia component has been found. That narrowing down is partly determined by whether the item was discovered in the orbiter's return-to-Earth flight path. A photo of the component, with something showing the scale of the piece, is very useful, says Ciannilli.

The CR&P Office uses an expensive database developed during the 2003 recovery effort for use by the Columbia Reconstruction Team in the Kennedy Shuttle Landing Facility Hangar. Called the CRDS (Columbia Reconstruction Database System), it includes the recovery location, latitude/longitude, images, and engineering descriptions of all Columbia debris received from February 2003 to the present.

Funded by NASA Kennedy, the CR&P Office seeks to simplify research and location of debris items, prevent further damage to the debris, make the database as accurate and comprehensive as possible, and receive, evaluate, document, inventory, store, ship, and track all Columbia hardware, whether located at KSC or elsewhere.

Painstaking search

Recovered elements of the craft range from dime-sized or smaller to weighing a few thousand pounds. "I personally attribute a lot of success in recovery of Columbia to

During search operations, this view of a KSC hangar shows a portion of the recovered pieces of Columbia debris. Credit: NASA Kennedy.

the volunteers. We had over 16,500 people join forces" to search for the vehicle, says Ciannilli.

Early in the process, NASA and the FAA partnered to assess the latter agency's radar data "to get an idea of where things were located," he says.

Soon after the orbiter's catastrophic breakup, a painstaking examination of the main 2,400-mi.[2] search corridor began. The combined efforts of five organizations—NASA, the Federal Emergency Management Agency , the EPA, and the U.S. and Texas Forest Services—made the search possible. Individuals from these agencies, aided by local authorities and landowners, worked long hours under arduous conditions over difficult terrain to recover debris. Extensive ground and air searches were carried out to scour a 10x240-mi. corridor along the projected shuttle reentry flight path.

Early in the recovery effort, teams from NASA, the FBI, the National Guard, urban search and rescue organizations, the Dept. of Public Safety, and others conducted a successful search in East Texas to recover and bring home Columbia's crew.

A FEMA Disaster Field Office based in Lufkin, Texas, was established as headquarters for the Columbia recovery operation. Over 100 federal, state, and local agencies, as well as volunteer groups, came together for the effort, deemed a model of cooperation that also set a high standard for future Dept. of Homeland Security cooperative endeavors.

The priorities of the participating agencies were threefold: Ensure public safety, retrieve evidence—pieces of the shuttle that could ultimately determine the cause of the tragedy—and reimburse the expenses of state and local governments and of private citizens who may have sustained property damage from the accident or search.

Guidelines prepared by the state of Texas, NASA, and the EPA enabled the teams to collect, document, tag, and transport nonhazardous debris without prior EPA or NASA clearance.

Among NASA's tasks was the rapid identification of orbiter-related hazardous materials, such as tanks containing toxic substances, or unexploded pyrotechnic devices. Once such objects were found, the EPA secured and removed them immediately. Working with local authorities, EPA also quickly cleared nearby school campuses and public access areas. In addition, it tested air and water samples taken along the flight path for shuttle contaminates. It found no evidence of hazardous material in the atmosphere or drinking water supplies.

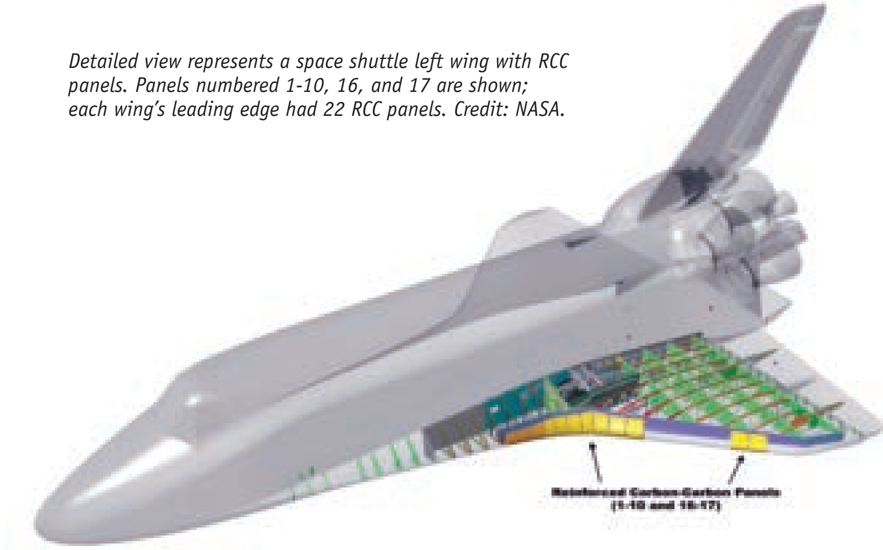
A round 40-in. aluminum storage tank from space shuttle Columbia's power reactant and storage distribution system was found in 2011, resting on the edge of Lake Nacogdoches in Texas. Lower lake water levels resulting from local drought conditions led to exposure of the hardware. Credit: NASA/Nacogdoches Police Dept.

Matriarch of the fleet

Ciannilli notes that recovered Columbia debris is available for study by researchers and the educational community. Scientific, academic, and governmental organizations that are interested, he says, are asked to submit their requests. Lehigh University, for example, used some components to conduct material/failure analysis for graduate students. Other groups have studied recovered items to delve into certification issues for spacecraft, or to reconstruct the physics that acted on the orbiter materials during and after reentry.

"Columbia was the oldest vehicle…the matriarch of the fleet," Ciannilli notes. "She had a great number of flights on her—28 missions—and experienced a lot of flight time and aging time." More pieces of Columbia will likely be borrowed for testing and used to aid understanding of the rigors of spaceflight and the reentry process, to

One of the larger pieces of recovered debris is Columbia's nose gear, shown here with tires still intact. Credit: NASA/CAIB.

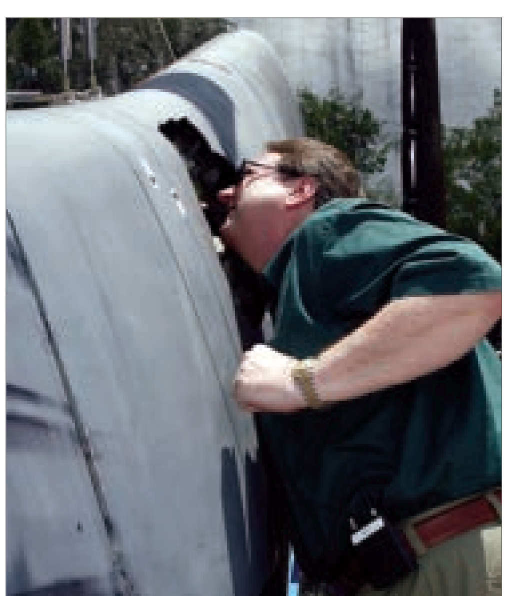


Detailed view represents a space shuttle left wing with RCC panels. Panels numbered 1-10, 16, and 17 are shown; each wing's leading edge had 22 RCC panels. Credit: NASA.

help shape a foundation for future spacecraft, and to educate new generations of those who will build them.

The doors of the CR&P Office are open for commercial firms engaged in supplying crew vehicles for NASA's use, he says. "It's an important sharing of information. When it comes to commercial crew, those folks are just starting to get their feet wet…just starting their design and early test phase of vehicles. There are a lot of lessons learned that can come from the government space shuttle program to commercial ventures."

Wayne Hale, a former NASA shuttle program manager, holds a similar view. "The Columbia accident offers, among other things, a set of technical lessons. How do structures fail? What kinds of stresses did that vehicle undergo…and therefore, how can we build better, safer spacecraft and aircraft in the future?"



CAIB member Scott Hubbard inspects the damaged RCC panel 8 following a test. Credit: NASA/CAIB.

For commercial groups, visiting the CR&P Office and viewing the collection of Columbia components also is a good idea, Hale tells *Aerospace America*. "It would be a good place for their management and leadership to go and hear the story. Also, keeping it there and allowing researchers access to Columbia as they get better and better research techniques…will pay off in the long run," he believes.

An earlier exhibit on Columbia also should be taken around for viewing by the NASA workforce, adds Hale. Similarly, having those who build commercial spacecraft go and visit the Columbia research office will reinforce the lesson that "bad things can happen if you don't pay close attention to details."

A design that invited disaster

Space policy expert John Logsdon, George Washington University professor emeritus, was a member of the Columbia Accident Investigation Board (CAIB). Among the board's duties was to ascertain the facts and determine the actual or probable causes of the mishap (both the dominant and contributing root causes), present important observations, and recommend actions aimed at preventing future accidents.

Logsdon became a CAIB member about a month after it was formed. His first experience as an official of the board, he recalls, was seeing the recovered debris, at that time sprawled out in a KSC hangar. The sight made an indelible impression. "You got a sense of the forces that had torn this vehicle apart. You had small pieces and big pieces; you saw the nose wheel intact."

Brought on to the CAIB for his space policy and space history expertise, Logsdon did not have the specific role of analyzing Columbia's fragments. "But those who did said that the debris told them the story… that the problem was on the left wing, and that there were vivid differences in the character of the remaining pieces that had been recovered," he notes. "As the forensic people say, 'something bad happened around here.'"

Concerning the lingering lessons of what Columbia's recovered debris can teach the commercial spaceflight community, Logsdon says he is not sure they need reminding about the risks of space. "Let's make sure the people who are building new systems recognize that something like this *can* happen," he emphasizes.

Logsdon observes that some Apollo astronauts, as well as others, have opposed the idea of commercial crew, seeing NASA as having unique expertise in how to accomplish human spaceflight. "And yet our [CAIB] findings were that NASA didn't do its job. So the idea that NASA can do this [human spaceflight] and the private sector cannot seems to me to fall down when one examines the indictment of NASA's performance in the Columbia board report….That idea doesn't square with the evidence."

Looking back on Columbia and the overall design of the space shuttle system, Logsdon says: "In retrospect, those design decisions look a little unfortunate." For example, vulnerable parts of the orbiter were put below, particularly the external tank, with the design requirement that things would not come off. But they did, from day one. This was "a design that invited disaster at a certain level," he says.

Physical cause statement

Another CAIB member was Scott Hubbard, then director of NASA Ames. He is now professor of aeronautics and astronautics at Stanford University.

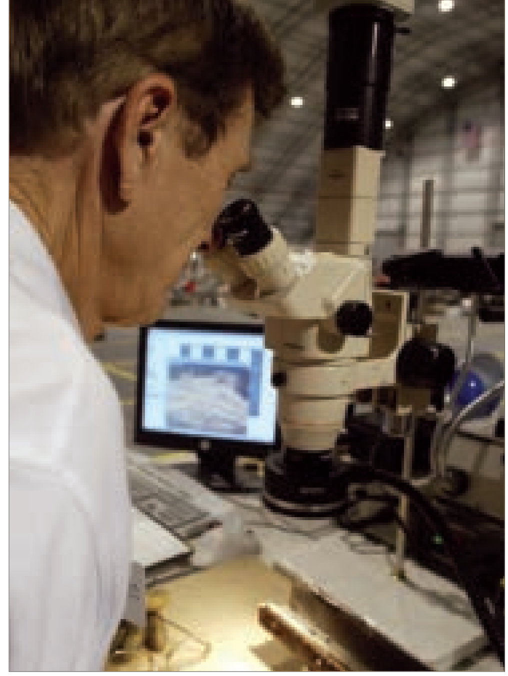
"It was the part count. The things that were recovered showed a lot more material from the right side of the orbiter than the left. The reconstruction of Columbia was all laid out like a crime scene grid. The distribution of what was recovered and what wasn't…that was another indicator that what happened was near panel 8 on the left wing. That was informative," Hubbard tells *Aerospace America*.

Quite literally, a 'telling piece' of evidence came from the recovered OEX (orbiter experiment support system) recorder, found buried in a slope by a firefighter in a previously searched area near Hemphill, Texas, some six weeks after the accident. From the OEX tape NASA was able to recover data recorded within two seconds of the actual destruction of Columbia. As a result of this find, experts retrieved 15 seconds of data not available anywhere else—information critical for the effort to resolve the root cause of the accident.

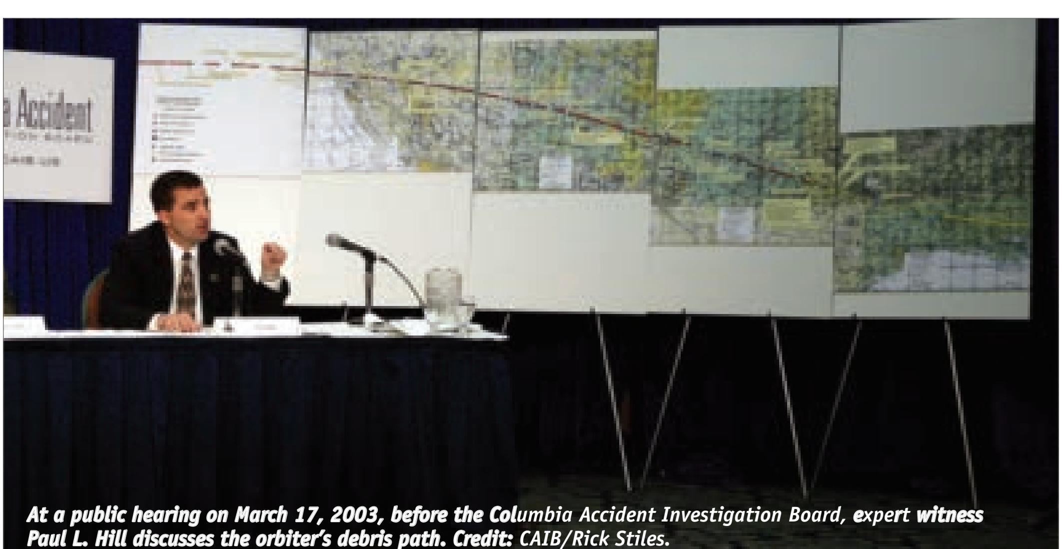
"The recorder showed us all the things that went off line when it happened. It began to give us a time line of what events occurred. All of that was extremely valuable as a piece of the total story at the time," Hubbard says.

But the true smoking gun came via computational modeling, reinforced by experimental testing with a large compressed-gas gun. At Southwest Research Institute in San Antonio, Texas, Hubbard oversaw tests

(Continued on page 45)



A reconstruction team member examines debris with a video-microscope, searching for clues to the events that led to Columbia's breakup. Credit: NASA/CAIB.



At a public hearing on March 17, 2003, before the Columbia Accident Investigation Board, expert witness Paul L. Hill discusses the orbiter's debris path. Credit: CAIB/Rick Stiles.

BEYOND Curiosity

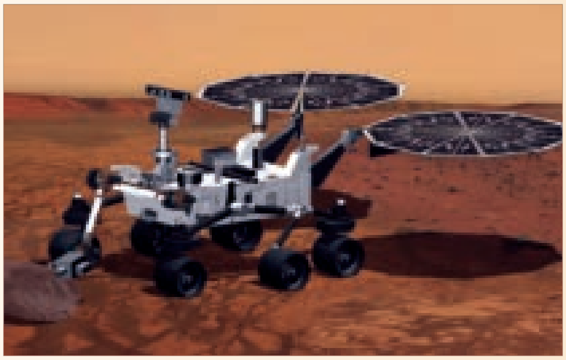
A MARS SAMPLE RETURN

NASA is weighing a matrix of new options and strategies for enabling the retrieval and return of Martian samples to Earth to determine if there is or ever was life on Mars. A Martian sample return is the top priority of the recent National Research Council (NRC) Planetary Decadal Survey.

Planned under an FY13 new start is a 2020 repeat of the plutonium-powered Curiosity Mars Science Laboratory (MSL) rover chassis and Sky Crane landing system, but with different instruments. Strongly endorsed by the Obama White House and the Office of Management and Budget, it would land on Mars in 2021. It remains to be seen, however, whether the new $1.5-billion mission will pass Congress, especially the fiscally conservative, Republican-controlled House of Representatives.

NASA believes the mission could provide a huge science payoff with minimal risk, since Curiosity is proving the MSL design and has retired the risk on virtually all of its components. These include key challenge areas that forced Curiosity into a two-year launch delay and a nearly $1-billion overrun. That cost growth pushed Curiosity's total cost, with launch vehicle, to nearly $2.5 billion.

A solar-powered version of Curiosity will be defined for a 2020 mission in case a plutonium-powered RTG proves unavailable. Credit: NASA.



The Mars exploration options for 2020 and beyond were conceived in part by NASA's Mars Program Planning Group (MPPG), composed of leading NASA and university planetary scientists, engineers, and technologists from the human and robotic programs.

The group has recommended that NASA consider post-2020 versions of the Curiosity rover, possibly solar powered, that could carry a rocket to fire samples

by Craig Covault
Contributing writer

Different configurations of Mars ascent vehicles are under consideration for future Mars sample return options. Credit: Wickman Spacecraft & Propulsion.

into Mars orbit. These would be retrieved by an orbiting robotic Earth return vehicle or an Orion spacecraft, on perhaps the first manned mission to orbit Mars, by the mid 2030s. The MPPG also recommended that upgraded versions of the lower cost rovers Spirit and Opportunity be considered for similar or supporting roles.

Under the MPPG strategy, the first in a series of robotic missions would begin after 2020, with more to follow every two years, so actual samples could be returned robotically as early as the late 2020s along with Mars orbiting return spacecraft.

The programs will be coupled from the start with human manned Mars orbital mission designs, so the human and robotic technologies can cross-pollinate to enable the return of more samples on board manned Orion Mars orbiter missions by the mid-2030s.

MPPG architecture and goals

MPPG's new architecture is a milestone in efforts to turn the U.S. space program's primary focus toward a joint science/human exploration plan with an initial goal of determining if life evolved beyond Earth in the solar system.

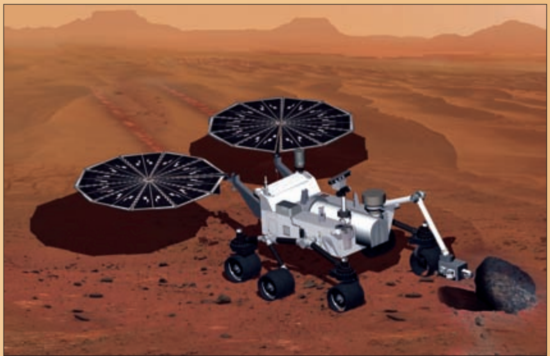
During 2012 the MPPG conducted an intensive assessment of what Mars missions the U.S. should pursue now that Curiosity is operational, and in view of the agency's limited budgets.

A key difference between this and previous mission studies is that this time "there was an imperative for strategic collaboration" between the human exploration, robotic, science, and technology divisions at NASA from the start, explains Orlando Figueroa, chairman of the MPPG. He previously served NASA as director of its overall Mars Exploration Program, as Solar System Division director, and as deputy director of NASA Goddard.

"The MPPG has given us a series of specific options and strategies about how NASA can develop a forward-looking and exciting

Now that the Curiosity rover has begun its work on the Martian surface, NASA is seeking to focus the U.S. space program on determining if life has ever existed on Mars. Among the agency's highest priorities is returning Martian samples to Earth, an effort likely to involve both manned and robotic missions. NASA's Mars Program Planning Group laid out strategy options for sample return missions that would involve a new 2020 Curiosity-type rover. It could cache samples for pickup later, and carry an instrument to detect existing life.

The Mars Program Planning Group raised the option of placing a Mars Ascent Vehicle launcher on a Curiosity-type chassis to fire samples into Martian orbit for pickup by a robotic orbiter or manned Orion. Credit: NASA.



Opportunity in its ninth year of roving Mars takes a self portrait as it circles rugged Santa Maria crater enroute to clay deposits that must have formed in water similar to fresh water on Earth. Such sites, more hospitable to early life, may be good sample return targets. Credit: NASA/JPL/Marco Di Lorenzo/www.KenKremer.com.

Mars exploration plan," says former astronaut John Grunsfeld, NASA associate administrator for space science. Grunsfeld has flown on five shuttle missions, three of them to service the Hubble Space Telescope. "We think that Orlando Figueroa and his team have queued up a great series of options and rationales to look at linking the science and human programs," he says.

The MPPG's purpose was to develop the foundations for a post-Curiosity program architecture for robotic exploration of Mars, consistent with President Obama's challenge to send humans to Mars in the 2030s. At the same time, its options had to remain true to the highest priority scientific goal of the 2011 NRC Decadal Survey for Planetary Science: A Mars sample return.

"That all makes sense," says Grunsfeld, "Because sending a robotic mission to Mars and returning a sample to Earth looks a lot like sending a crew to Mars and returning them safely to Earth."

The MPPG reached out to Mars-related science, technology, and engineering communities, both within and outside NASA, to develop the new mission options and architecture alternatives for consideration by senior agency officials.

Under the MPPG options, such a mission would be accomplished by either robotic or human means, or a combination of the two, depending on which of the proposed strategies are pursued.

One key issue was whether the current Mars orbiter relay communications infrastructure would need to be upgraded starting with the 2018 launch opportunity, or whether the high payload mass possible with the unusually favorable 2020 launch window argued more for a rover.

During the last quarter of 2012, NASA studied the issue and determined that with minimal spending, the agency could develop more efficient operations with the Mars Reconnaissance Orbiter (MRO), increasing its lifetime by at least two years to 2020 or beyond.

That option—along with the planned 2013 U.S. MAVEN (Mars atmosphere and volatile evolution) orbiter for relay and atmospheric science, and the 2016 European/Russian Trace Gas Orbiter (which will also be a relay)—could support surface relay operations well into the 2020s.

That caused NASA to bypass the 2018 orbiter window for a 2020 Curiosity-type rover. "Besides, the surface is where the action is," Grunsfeld says.

Figueroa told a gathering at the Lunar and Planetary Institute in Houston that one of the goals of the MPPG is for NASA not to skip more than one Mars launch opportunity in a row (meaning no more than four years between missions).

NASA formed the MPPG because of the need to replan the Mars exploration strategy in light of three baseline factors:

- Funding cuts, including a 38.5% cut to NASA's original $361-million FY13 budget estimate for Mars exploration, and an accompanying White House directive for future NASA spending reductions for Mars. The MPPG was tasked to "define technolo-

Curiosity: Paving the way for human exploration

There is already active cooperation between the human and robotic exploration science teams operating Curiosity, which carries a radiation assessment detector, sent to Mars specifically to prepare for future human exploration.

Curiosity also carries a Russian space agency pulsing neutron generator sensitive enough to detect water content as low as one-tenth of 1% and to resolve layers of water and ice several feet below the surface. This type of instrument will also be a vital tool for future human explorers.

On its heat shield, Curiosity carried the NASA Langley MEDLI (MSL entry, descent, and landing instrument), an array of 14 temperature and pressure sensors for mapping critical reentry data that can later be applied to much larger heat shields used for manned landers.

gies and options that could provide notional Mars exploration pathways into the 2030s," Figueroa said.

- President Obama challenged NASA to develop the Space Launch System heavy-lift booster and Orion spacecraft capabilities for astronauts to orbit Mars and return safely to Earth by the mid-2030s. This goal drove the MPPG to come up with options that involved collaboration between the human and robotic space communities "because the country is on a course to have human capabilities at Mars by the 2030s," said Figueroa.
- The NRC's 2011 Planetary Science Decadal Survey recommendation for Mars exploration singled out a sample return as the highest planetary priority of the 2020s.

The MPPG was tasked with defining options and strategies that are responsive to the primary scientific goals of the NRC Decadal Survey. That study chose a Mars sample return as its top science objective because, "crucially, the Martian surface preserves a record of earliest solar system history on a planet with conditions that may have been similar to those on Earth when life emerged," says the survey.

"It is now possible to select a site on Mars from which to collect samples that will address the question of whether the planet was ever an abode of life," the council reports.

The Curiosity rover is assessing the habitability of a specific area—the central layered hills of Gale Grater—for evidence of the area's suitability, nearly 3 billion years ago, as a past habitat for life.

The first big casualty of the tight Mars budgeting was NASA's role in what would have been a joint U.S./European ExoMars program involving a specialized astrobiology rover to assess samples on the surface for evidence of past life or prebiotic chemistry. In place of the U.S., ESA is now teaming with the Russian space agency.

Building on past efforts

In planning a sample return strategy, Figueroa's team drew lessons from the initial Mars replanning effort led in 2000 by G. Scott Hubbard, then deputy director for research at NASA Ames.

That replanning followed the 1992 loss of the Mars Observer orbiter and the 1999 loss of four NASA Mars spacecraft: the South Polar Lander, its two attached Deep Space 2 hard landers, and the Mars Climate Orbiter—losses all due to human error.

In the Hubbard replanning effort, the science theme 'follow the water' and its related overarching program strategy were reflected in a sequence of interconnected strategic missions. The results were the 2001 Mars Odyssey orbiter and the 2005 MRO, whose water-related goals involved use of advanced sensors and imaging of the landing site; the strategy also included critical relay capability for the landers.

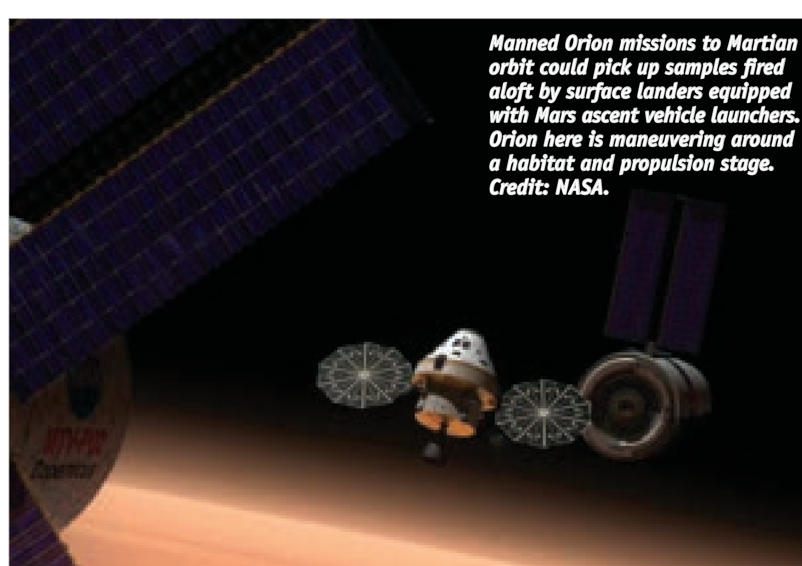
The landers and rovers that came out of Hubbard's 2000 plan were the water-related geology rovers Spirit and Opportunity; the separately planned 2008 Phoenix north polar lander, which found perchlorates and icy brine; and Curiosity.

Interspersed among the strategic flights are the $500-million-class MAVEN Mars orbiter, set for launch later this year to gather atmospheric data, and the 2016 InSight, a Phoenix-type lander. InSight carries a French seismometer and German heat flow instruments that will be lifted onto the surface by the lander's manipulator arm.

Choosing a path

Based on weeks of input, the team recommends that NASA look at two different 'pathways,' either of which would fulfill sample return objectives, one sooner than the other. The options are:

Pathway-A: This would be based on a near-term search for signs of *past life* using samples collected from a single Martian area determined with existing data to have astrobiological significance. Those samples would be returned to Earth as soon as possible. The group says its studies show that two types of mission strategies are viable:



Manned Orion missions to Martian orbit could pick up samples fired aloft by surface landers equipped with Mars ascent vehicle launchers. Orion here is maneuvering around a habitat and propulsion stage. Credit: NASA.

Curiosity and its Mt. Sharp destination were captured 200 million mi. from Earth by a camera on the 7.5 ft. robotic arm. NASA will build a duplicate rover for launch in 2020, possibly with sample collection and life detection instrumentation. Credit: NASA/JPL/Marco Di Lorenzo/ www.KenKremer.com.

•Pathway-A1, where the sample return objective would be spread across three or four Mars missions employing "multiple focused spacecraft."

•Pathway-A2, which would combine functions into one or two larger multifunction spacecraft, potentially lowering costs.

The MPPG says the strategies match "the highest priority 'large mission' recommended by the NRC Decadal Survey" and that the "MPPG mission concepts have reduced costs" compared with NRC Decadal Survey concepts for this case.

Pathway-B: This strategy would search for signs of *past life* based on analysis by sensors on the surface at multiple sites. Using in-situ information (ideally from three sites), the science community would select optimal samples for return to Earth, according to the group.

Examining multiple sites would dramatically improve the probability of identifying biologically relevant samples.

The rocks and soil would be returned from sites where in-situ measurements show the rock units were formed under conditions most favorable for habitability and for the preservation of biosignature—the kinds of sites Curiosity is seeking.

The search for existing life in 'modern habitats' would also be done, especially since more evidence of liquid water on or near the surface has come to light since the completion of the Decadal Survey, which focused on past life.

But the MPPG's reticence to fly biological or other sensors for analysis of *existing life* was disappointing to initial reviewers, even to Grunsfeld, to some extent.

Grunsfeld says this does not mean the MPPG team is interested only in past Mars life, as opposed to both current and previous life. He stresses that, actually, "the team said something different. It said members in the science community would find it very interesting to [put] a life finder chip on a rover to find existing water or life.

"What we are doing is putting together a framework" for future missions, he says. "I pressed the team about it, but it did not fit into their plan for an architecture."

But at the announcement of the 2020 rover plan, Grunsfeld said that the Science Definition Team planning the rover's science objectives would be encouraged up front to look favorably on the potential for life detection, and on carrying a sample selection and cache capability.

Expanding alternatives

A key juncture for the MPPG effort was a large meeting of the robotic science, technology, and human spaceflight communities at the Lunar and Planetary Institute last June near NASA Johnson. The sessions ex-

ROVER OPTIONS

The four rover options differ in cost and in several other areas:

•Rover-A, costing up to $1.38 billion, would be a clone of Spirit and Opportunity, but with new avionics and an added sampling capability. It could be launched to Mars on a SpaceX Falcon 9, but fitting it in the original MER heat shield will be a challenge. Spirit was operational for more than six years before dying in March 2010, stuck in a sand trap. On January 24, Opportunity's ground controllers celebrated its ninth year of roving Mars.

•Rover-B is another MER-derived design that could be launched on a Falcon 9. It would be a bit more expensive, up to $1.4 billion, because its slightly larger volume would require "new airbag and touchdown system development," says the MPPG final report.

•Rover-C, for sampling would be based on the MSL design, with large aft-mounted circular solar arrays instead of an RTG. The rover itself could be built for about $1.7 billion, but launching it would require an Atlas V.

A 2020 or later RTG-powered rover would actually be cheaper, because of all of the design and testing for an RTG electrical power and thermal distribution system, to keep key areas of the vehicle warm using residual heat generated by the plutonium system. That design must be different for an MSL-type solar-powered rover.

•The car-sized Rover D would be the most ambitious of the new upgraded designs, because on its top deck it would carry a Mars ascent vehicle rocket measuring about 6x2 ft. Traveling wherever the rover traveled, the rocket would fire collected samples into Martian orbit, where they would be retrieved and then maneuvered back to Earth. Samples would be loaded robotically into the ascent vehicle's payload container.

Its costs are still to be determined, but this concept, combined with an Orion crew retrieval in Martian orbit in the mid 2030s, is gaining popularity in NASA.

panded the trade space for alternative concepts on accessing the surface sampling and analysis instrumentation and the capabilities of the surface systems.

According to the MPPG report, multiple dual-use human/robotic technologies were cited, including optical communications, deep space atomic clocks, solar electric propulsion, and large deployable supersonic decelerators that could be used for "early" sample return missions by the mid-2020s.

Selected ideas served as a catalyst for the MPPG to charter subteams to explore lower cost approaches to sample return, including hardware such as a solar electric propulsion-propelled orbiter that would rendezvous with samples launched from the surface, than return to the vicinity of Earth, where an Orion astronaut crew beyond Earth orbit would retrieve them for return to a ground-based laboratory or the ISS. This could be done in the late 2020s using capabilities such as:

- A "mini Mars ascent vehicle" rocket design that could be landed with airbags, then robotically loaded with several pounds of samples that would be fired off the surface to Martian orbit for pickup.
- An Orion human-crew-based sample return from Martian orbit in the mid-2030s.
- Mini-rovers that could be deployed two or three at a time using a Mars Exploration Rover (MER) airbag system.
- Small extreme-terrain vehicles that could reach difficult Martian areas for sample pickup.

Launch options

The MPPG looked at accomplishing a Mars sample return with one, two, or three launches. The first, a single SLS mission concept for 2024, found no real support, but sample return operations involving two and three launches will remain under active study and involve:

- Three launches: The architecture proposed to the Decadal Survey by its separate analysis teams proposed a three-launch mission with the first flight carrying a single Curiosity/Sky Crane-type 'sampling rover.' The second would carry a moderately sized fixed lander with a Mars ascent vehicle launcher and a small 'fetch' rover that could retrieve rock samples from the sampling rover. The third launch would carry a sample return orbiter.
- Two launches: In this more limited scenario, a Curiosity-type sampling rover and its Sky Crane lander would be launched first. A second mission would carry a lander with the ascent vehicle, a small fetch rover, and a small Earth return orbiter propelled by solar electric power.

Opportunity, here undergoing prelaunch tests, is now into its ninth year of successful Martian surface operations. The MPPG said upgraded versions of the MERs could be useful to find and cache samples, then transfer them to a more expensive lander with an ascent vehicle launcher. Credit: NASA/JPL.

Rover choices

Finally, four rover options were defined by the MPPG as capable of carrying out various Mars sample return missions. Two are upgraded MERs like Spirit and Opportunity, with airbag landing systems; the other two are derived from the MSL Curiosity design and require a Sky Crane landing system. All would have guided entry capability for pinpoint landings like the one performed by Curiosity. However, the two Curiosity-derived rovers could possibly be powered by circular solar arrays instead of a radioisotope thermoelectric generator (RTG).

The 2020 MSL-type rover is now aimed at using Curiosity's backup plutonium RTG system and possibly even some of its remaining plutonium. The DOE is working to develop additional nuclear power sources for the follow-up MSL-type rovers. But NASA is also studying more costly solar array systems in case a nuclear RTG for the 2020 spacecraft should be unavailable.

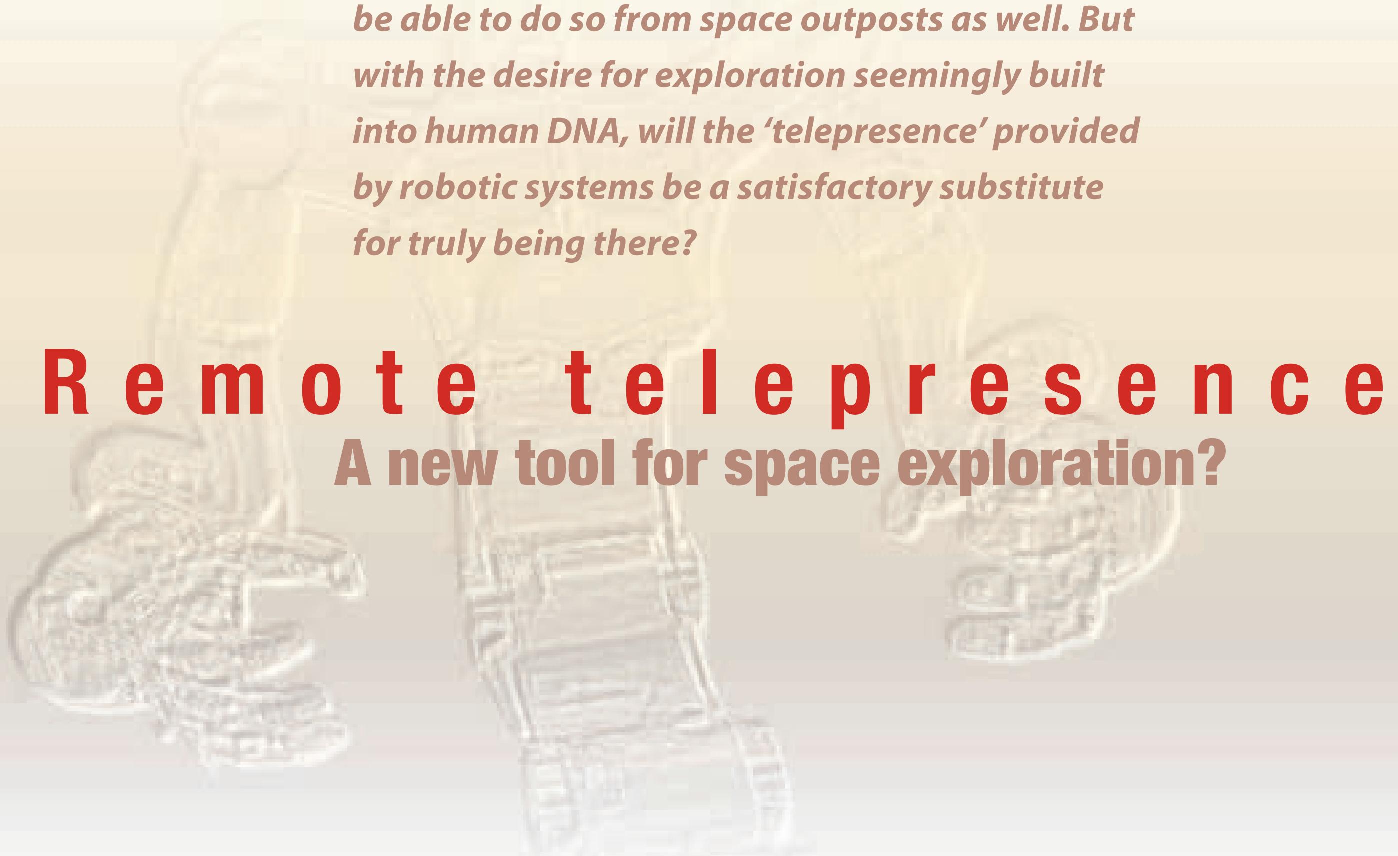
Going with upgraded MER and MSL designs would keep the highly experienced JPL/Lockheed Martin and other Mars contractor teams intact.

Grunsfeld says that before rovers start to cache samples, he wants to make sure they have the right tools for selecting which samples to cache. These could include life detection instruments or new drills to obtain rock and soil core sections, something that Curiosity's rock drill cannot do.

Advances in telerobotics are making it possible to conduct remote explorations of distant worlds. Human operators can now control their mechanical surrogates from Earth, and will soon be able to do so from space outposts as well. But with the desire for exploration seemingly built into human DNA, will the 'telepresence' provided by robotic systems be a satisfactory substitute for truly being there?

Remote telepresence

A new tool for space exploration?



by Leonard David
Contributing writer

Significant strides are being made in telerobotics, the ability to place human cognition and dexterity in places too perilous for flesh and bone, whether to probe the deepest oceans, dig out resources from mines, or maintain undersea oil pipelines and telecommunications cables. In addition, above our heads, passenger aircraft increasingly share the skies with all manner of unpiloted airborne vehicles, controlled from a distant command center.

Space exploration planners are now contemplating how they can adapt telerobotics to achieve tasks on other worlds. Extending human cognition to the Moon, Mars, near-Earth objects, and other bodies could reduce the challenges, expense, and danger of hurling humans to such hazardous surfaces and deep gravity wells.

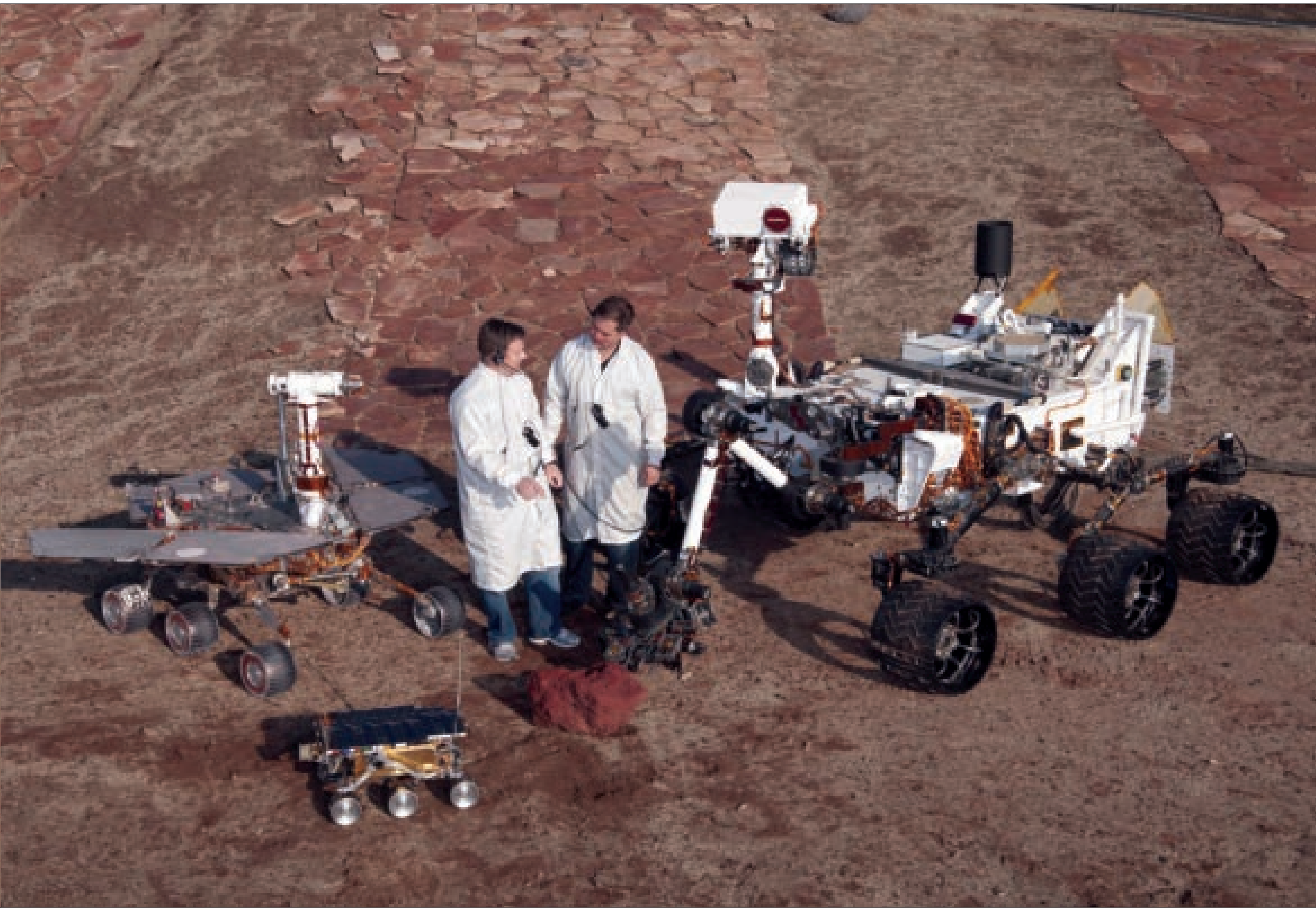
Conversely, some believe that sending mechanical surrogates to do an astronaut's work runs counter to the core value of human space exploration—that crewed space exploration is built into our DNA and answers the call of destiny.

But pitting astronauts against machines is not just contentious; it also overlooks the advantages of combining their attributes to create a true human-robot partnership.

Early pathfinders

Momentum appears to be building for future space expeditionary crews who remotely operate systems that are deployed on planetary bodies, doing so from, say, in-space locales. From a habitat circling a planet or in a module situated at a Lagrange point, astronauts could use high-quality telepresence to conduct surface science, piece together infrastructure, or scout out and unearth resources on other worlds.

In some cases, while landing crews on



Three generations of Mars rovers include tiny Sojourner, a Spirit/Opportunity-class rover, and the larger, Curiosity-class robot now on Mars. Developed at JPL, these NASA robots are seen as steps toward more advanced human-machine interaction to investigate a variety of worlds. Credit: NASA/ JPL-Caltech.

celestial surfaces may be the ultimate ambition, planting human cognition at these locations via telepresence could be achieved far more quickly and at lower cost. In addition, if remote telerobotic control can be established on the Moon, for example, could this capability help hone future activities at other planetary bodies, particularly at Mars?

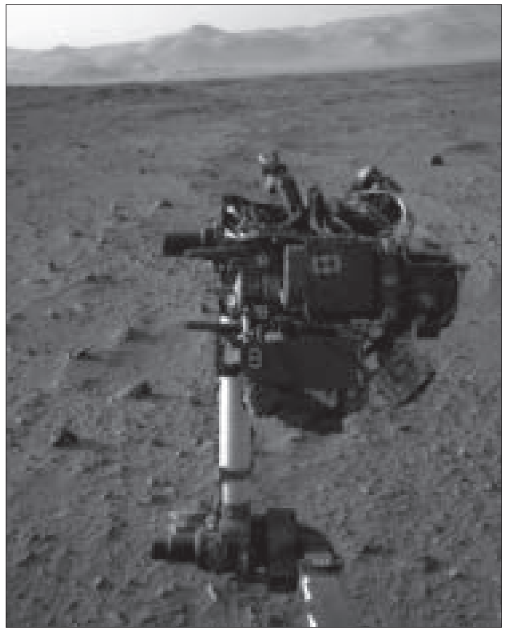
"Telepresence has the potential to vastly increase the capabilities for human exploration of the most challenging and revealing locations in the solar system," says Harley Thronson, senior scientist for advanced concepts in the Astrophysics Science Division, Science and Exploration Directorate, at NASA Goddard.

"Landing humans or robots on the surfaces of other worlds and within deep gravity wells, with a subsequent ascent, is a very expensive undertaking. In advance of landing humans on another world, astronauts from orbit operating sophisticated robotic surface explorers may be the far less expensive pathfinders, surveying, testing, and sampling for the humans that would follow," Thronson tells *Aerospace America*.

This major enhancement of human exploration potential, says Thronson, is enabled by three parallel technological advances: high-bandwidth communication, advanced robotics, and low latency—that is, placing human operators outside the deep gravity wells of other worlds, yet 'close enough' so that the round-trip light-travel time is comparable to time scales associated with the human hand-eye-brain system. "The key technologies to enable effective telepresence are nearly at hand, first to the vicinity of the Moon, then one day beyond the Earth-Moon system," he says.

"Effective telepresence offers the opportunity for humans to explore worlds

NASA's Curiosity rover now on Mars is well armed...but are human arms better? The increasing role of telepresence is yielding new insight into the value of robots and human explorers—and perhaps the melding of both to increase the productivity of space exploration in the future. Credit: NASA/JPL-Caltech.



safely from orbit that they will never visit directly—like the surface of Venus, or beneath the clouds of Titan," Thronson says. "Sophisticated telepresence on Earth gives us great confidence that this new capability for human spaceflight can be achieved, such as we now see in telesurgery, robotic mining, and robotic undersea exploration."

Cognitive compromises

Holding a similar view is Dan Lester of the Dept. of Astronomy at the University of Texas in Austin. Lester, who is working with NASA on cislunar operations involving science and exploration, notes that there are countless lessons to be learned from the terrestrial telerobotics community. "That's all happening right now, in a big way, and space exploration has a lot to learn from those endeavors. They don't use space-qualified hardware. But their operations management and protocols have important lessons for us."

It is precisely this explosion of technological capability that prompts talk about extending telepresence into space, Lester explains. "Decades ago, when we wanted to put human cognition on the Moon, there was exactly one way to do it…and that was putting people there—boots on the ground. But this is no longer the only option."

The Justin mobile robotic system was developed at the German Aerospace Center, DLR. With compliant controlled lightweight arms and two four-fingered hands, Justin is an ideal experimental platform. Credit: DLR.

Fast forward to today

Lester underscores what he believes is an important and perhaps overriding question: To what extent do the public and the U.S. Congress buy into an exploration strategy that does not involve humans going all the way to an exploration site? "In many respects," he suggests, "what telepresence is making us do is redefine what we mean by the word 'exploration.' To what extent do we have to 'be there' to be explorers? What does 'being there' mean? It doesn't mean what it used to mean," he contends.

Still, the distances over which robots are exercised impose a time delay on their control. For the Moon, that two-way delay is at least 2.6 seconds; for Mars it is far longer, in the 8-40-minute range.

These delays are, at minimum, what is routinely endured in 'experiencing' Mars through rover automatons. What kind of personal experience has you turning your head, then waiting 40 minutes to see the view? Lester asks: Is experiencing distant space destinations through electromechanical surrogates really possible?

Minimizing communication delay time, or latency, says Lester, is a key to achieving telepresence, and that translates into putting human cognition at distant sites. "In order to achieve it, humans need only be close, so the travel problem becomes sending astronauts to the *vicinity* of exploration sites, and not necessarily landing on them. Landing humans can be almost half the cost of putting human cognition at these sites."

Thronson and Lester were key organizers of an Exploration Telerobotics Symposium held last May at Goddard that brought together astronauts, scientists, engineers, and robotic specialists from a mix of Earth and space applications fields.

In many respects, Lester says, telepresence is a strategy that challenges traditional definitions of exploration. Can we be explorers without actually setting foot at an exploration site? The space science community is comfortable with that premise, though control of robotic assets from Earth involves serious cognitive compromises. "It was clear to the symposium participants that exploration by telepresence established clear synergy between robotics and human spaceflight, and had a strong generational grounding. The 'wired' generation may be far more accepting of such a strategy than an older generation," he surmises.

Robotic right stuff

The Mars Science Laboratory's Curiosity rover provides a good opportunity to contrast the exploration effectiveness of space robots with that of on-the-spot humans.

First, it depends on what you run into on Mars, explains John Grotzinger, MSL project scientist from the California Institute of Technology. Curiosity, the size of a small car, is essentially an automated geologist operated by a large team of handlers on Earth. The team is also using orbital imagery of the site the rover is exploring.

Already, Curiosity has shown its robotic right stuff in surveying its surroundings. “With a robot we can actually test the hypotheses, including the alternatives, pretty quickly and efficiently and arrive at a consensus opinion,” Grotzinger says. “I would say it’s simply an issue of signal to noise. If the geological signal of the process is large enough, it’s very easy to build consensus.”

On the other hand, what if Curiosity rolls up to the unexpected, something that has no earthly analogs or is hard to analyze? “I think if you’re working with a robot—and a very large team—it becomes very difficult to reach consensus. Therefore, there’s really no substitute for a human when it comes to exploring very complex situations. The triage that you can do mentally as you pass your judgment over the options and command yourself to walk to different places and make different measurements is really the compelling reason for wanting to do human exploration. It’s just so much more efficient, and you probably will arrive at conclusions that are more likely to be correct than if you had just a robot,” Grotzinger responds.

“But it’s the same problem you’d go through as an individual saying, ‘Do I have enough water, or do I need to go back to the car and refill my water bottle before I go up there?’ So we’re always doing the optimization…there’s always a compromise in terms of how far you go versus the geology you achieve,” he adds.

According to Paul Spudis, senior staff scientist at the Lunar and Planetary Institute (LPI) in Houston, Texas, the extent to which true telepresence is needed for effective geological exploration is unclear. “This is a result of both the lag in telepresence technology—for example, very high bandwidth visual and tactile sensory systems—and our poor understanding of what the field experience entails from a human cognitive viewpoint.”

Spudis says his experience with using remote systems to conduct geology has been less than edifying. “I note both poor situational awareness and a significant diversion of concentration on technical means of the human-robot interface versus conducting surface exploration. In other words, as a replacement for human field exploration, it leaves a lot to be desired.”

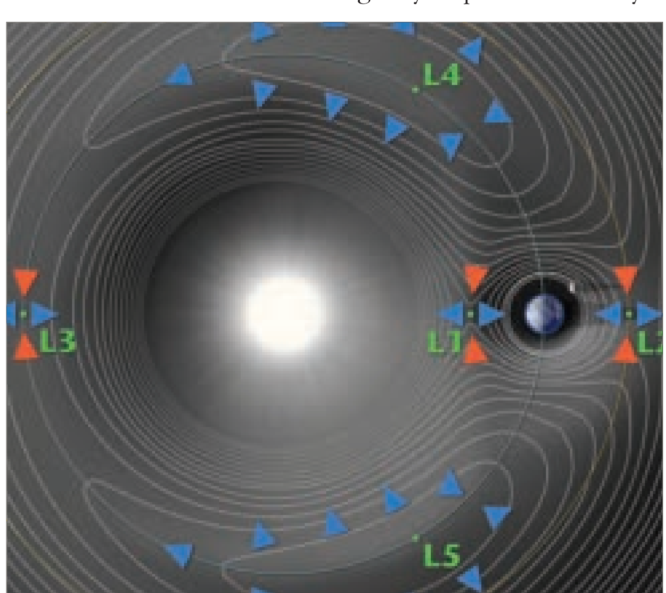
NASA’s Curiosity drives up a ramp during a test at JPL on September 10, 2010. The rover uses a rocker bogie suspension system to drive over uneven ground. Image Credit: NASA/JPL-Caltech.

Libration point practice

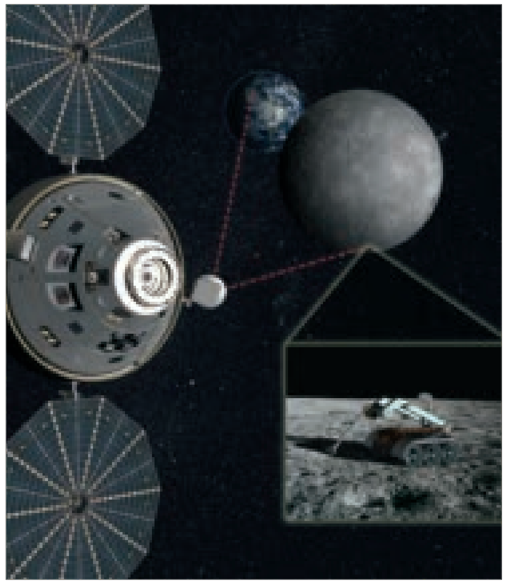
There are new studies under way to use an Earth-Moon Lagrange point (E-M L2) to conduct human-controlled telepresence exploration on the lunar landscape.

Last February, NASA’s William Gerstenmaier, associate administrator for human exploration and operations, requested that a team be formed to develop a ‘cohesive’ exploration concept aimed at the E-M L2 spot in space. Libration or Lagrange points are places in space where the combined gravitational pull of two large masses roughly balance each other out, allowing spacecraft to essentially ‘park’ using minimal amounts of propellant.

An earlier appraisal of E-M L2, which is near the lunar far side, labeled this destination the ‘leading option’ for a near-term exploration capability. E-M L2 could serve as a gateway for capability-driven exploration of destinations such as near-lunar space, the Moon, asteroids, the moons of Mars and, ultimately, Mars itself. This capabilities-driven NASA architecture is one that should use the agency’s Space Launch Sys-



Studies are under way to use an Earth-Moon Lagrange point to conduct human-controlled telepresence exploration on the Moon.

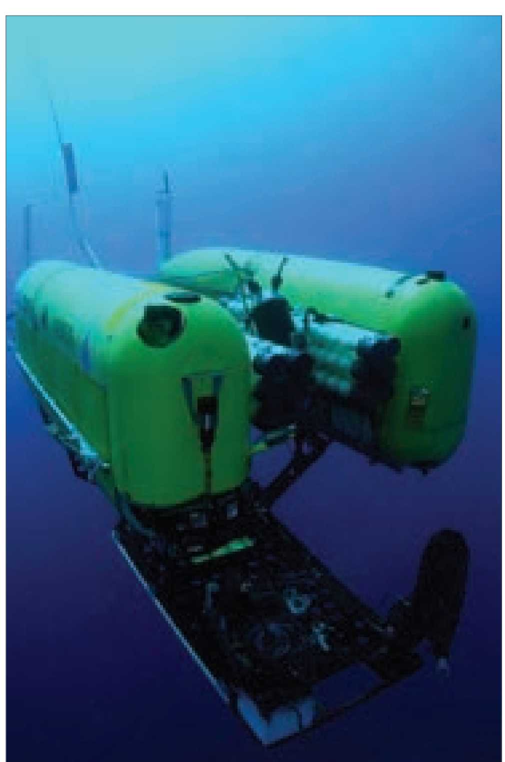


An artist's depiction shows the Earth and Moon as they would appear from an L2 halo orbit reached by an Orion spacecraft. From that site, astronauts would control robotic hardware on the surface. Now under way are discussions on building up a human-tended habitat at the Earth-Moon L2 location to enable telerobotic activities on the lunar surface. Credit: Lockheed Martin.

tem and the Lockheed Martin-built Orion multipurpose crew vehicle "as the foundational elements."

Planners at Lockheed Martin Space Systems in Denver have blueprinted a plan using Orion to support an E-M L2 far-side Moon mission that would permit an astronaut crew to have continuous line-of-sight visibility to the entire far side of the Moon and to Earth.

Josh Hopkins, a Lockheed Martin space exploration architect, says that, from a halo orbit around that L2 point, a crew could control robots on the lunar surface. Teleoperated science tasks include snagging rock specimens for return to Earth from the Moon's South Pole-Aitken basin and robotically unfurling a low-frequency array of radio antennas to observe the first stars in the early universe. The E-M L2 outing would be a stepping stone toward treks to asteroids, and toward human missions to the moons of Mars in later years, he advises.



The Nereus underwater robot investigates hydrothermal vents along Earth's deepest mid-ocean ridge in the Cayman Trough. This unique vehicle can operate either as an autonomous, free-swimming robot for wide-area surveys, or as a tethered vehicle for close-up investigation and sampling of seafloor rocks and organisms. Credit: Advanced Imaging and Visualization Laboratory, Woods Hole Oceanographic Institution.

A Lockheed Martin white paper provided to *Aerospace America* on the E-M L2 proposal cites a number of benefits that would evolve from such an effort:

- Astronauts on an L2/far-side mission would travel 15% farther from Earth than did the Apollo astronauts—and spend almost three times longer in deep space.
- Each flight would prove out Orion's life support systems for one-month missions before attempting a six-month-long asteroid mission.
- It would demonstrate the high-speed reentry capability needed for return from the Moon or deep space—40-50% faster than reentry from LEO.
- The mission would measure astronauts' radiation dose from cosmic rays and solar flares to verify that Orion provides sufficient protection. Currently the medical effects of deep space radiation are not well understood, so a one-month mission would improve our understanding without exposing astronauts to excessive risk.

Meanwhile, NASA strategic space planners also foresee that an E-M L2 waypoint would facilitate assembly and servicing of satellites and large telescopes, among a host of other benefits. As Lockheed Martin notes, if an astronaut-tended E-M L2 waypoint were established, it would also represent the farthest distance travelled by humans since the Apollo 17 Moon landing in 1972. Extended stays at E-M L2 require advances in life sciences and radiation shielding for crews that sojourn outside the protection of Earth's Van Allen radiation belts.

In a memo written last year, Gerstenmaier added that E-M L2 "is a complex region of cislunar space that has certain advantages as an initial staging point for exploration, but may also have some disadvantages that must be well understood."

Testing from ISS

Jack Burns, director of the LUNAR (Lunar University Network for Astrophysics Research) Center at the University of Colorado, Boulder, has been spearheading an

E-M L2 exploration and science mission concept using Orion and a teleoperated lander/rover.

Burns is working with NASA Ames to use its K10 rover to simulate deployment of polyimide film antennas as they would be unfurled on the Moon's far side. That activity, scheduled for later this year, would be linked to astronauts onboard the ISS who would teleoperate the Ames-situated K10 to stretch out antennas via control from space. At the Moon, using astronauts positioned at the E-M L2 site, the polyimide film would be unrolled to form the array. The far-side-deployed antennas would then be electronically phased to produce a sensitive radio interferometer that would conduct cosmological investigations in silent solitude, free of the buzz and static emitted on Earth.

The use of astronauts at L-2 to teleoperate surface robots on the far side of the Moon is possible, but offers no real advantage over controlling them from Earth, says LPI's Spudis. Much is made of the latency factor or time delay, but the specific tasks envisioned for this mission—retrieval of a kilogram of lunar rock and soil, and the surface layout of the radio dipole antenna for astronomy—can be easily accomplished by time-delayed teleoperation, he argues.

Spudis says he has no problem with using the L-points, "but they are means to an end, not an end unto themselves." Unless you are on the Moon cranking out propellant for export, you are not creating new spaceflight capability. Rather, you are just checking a box in an attempt to make people think you are accomplishing something, he asserts.

"I actually think these telerobotic initiatives are very exciting, and can increase exploration efficiency considerably. I do not want to appear to be opposed to them," notes Ian Crawford of the Department of Earth and Planetary Sciences at Birkbeck College, University of London. However, he adds, they will not be as good as having people on planetary surfaces, where this is possible, for several reasons. First, teleoperated vehicles are unlikely to be as versatile or nimble as human explorers. Second, the various life sciences investigations that have been proposed for the lunar surface cannot be done telerobotically, because humans are the test subjects!

ESA astronaut Christer Fuglesang works with an exoskeleton in the robotics lab at ESTEC. This wearable robot—a combination of arm and glove with electronic aids to reproduce the sensations a human hand would feel—enables a remote operator to work as though he were at a distant site. With haptic telepresence, which adds the sense of touch, anyone purportedly can operate a robot without training. Credit: ESA, J. v. Haarlem.

Most important, Crawford says, is that "to make them cheap, telerobots are likely to be left on the planetary surface when their mission ends. But this means that geological samples are less likely to be returned, which was a major benefit of the manned Apollo missions. Since the astronauts had to come back, they could bring soil and rock samples back with them."

Low latency telepresence

James Garvin, chief scientist at NASA Goddard, helped chair last May's Exploration Telerobotics Symposium. The lessons he took away were many. They include some specific examples where a low latency telepresence on a planetary or asteroidal surface could permit the level of situational awareness and in-situ cognition needed for

Why explore via telepresence?

•EDL (entry, descent, and landing) and subsequent ascent are risky and expensive. The last 100 km can be the hardest part of a trip to a planetary surface, the return takeoff equally difficult.

•Low latency, advanced robotics, and high communication bandwidth are independently enabling and important to apply. Together, they provide a powerful new capability in human exploration.

•Key technologies for low latency telerobotics are at hand, or will be in the near future.

•Human surface exploration requires environmental control and life support systems that are different from in-space systems proven on ISS—and entails greater expense if humans operate within gravity wells.

•Surfaces of other worlds present contamination issues such as dust and toxicity. These complicate human operations involving items such as pressure seals for EVA suits and habitats.

•Human explorers can be in only one place at a time at an exploration site.

•Radiation issues make planetary surfaces potentially harmful to humans and may also be very expensive to ameliorate.

•Remote telepresence opens up possible destinations (Venus, Mercury, Io, and Titan, for example) that humans may never directly visit because of surface conditions such as heat and pressure.

•Space-based telepresence can build on terrestrial experience and capabilities, extending field science to new places 'as if we were there,' beyond the scope of high latency robots such as Spirit, Opportunity, and Curiosity.

Adapted from findings of the Exploration Telerobotics Symposium held May 2-3 at NASA Goddard. Courtesy of Azita Valinia , Harley Thronson, Jim Garvin, and George Schmidt (NASA/Goddard); and Dan Lester (University of Texas).

Telerobotic control from ISS

A test slated for later this year is designed to develop an ISS-to-ground interface for telerobotic control, to be staged by ESA's Multi-Purpose End-To-End Robotic Operation Network (METERON). This experiment and architecture are keyed to validating future human-robotic mission operations concepts from space, using the ISS. André Schiele, founder in 2011 of ESA's Telerobotics and Haptics Laboratory, is leading the effort.

In the first METERON tests, station astronauts will operate ESA's Eurobot prototype from a computer equipped with special screens and a joystick. In the next phase, the engineers will allow astronauts to control a robot that has the sense of force and of 'touch.' It can be connected to robots like Justin, developed by the German Aerospace Center, DLR.

These senses will give astronauts "a real feeling of the forces that the arms of the robots are experiencing in their environment," says Schiele.

"The space station is the perfect orbital platform to simulate very realistic scenarios for human exploration," says Kim Nergaard, ESA's METERON ground segment and operations manager. "First we have to set up a robust communication architecture, establish an operations system, and define a protocol to allow astronauts, robots, and our ESA control center to work efficiently together. This is not as easy a task as it seems," he reports.

What these efforts will accomplish is to prove out at least the basic operational and communication concepts and protocols for on-orbit telerobotics, which may be used for work on the lunar or Martian surface, with control from human operators in orbit above, observes Dan Lester of the University of Texas in Austin. "It is an important first step for this kind of work, and makes excellent use of the ISS."

That strategy, however, does have some disadvantages, Lester adds.

"In order to achieve very low latency, you can't go through the Tracking and Data Relay Satellite System, which is what ISS uses for most of its data communications. You need a direct-to-ground link. But the problem with that is that such linkages are only possible when you're flying overhead. So for a given single ground receiving antenna, you'll only get 5-10 minutes of connect-time… maybe once a day. So while you can prove the operational concepts and protocols, you sure won't be able to exercise them very much," Lester notes. "That's why telerobotic control from ISS won't really completely prove out strategies for on-orbit telerobotics at Mars. Doing work from Earth-Moon L1 or L2 on the lunar surface will be far more instructive in this regard."

One could ask why one even needs to practice telerobotic control from ISS and not just do it from the next room?

There are several reasons, says Lester. First, the communication strategy is an important one. Orbit-to-ground communication is challenging, in an error-and-delay-tolerant mode. Second, it turns out that carrying out telerobotic control in 0-g is not quite like operating it in 1-g. That is, operating a joystick properly is really helped by having your arm gravitationally 'grounded.' Furthermore, it is not completely clear how good a sense of telerobotic control one has for a vehicle in a gravity well, done from a control station in 0-g. "Your brain isn't quite 'thinking' gravity anymore," he says.

advanced scientific investigations involving the highest priorities in planetary science. "But more work is needed to develop specific scenarios by which they could be implemented," he suggests.

For the near term, Garvin proposes, a continued dialogue among scientists, technologists, engineers, and experienced terrestrial telerobotics/telepresence experts is needed. More workshops, perhaps virtual ones, could help develop specific activities, experiments, studies, and investments to refine the key questions and capability gaps associated with space-based low latency telepresence in specific locations and for particular purposes.

The K10 planetary rover has four-wheel drive and all-wheel steering on a passive rocker suspension, a design that allows operation on moderately rough terrain.

On the science side, Garvin stresses, "There is a profound lack of real experience with low latency telepresence here on Earth, in geological field situations, with which to understand how to utilize the obvious benefits of this approach on the Moon, Mars, asteroids, or beyond." This experience gap limits our understanding of how to develop the engineering and technology capabilities required for using low latency telepresence in deep space field science.

Garvin senses that there is "bona fide enthusiasm" for low latency telepresence as part of a "flexible path" approach for deep space human exploration. Indeed, human spaceflight can provide significant field science and other activities at new destinations without having to initially place human boots on the ground.

Clearly there are settings and environments where human field explorers on other worlds *should never go*, Garvin emphasizes. In such places, even very local low latency telepresence operations, with robots there and people in nearby safe havens, could be essential.

"My general feeling is that low latency telerobotics is a critical capability that must be investigated so that future human-robotic scientific activities can open up new frontiers in our scientific understanding of Mars, the Moon, asteroids, Venus, and other targets of exploration opportunity," Garvin concludes.

Recovery
(Continued from page 31)

Columbia's Final Flight: STS-107

The STS-107 crew (l-r): Mission Specialist David M. Brown, Mission Commander Rick D. Husband, Mission Specialist Laurel Blair Salton Clark, Mission Specialist Kalpana Chawla, Payload Commander Michael P. Anderson, Mission Pilot William C. McCool, and Payload Specialist Ilan Ramon. Credit: NASA.

Note: For information on the Columbia Research and Preservation Office, visit ***http://columbia.nasa.gov***

that helped to prove that a piece of insulating foam from the large exterior fuel tank of the shuttle system had broken free 82 seconds after launch and struck the leading edge of the orbiter's left wing.

The final CAIB conclusion was that the foam impacted panel 8 of the RCC thermal protection system on the orbiter's leading edge. That anomaly permitted the penetration of hot reentry gases and led to the loss of Columbia and its crew. The impact against RCC panel 8 produced a hole in the panel roughly 16x16 in. Analysts estimated that a hole 10 in. across could have caused a loss of the orbiter on reentry.

During Columbia's fatal return to Earth, superheated air entered the leading-edge insulation and progressively melted the aluminum structure of the left wing, until increasing aerodynamic forces led to loss of control, failure of the wing, and disintegration of the orbiter.

"We stated very explicitly what happened," Hubbard says. The test put an exclamation point or period to our physical cause statement. There are no disclaimers in there. There's no 'most probable'… there's no 'we believe that.'"

There are risks that go with space travel, Hubbard emphasizes. "It's a 'one strike and you're out' business. It's very unforgiving. I think one of the principal lessons from Columbia was that organizations that attempt to do very bold and potentially risky things need to be learning organizations."

Beware the new normal

Ciannilli also points to lessons learned. "We learned that we didn't understand some of the hardware as well as we thought we did. Some of our testing was based on data from 25 or 30 years earlier. That data and modeling were not as complete and as accurate as we thought," he says. "As the flight history went on and different experiences were gained over 30 years, we didn't really update all the models."

Some of CAIB's findings clearly show that there is a need to "watch your data," Ciannilli says. "Keep things updated. Keep vigilant on what your data is really telling you. Off-nominal things can, over time, look normal. Keep an eye on those things that aren't good that creep into becoming 'the new normal.'"

For Ciannilli the experience gained in tending the Columbia Research and Preservation Office leads to a central observation: "There's so much to share, so much to learn, and so much to grow from," he says.

25 Years Ago, February 1988

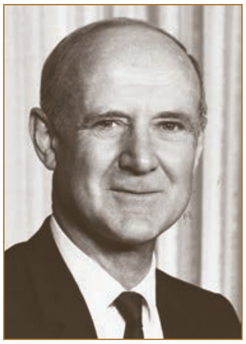
Feb. 3 The Air Force launches a 1,650-lb F-9 meteorological satellite into orbit from Vandenberg AFB. An Atlas-E rocket boosts the spacecraft, which is placed in a near-polar orbit. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 153.

Feb. 3 As part of industry-wide tests to develop more efficient airliners, McDonnell Douglas fits a large General Electric unducted turbofan to an MD-80. If the engine proves efficient and reliable, it will be incorporated into the new MD-91 and -92 series of airliners. NASA, *Astronautics and Aeronautics, 1986-1990*, p. 153.

Feb. 8 Using a Delta 181 rocket as a booster, NASA places the 3-ton Strategic Defense Initiative experimental payload into orbit from Cape Canaveral, Fla. The SDI payload consists of a sensor platform and 15 small satellites, four of which are used to simulate the upper stages of Soviet ICBMs and the rest to simulate reentering warheads. A hundred ground tracking stations follow the progress of the12-hr mission, which is deemed a successful experiment. NASA, *Astronautics and Aeronautics, 1986-1990*, pp. 153-154.

50 Years Ago, February 1963

Feb. 1 The American Institute of Aeronautics and Astronautics is officially formed with the merger of the American Rocket Society (established in 1930) and the Institute of the Aerospace Sciences (founded in 1932). AIAA thereby becomes the country's largest professional aerospace organization. The merger has come about after a year of study and debate. New Zealand-born William H. Pickering, director of JPL, becomes AIAA's first president. D. Daso, *U.S. Air Force: A Complete History*, p. 427; *Astronautics and Aerospace Engineering*, February 1963, p. 19.



Feb. 4 The first helicopter landings at the South Pole are made by three Bell Iroquois aircraft of the Navy. Assigned to the Sixth Air Development Squadron, which has been operating in the Antarctic for eight years, the helicopters were sent to the South Pole for a topographical survey of Mount Weaver. *Flight International*, Feb. 21, 1963, p. 249.

Feb. 4-6 McDonnell F-4B fighters and an aircraft carrier are successfully used off the New Jersey coast in tests of the first fully automated airborne intercept system. The Navy-Grumman E-2A Hawkeye airborne early warning and combat intercept control system is designed to operate from aircraft carriers and can detect distant targets. With no voice transmission of any kind, the system directs the F-4Bs to intercept and attack targets. *Aviation Week*, Feb. 25, 1963, p. 30.

Feb. 6 The first Titan 2 ICBM to be launched by an all-USAF crew is fired from Cape Canaveral, Fla., and carries a General Electric MK 6 reentry vehicle, the heaviest in the Air Force's current inventory, to a range of more than 6,500 mi. The crew consists of nine officers and 63 airmen. *Aviation Week*, Feb. 11, 1963, p. 37.

Feb. 8 Britain's Hawker Aircraft P-1127 VTOL jet strike fighter completes the first-ever vertical takeoff and landing test aboard the carrier Ark Royal. It is the first aircraft other than a helicopter to accomplish this feat. *Washington Post*, Feb. 9, 1963; *Aviation Week*, Feb. 25, 1963, p. 100.

Feb. 9 The first Boeing 727 midsize narrowbody jet makes its maiden flight, taking off from Renton Municipal Airport near Seattle. Also the first three-jet-engine airliner, the 727 becomes very successful, with production continuing into the 1970s. This mainstay of domestic route networks is used on short- and medium-range international routes as well. Passenger, freighter, and convertible versions also are built. The initial 727 has three Pratt & Whitney JT8D turbofan engines of 14,000-lb thrust each and can carry 70-114 passengers. *The Aeroplane*, Feb. 14, 1963, pp. 12, 22.

Feb. 10 Louis Paulhan, the French aviation pioneer who in 1910 flew Le Canard, the world's first seaplane, dies at age 80 at Saint-Jean-de-Luz, France. Le Canard, built by Henri Fabre, was the first seaplane to take off from water under its own power. Paulhan had taught himself to fly in 1909 and was issued French pilot license No.10. He took part in many air shows and set numerous records, winning the *Daily Mail* Grand Prize for his London-to-Manchester flight. He served as a fighter pilot in

Past

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

Feb. 23, 1938

WW I, then became a seaplane builder, producing the first all-metal seaplane in France in 1928. *The Aeroplane*, Feb. 14, 1963, p. 30.

Feb. 11 NASA launches an Argo D-8 Journeyman four-stage solid-propellant sounding rocket from Point Arguello, Calif., up to almost 1,000 mi. It carries a 104-lb instrumented payload to probe the hazards of the radiation belts, especially from the previous year's nuclear testing. *Flight International*, March 1, 1963, p. 83.

Feb. 15 North American Aviation's YAT-S28E, a turboprop version of its T-28 trainer, makes its first flight at the company's Columbus, Ohio, division. Designed for counterinsurgency operations, the new aircraft can carry a heavy load of bombs, detachable .50-caliber machine gun pods, and wing-tip-mounted Sidewinder heat-seeking air-to-air missiles. *Aviation Week*, Feb. 25, 1963, p. 34.

Feb. 18 Transit 5A, the prototype of the Navy's operational navigation satellite, is launched into a polar orbit by a four-stage solid-propellant Blue Scout launch vehicle from the Naval Missile Facility at Point Arguello, Calif. However, the Transit's radio fails after 20 hr in orbit, although secondary experiments are successful. *United States Naval Aviation 1910-1980*, p. 248.

75 Years Ago, February 1938

Feb. 1 The Dutch East Indian air force is transformed into an independent body and coordinated to the army and navy of The Netherlands. *Interavia*, Feb. 1, 1938, p. 9.

Feb. 14 For the first time in history a full-sized aircraft, the Focke-Wulfe Fw-61 helicopter, is flown inside a building. The vehicle is piloted by Hanna Reitsch in the Deutschland Halle in Berlin's Sports Palace. Interavia, Feb. 17, 1938, p. 8; A. van Hoorebeeck, *La Conquete de L'Air*, p. 311.

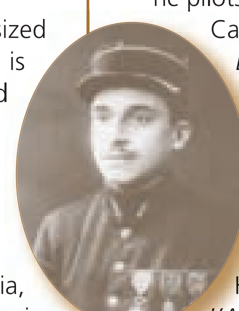
Feb. 15 Six four-engined Boeing Y1B-17 bombers depart Langley Field, Virginia, for Miami, whence they fly via Lima to Buenos Aires for the inaugural ceremonies of President Roberto Ortiz. The goodwill flight is also an opportunity to display the new U.S. flying equipment being tested in the long-range mission. From Buenos Aires, the aircraft proceeds to other South American capitals. *Interavia*, Feb. 17, 1938, p. 15.

Feb. 23 Two aircraft joined together to form the Short-Mayo composite aircraft are successfully separated in flight over Rochester, Kent, England. The lower, or carrier, plane is the flying boat Maia, while the top machine is the seaplane Mercury. The plan is to have the composite craft, Maia, fly as far as it can go and then release the Mercury to continue across the Atlantic with its load of mail. The experiment is one approach to long-range air mail flight. L. Payne, *Air Dates*, p. 75.

100 Years Ago, February 1913

Feb. 3 French aviator Marc Pourpe organizes the first flight in Singapore when his partner Georges Verminck flies their Bleriot. A. van Hoorebeeck, *La Conquete de L'Air*, p. 98.

Feb. 8 Lt. John Towers reports that the Navy's aviation element, which is currently stationed at Guantanamo Bay, Cuba, is making good progress in developing the techniques for bombing, aerial photography, and wireless communication. Especially impressive to Towers is the accuracy with which the group has been able to drop bombs while using a sight developed by one of the pilots. *United States Naval Aviation: 1910-1970*, p. 7.



Feb. 20 Marc Pourpe completes the first aerial voyage in Indochina when he pilots his Bleriot from Saigon to Cape Saint-Jacques, Vietnam. *L'Opinion*, a journal published in Saigon, includes a congratulatory editorial by M. Garros, a lawyer and father of famous French aviator Roland Garros. A. van Hoorebeeck, *La Conquete de L'Air*, p. 98.

Feb. 26 The chief constructor of the Navy approves the building of the service's first wind tunnel, to be located at the Washington Navy Yard. *United States Naval Aviation: 1910-1970*, p. 7.

University of Colorado
Boulder

Aerospace Engineering Sciences

The Department of Aerospace Engineering Sciences at the University of Colorado Boulder invites applications for a tenure-track faculty position in the Bioastronautics focus area. Applicants are sought with expertise in the field of human spaceflight research including, but not limited to, human spacecraft design and analysis, life support systems, spacesuit technologies, and biomedical countermeasures for long duration spaceflight. Familiarity with NASA and international space programs, as well as with the emerging commercial spaceflight sector under the purview of the FAA, is desired.

Candidates will be considered at the Assistant, Associate or Full Professor level, commensurate with experience. Applicants should demonstrate the potential for establishing a robust research program, excelling at teaching aerospace engineering courses, and mentoring undergraduate and graduate students.

Opportunities for collaboration exist with the BioServe Space Technologies Center and the FAA Center of Excellence for Commercial Space Transportation, both housed in the Aerospace department. Applicants are also encouraged to pursue multidisciplinary interests across the department, college and campus, and to establish interactions with the various space-related companies in the Boulder/ Denver area and across the nation.

The duties of this position include teaching, research and service to the university and professional community. A Ph.D. in an appropriate engineering or science field is required. For more information about the department, please visit http://www.colorado.edu/aerospace.

Applicants should electronically submit their application to job posting #815811 on www.jobsatcu.com, including their Curriculum Vitae, statements of research and teaching interests, and the names and contact information of four references. Address the cover letter to Prof. David Klaus, Search Committee Chair, Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO 80309-0429. Applications will be considered starting March 1, 2013.

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Faculty Positions

Department of Aerospace Engineering

The Department of Aerospace Engineering at Embry-Riddle Aeronautical University in Daytona Beach, Florida, invites applications for several tenure-track faculty positions at the ranks of Assistant, Associate, and Full Professor. The positions commence in January 2013 or August 2013. The department offers Bachelor's and Master's degrees in Aerospace Engineering. A Ph.D. program will begin in Fall 2013. The undergraduate program is the nation's largest with about 1300 full-time students and has been ranked at the top of its category by *U.S. News and World Report* for the past twelve years. In the past five years the Department has been focused on expanding its graduate programs, the research facilities, launching a doctoral program, and recruiting top talent with the goal of becoming one of the leading aerospace engineering departments in the nation.

Successful candidates for the Assistant Professor rank should demonstrate a potential to establish and grow a strong research program and to excel at teaching and mentoring undergraduate and graduate students. Successful applicants for Associate Professor and full Professor rank should have an exemplary record of teaching and scholarly activities including externally funded research.

An earned doctorate in Aerospace Engineering or a closely related field is required. Industrial experience and design experience are highly desirable. Rank and salary will be commensurate with qualifications. Women and underrepresented minorities are especially encouraged to apply. Applicants must submit a cover letter, curriculum vitae, a detailed research and teaching plan and the names of at least three references. Please submit these materials by applying online to www.erau.edu/jobs. Search for Faculty positions in Daytona Beach, FL, and reference IRC49067.

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AIAA Bulletin

Inside the Astrotech payload processing facility near NASA's Kennedy Space Center in Florida, the Tracking and Data Relay Satellite, TDRS-K, is being checked out prior to being encapsulated inside the Atlas V payload faring in preparation for launch.

The TDRS-K spacecraft is part of the next-generation series in the Tracking and Data Relay Satellite System, a constellation of space-based communication satellites providing tracking, telemetry, command and high-bandwidth data return services. Launch of the TDRS-K on the Atlas V rocket is planned for 29 January 2013. (*Image credit: NASA/Jim Grossmann*)

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

Meeting Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
2013				
10–14 Feb†	**23rd AAS/AIAA Space Flight Mechanics Meeting**	Kauai, HI	*May 12*	**1 Oct 12**
2–9 Mar†	**2013 IEEE Aerospace Conference**	Big Sky, MT (Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org)		
19–20 Mar	**Congressional Visits Day**	Washington, DC (Contact Duane Hyland, duaneh@aiaa.org)		
25–27 Mar†	**3AF-48th International Symposium of Applied Aerodynamics Aerodynamics of Small Bodies and Details**	Saint-Louis, France (Contact: Anne Venables, secr.exec@aaafasso.fr, www.3af-aerodynamics2013.com)		
25–28 Mar	**22nd AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar** (Dec) **AIAA Balloon Systems Conference** **20th AIAA Lighter-Than-Air Systems Technology Conference**	Daytona Beach, FL	*May 12*	**5 Sep 12**
8–11 Apr	**54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **21st AIAA/ASME/AHS Adaptive Structures Conference** **15th AIAA Non-Deterministic Approaches Conference** **14th AIAA Dynamic Specialist Conference** **14th AIAA Gossamer Systems Forum** **9th AIAA Multidisciplinary Design Optimization Conference**	Boston, MA	*Apr 12*	**5 Sep 12**
10–12 Apr†	**EuroGNC 2013, 2nd CEAS Specialist Conference on Guidance, Navigation and Control**	Delft, The Netherlands (Contact: Daniel Choukroun, d.choukroun@tudelft.nl, www.lr.tudelft.nl/EuroGNC2013)		
15–19 Apr†	**2013 IAA Planetary Defense Conference**	Flagstaff, AZ (Contact: William Ailor, 310.336.1135, william.h.ailor@aero.org, http://www.pdc2013.org)		
23–25 Apr†	**Integrated Communications Navigation and Surveillance 2013**	Herndon, VA (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.i-cns.org)		
8 May	**2013 Aerospace Spotlight Awards Gala**	Washington, DC		
13–16 May	**Reinventing Space Conference**	Los Angeles, CA (Contact James Wertz, jwertz@smad.com; www.reinventingspace.org)		
15–17 May†	**Seventh Argentine Congress on Space Technology**	Mendoza, Argentina (Contact: Pablo de Leon, 701.777.2369, Deleon@aate.org, www.aate.org)		
27–29 May	**19th AIAA/CEAS Aeroacoustics Conference (34th AIAA Aeroacoustics Conference)**	Berlin, Germany	*Jul/Aug 12*	**31 Oct 12**
27–29 May†	**20th St. Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia (Contact: Prof. V. Peshekhonov, +7 812 238 8210, icins@eprib.ru, www.elektropribor.spb.ru)		
29–31 May†	**Requirements for UTC and Civil Timekeeping on Earth: A Colloquium Addressing a Continuous Time Standard**	Charlottesville, VA (Contact: Rob Seaman, 520.318.8248, info@futureofutc.org, http://futureofutc.org)		
6 Jun	**Aerospace Today ... and Tomorrow: Disruptive Innovation, A Value Proposition**	Williamsburg, VA (Contact: Merrie Scott: merries@aiaa.org)		
12–14 Jun†	**6th International Conference on Recent Advances in Space Technologies (RAST 2013)**	Istanbul, Turkey (Contact: Suleyman Basturk, rast2013@rast.org.tr, www.rast.org.tr)		
17–19 Jun†	**2013 American Control Conference**	Washington, DC (Contact: Santosh Devasia,devasia@u.washington.edu,http://a2c2.org/conferences/acc2013)		
24–27 Jun	**43rd AIAA Fluid Dynamics Conference and Exhibit** **44th AIAA Plasmadynamics and Lasers Conference** **44th AIAA Thermophysics Conference** **31st AIAA Applied Aerodynamics Conference** **21st AIAA Computational Fluid Dynamics Conference** **5th AIAA Atmospheric and Space Environments Conference** **AIAA Ground Testing Conference**	San Diego, CA	*Jun 12*	**20 Nov 12**
14–17 Jul	**49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit** **11th International Energy Conversion Engineering Conference (IECEC)**	San Jose, CA	*Jul/Aug 12*	**21 Nov 12**
14–18 Jul	**43rd International Conference on Environmental Systems (ICES)**	Vail, CO	*Jul/Aug 12*	**1 Nov 12**
11–15 Aug†	**AAS/AIAA Astrodynamics Specialist Conference**	Hilton Head Island, SC (Contact: Kathleen Howell, 765.494.5786, howell@purdue.edu, www.space-flight.org/docs/2013_astro/2013_astro.html)		

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
12–14 Aug	**AIAA Aviation 2013: Charting the Future of Flight** **Continuing the Legacy of the AIAA Aviation Technology, Integration, and Operations (ATIO) Conference and Featuring the 2013 International Powered Lift Conference (IPLC) and the 2013 Complex Aerospace Systems Exchange (CASE)**	Los Angeles, CA	*Oct 12*	**28 Feb 13**
19–22 Aug	**AIAA Guidance, Navigation, and Control Conference** **AIAA Atmospheric Flight Mechanics Conference** **AIAA Modeling and Simulation Technologies Conference** **AIAA Infotech@Aerospace Conference**	Boston, MA	*Jul/Aug 12*	**31 Jan 13**
10–12 Sep	**AIAA SPACE 2013 Conference & Exposition**	San Diego, CA	*Sep 12*	**31 Jan 13**
6–10 Oct†	**32nd Digital Avionics Systems Conference**	Syracuse, NY (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)		
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)	
2014				
13–17 Jan	**AIAA SciTech 2014** **(AIAA Science and Technology Forum and Exposition 2014)** Featuring **22nd AIAA/ASME/AHS Adaptive Structures Conference, 2nd AIAA Aerospace Sciences Meeting, 15th AIAA Gossamer Systems Forum, AIAA Guidance, Navigation, and Control Conference, AIAA Infotech@Aerospace Conference, 28th Microgravity Symposium on Gravity-Related Phenomena in Space Exploration, 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, 16th Weakly Ionized Gases Workshop, 32nd ASME Wind Energy Symposium**	National Harbor, MD		**5 Jun 13**
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)		
26–28 May	**21st St. Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia (Contact: Prof. V. Peshekhonov, +7 812 238 8210, icins@eprib.ru, www.elektropribor.spb.ru)		
16–20 Jun	**AVIATION 2014** **(AIAA Aviation and Aeronautics Forum and Exposition)** Featuring **20th AIAA/CEAS Aeroacoustics Conference, 23rd AIAA Aerodynamic Decelerator Systems Technology Conference, 30th AIAA Aerodynamic Measurement Technology Conference, AIAA/3AF Aircraft Noise and Emissions Reduction Symposium, 32nd AIAA Applied Aerodynamics Conference, AIAA Atmospheric Flight Mechanics Conference, 6th AIAA Atmospheric and Space Environments Conference, 14th AIAA Aviation Technology, Integration, and Operations Conference, AIAA Balloon Systems Conference, 22nd AIAA Computational Fluid Dynamics Conference, AIAA Flight Testing Conference, 7th AIAA Flow Control Conference, 44th AIAA Fluid Dynamics Conference, AIAA Ground Testing Conference, 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference, 21st AIAA Lighter-Than-Air Systems Technology Conference, 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, AIAA Modeling and Simulation Technologies Conference, 45th AIAA Plasmadynamics and Lasers Conference, 45th AIAA Thermophysics Conference**	Atlanta, GA		**12 Nov 13**
28–30 Jul	**Propulsion and Energy 2014** **(AIAA Propulsion and Energy Forum and Exposition)** Featuring **50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 44th International Conference on Environmental Systems, 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 **23rd AIAA Aerodynamic Decelerator Systems Technology Conference, 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**

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

AIAA Courses and Training Program

DATE	COURSE	VENUE	LOCATION
2013			
1 Feb–30 Jun	**Introduction to Computational Fluid Dynamics**	Home Study	
1 Feb–30 Jun	**Advanced Computational Fluid Dynamics**	Home Study	
1 Feb–30 Jun	**Computational Fluid Turbulence**	Home Study	
1 Feb–30 Jun	**Introduction to Space Flight**	Home Study	
1 Feb–30 Jun	**Fundamentals of Aircraft Performance and Design**	Home Study	
7 Feb	**Introduction to Bio-Inspired Engineering**	Webinar	
13 Feb	**CADAC++ Framework for Aerospace Simulations**	Webinar	
28 Feb–1 Mar	**Mathematical Introduction to Integrated Navigation Systems, with Applications**	The AERO Institute	Palmdale, CA
28 Feb–1 Mar	**Optimal State Estimation**	The AERO Institute	Palmdale, CA
4–5 Mar	**Modeling Flight Dynamics with Tensors**	National Aerospace Institute	Hampton, VA
20 Mar	**Risk Analysis and Management**	Webinar	
3 Apr	**UAV Conceptual Design Using Computer Simulations**	Webinar	
6–7 Apr	**Advanced Composite Structures**	SDM Conferences	Boston, MA
6–7 Apr	**Basics of Structural Dynamics**	SDM Conferences	Boston, MA
15–16 Apr	**A Practical Introduction to Preliminary Design of Air Breathing Engines**	The Ohio Aerospace Institute	Cleveland, OH
15–16 Apr	**Computational Heat Transfer (CHT)**	The Ohio Aerospace Institute	Cleveland, OH
24 Apr	**Space Radiation Environment**	Webinar	
10–11 Jun	**Introduction to Spacecraft Design and Systems Engineering**	The Ohio Aerospace Institute	Cleveland, OH
10–11 Jun	**Aircraft and Rotorcraft System Identification: Engineering Methods and Hands-on Training Using CIFER®**	The Ohio Aerospace Institute	Cleveland, OH
22–23 Jun	**Fundamentals of Hypersonic Aerodynamics**	Fluids Conferences	San Diego, CA
22–23 Jun	**Verification and Validation in Scientific Computing**	Fluids Conferences	San Diego, CA
18–19 Jul	**Liquid Propulsion Systems—Evolution and Advancements**	Joint Propulsion Conference	San Jose, CA
18–19 Jul	**A Practical Introduction to Preliminary Design of Air Breathing Engines**	Joint Propulsion Conference	San Jose, CA
18–19 Jul	**Missile Propulsion Design and System Engineering**	Joint Propulsion Conference	San Jose, CA
29–30 Jul	**Introduction to Space Systems**	National Aerospace Institute	Hampton, VA
29–30 Jul	**Phased Array Beamforming for Aeroacoustics**	National Aerospace Institute	Hampton, VA
29–30 Jul	**Turbulence Modeling for CFD**	National Aerospace Institute	Hampton, VA
11 Sep	**Missile Defense: Past, Present, and Future**	Webinar	
23–24 Sep	**Gossamer Systems: Analysis and Design**	The AERO Institute	Palmdale, CA

**Courses subject to change*

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From the Corner Office

THE INSTITUTE IN THE YEAR OF THE SNAKE

Klaus Dannenberg, Deputy Executive Director

I am not a big believer in horoscopes, but I happened to see that 2013 is the Year of the Snake according to the Chinese Lunar calendar. So I examined our future according to the Chinese astrologers. Their astrological overview indicates that AIAA will confront many tests this year and that we should learn much from these tests and difficulties—but our Lucky Star will help us. Further, we need to focus on developing ourselves to achieve great things in our work. Although the skeptic in me thinks the astrologers were pretty smart to have the horoscopes generic enough to apply to everybody in every situation, I also thought this horoscope appropriately describes our ongoing changes in our conference models during the extremely challenging current conference environment.

Tests and Difficulties

To say that the current environment has been challenging with regard to gaining approval for government attendance at conferences is a gross understatement! With the yearlong threat of sequestration, planned budget cuts in discretionary accounts, and the severe conference limitations resulting from last year's GSA scandal, participation limits for events has become extremely tight, requiring approvals at the Departmental level for attendance numbers that were common a year ago. Some agencies have even implemented an agencywide ban on conference attendance. Several of our sister associations have had severe impacts on their government attendance, a few even canceling their annual meetings. Other associations are taking similar action to those that AIAA initiated several years ago—consolidating meetings and relocating them to more acceptable locations for government participation.

The Institute is taking a number of actions to preserve the content and participation at our events, and we know our membership at large is concerned about how that their conference experience is changing. Be assured that AIAA is working hard to redefine and broaden our events and the ancillary activities associated with them in a manner that will still appeal to the bulk of our membership and new emerging constituencies, while addressing the concerns raised by the governmental limitations. We want to preserve the hard-earned capabilities and reputation that we have developed over the years with regard to information exchange, networking, mentoring, and public awareness while making the events more affordable, providing higher value, and truly assuring that they are "must-attend" events for our professional communities.

A Focus on Developing Great Achievements

Although I'd like to depend on that "Lucky Star" the astrologers promised, our new Executive Director, Sandy Magnus, did not think that was a viable strategy. So we are using and integrating all of our resources to work the interrelated problems as they arise. We can thank the Institute's leadership of the past few years for embarking on our New Events Model. That revised approach, i.e., having fewer yet larger and more relevant events, has been embraced by our customers and is making it easier for our attendees to justify participation in AIAA events. In addition, we are working several other parallel efforts to explain our events and to justify participation in them to the responsible executives in each agency. Our Public Policy Committee (PPC) is working to modify legislation to soften the conference limitations for technical activities since lessons learned are most often passed on informally at events like ours. Additionally, the PPC is working with OMB to mitigate some of the severe limitations on events, by showing that our New Events Model already accomplishes much of what is desired financially while creating greater value and enhancing the effectiveness of event participants. Finally, we are supporting our client agencies with data as they each attempt to gain approvals for their own participation based on their unique situation. At this writing, a few days prior to the Aerospace Sciences Meeting (ASM), it appears that most of these efforts are bearing fruit. That's not to say there will be no impact, but in the current environment, having an ASM of roughly comparable size and consistent high quality is a pretty remarkable achievement!

I continue to be amazed at how often circumstances work out when we are prepared. By creating a focus a few years ago on adding value and enhancing our efficiencies at our events, we were ready to address these challenging situations when they arose this year. Getting acceptance of those changes has been hard, but if we had not already been transforming our events, we would have suffered more significant impacts. We have a viable approach ready to implement that addresses many of the concerns and still leverages our legacy. Nevertheless, we still want to enhance our new events. If you have additional ideas for consideration, please contact me at klausd@aiaa.org and let's talk.

On 14 November in Somers Point, NJ, **Dr. Wilson Felder** was honored at a celebration as he retired from his position as Director, FAA William J. Hughes Technical Center. From left to right: Laura McGill, AIAA Fellow and VP Standards; Michael Konyak, AIAA Associate Fellow and Southern New Jersey Section Chair; Dr. Mark Lewis, AIAA Past President and Fellow; Dr. Wilson Felder, AIAA Fellow and former VP Standards; Charles Kilgore, AIAA Southern New Jersey Section Senior Member; Scott Doucett, AIAA Associate Fellow and Southern New Jersey Section Treasurer; Roy Reichenbach, AIAA Fellow; Joseph Burns, AIAA Southern New Jersey Section Associate Fellow.

AIAA ANNOUNCES 2013 FELLOWS AND HONORARY FELLOWS

AIAA is pleased to announce the 2013 AIAA Fellows and Honorary Fellows. Presentation of the new Fellows and Honorary Fellows will take place at the AIAA Aerospace Spotlight Awards Gala, Wednesday, 8 May 2013, at the Ronald Reagan Building and International Trade Center, in Washington, DC.

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

Allen E. Fuhs, Naval Postgraduate School
William H. Gerstenmaier, NASA Headquarters
David Ian Poll, Cranfield University
David W. Thompson, Orbital Sciences Corporation

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

Edward H. Allen, Lockheed Martin Aeronautics Company
Frank H. Bauer, Emergent Space Technologies
Christina L. Bloemaum, Iowa State University
Hsiao-Hua K. Burke, Lincoln Laboratory
Wesley G. Bush, Northrop Grumman Corporation
Joaquin, H. Castro, Pratt & Whitney Rocketdyne
Ray. G. Clinton Jr., NASA Marshall Space Flight Center
Victoria L. Coverstone, University of Illinois
Frank L. Culbertson, Orbital Sciences Corporation
Basil Hassan, Sandia National Laboratories
Stephen D. Heister, Purdue University
Kathleen C. Howell, Purdue University
Laurence D. Leavitt, NASA Langley Research Center
Feng Liu, University of California at Irvine
Asad M. Madni, BEI Technologies, Inc.
Dennis A. Muilenburg, Boeing Defense, Space & Security
Jaime Peraire, Massachusetts Institute of Technology
Michael W. Plesniak, George Washington University
Andre J. Preumont, Universite Libre de Bruxelles
James D. Raisbeck, Raisbeck Engineering, Inc.
Rami R. Razouk, The Aerospace Corporation
Gwynne E. Shotwell, Space X
Friedrich K. Straub, Boeing Defense, Space & Security
Frank L. Van Rensselaer, VanRSpace
Aspi R. Wadia, GE Aviation
Steven H. Walker, Defense Advanced Research Projects Agency
Kevin. A Wise, Boeing Defense, Space & Security

AIAA President Michael Griffin stated: "Being named a Fellow of AIAA is among the highest honors that can be bestowed upon an aerospace professional, and represents recognition from colleagues and peers for significant and long-standing contributions to our community. And beyond that, recognition as an AIAA Honorary Fellow elevates one to the very pinnacle of our profession. This year's selection committee has done an outstanding job of identifying those who meet these standards. I congratulate each member of this year's class of Fellows and Honorary Fellows."

In 1933, Orville Wright became AIAA's first Honorary Fellow. Today, AIAA Honorary Fellows and AIAA Fellows are the most respected names in the aerospace industry. For more information about AIAA's Fellows and Honorary Fellows program, please contact Sonja Moore at sonjam@aiaa.org or 703.264.7537.

PROF. TIMOTHY LIEUWEN APPOINTED AS NEW EDITOR-IN-CHIEF OF PROGRESS IN ASTRONAUTICS AND AERONAUTICS SERIES

On 11 January 2013, AIAA President Michael Griffin formally appointed **Prof. Timothy Lieuwen** as the permanent editor-in-chief of the Progress in Astronautics and Aeronautics book series. Prof. Lieuwen served a one-year term as interim editor-in-chief of the series during 2012, following the retirement of Prof. Frank Lu.

Dr. Lieuwen holds a B.S. in mechanical engineering from Calvin College and M.S. and Ph.D. degrees in mechanical engineering from Georgia Institute of Technology. He is currently a professor in the School of Engineering at Georgia Tech and also serves as the executive director of the Strategic Energy Institute. A leader in combustion and propulsion research, Lieuwen's primary interests lie in clean energy and alternative fuels. Over the past decade he has sought to better understand unsteady combustor processes and the influence of alternative fuel composition on combustor operability and emissions. This work has been supported by a number of government agencies and companies, contributing to advances in power generation, propulsion, and refinery burners, and where research results have yielded several patents.

Lieuwen is a prolific conference contributor, presenter, and journal author and is known for his commitment to engineering education. He has written or edited four books, including a volume in the Progress Series, *Combustion Instabilities in Gas Turbine Engines: Operational Experience, Fundamental Mechanisms, and Modeling*, which was published in 2005. His editorial expertise extends to service as a journal associate editor for the *Journal of Propulsion and Power*, and also for journals published by the Combustion Institute and others in the fields of combustion and propulsion. Along with his contributions to the literature, Prof. Lieuwen's leadership in education is exemplified currently by his role as the education subcommittee chair for AIAA's Propellants and Combustion Technical Committee. His standing within the engineering community has been recognized many times and he is the recipient of numerous awards, including the ASME George Westinghouse Silver Medal, a National Science Foundation CAREER award, AIAA's Lawrence Sperry Award, and two ASME-IGTI Turbo Expo "Best Technical Paper" awards, among others. Prof. Lieuwen is an AIAA Associate Fellow and an ASME Fellow.

Progress in Astronautics and Aeronautics is AIAA's oldest book series. The first volume was published in 1960 in Progress in Astronautics and Rocketry, a series from the American Rocket Society; the number of volumes now exceeds 240. The series originally was intended to showcase literature derived from specialized symposia, and it continues to be devoted to books that present a particular, well-defined subject reflecting advances in aerospace science, engineering, or technology. Edited collections of papers traditionally were the hallmark of the series, but in recent years books by single authors also have found their place in the Progress Series.

To evaluate candidates and recommend a new editor-in-chief, in October 2012 AIAA Vice President of Publications Prof. Vigor Yang appointed an ad hoc search committee chaired by Michael Mendenhall, President and Chief Executive Officer of Nielsen Engineering & Research, Inc. The other search committee members were long-time advocates of the Progress Series from the publishing community within AIAA. Tim Lieuwen was selected from a competitive pool of applicants and becomes the fourth editor-in-chief of Progress in Astronautics and Aeronautics.

The first editor of the series was Martin Summerfield of Princeton University, who not only launched the series but continued to serve until 1990, overseeing the publication of 122 volumes. When presented with the opportunity to serve as editor-in-chief of the Progress Series, Lieuwen expressed excitement not only at the opportunity to make a visible contribution to the profession but also to follow in the footsteps of Prof. Summerfield. Subsequent editors were A. Richard Seebass of the University of Colorado at Boulder (1990–1995); Paul Zarchan, originally with Charles Stark Draper Laboratory and then MIT Lincoln Laboratory (1996–2004); and most recently Frank Lu of the University of Texas at Arlington (2005–2011).

Looking toward the future, Prof. Lieuwen is committed to the hard work of identifying important topics and acquiring and developing manuscripts for the series. He is excited by the new opportunities presented by e-books and other electronic content, and he intends to address emerging issues in aerospace science and technology while still maintaining the original vision and purpose of the series. There is no doubt that Tim Lieuwen's experience across academia, government, and industry, as well as his strong commitment to engineering education will contribute to the continued success of this premier book series.

SENIOR MEMBER HUEBNER GIVEN VÖLGYES AWARD

Charles Huebner, a member of CEU Business School's Advisory Board, has been honored with the Dr. Iván Völgyes Award for Promotion of Hungarian-American Business Relations by the American Chamber of Commerce in Hungary. The annual award recognizes individuals who have played an outstanding and exemplary role in developing Hungarian-American business relations over the past years. Mr. Huebner has been in Hungary since 1990 when he established, organized, staffed, and ran the operations of the Hungarian American Enterprise Fund in Budapest as its executive vice president and managing director. A member of AIAA (then the American Rocket Society) since 1958/59, Mr. Huebner was one of three officers winning the 1960 ARS award presented by Werner von Braun.

Earlier in his career Mr. Huebner worked at the U.S. Air Force and NASA's Apollo program as an officer, project engineer, and manager. Later he joined the General Electric Company as a senior staff executive responsible for businesses with revenues in excess of $10 billion.

Dr. Huebner received a Ph.D. from The American University in Washington, DC. He earned an M.S. degree in Aero and Astronautics from M.I.T. and graduated first in his class, summa cum laude, from the University of Detroit. He is an active member and a past President of AmCham.

The Dr. Iván Völgyes award was launched in 2005. Born in Hungary, Dr. Iván Völgyes moved to the United States in 1956, where he worked on John F. Kennedy's election campaign in 1959 and then followed him into the White House. After the fall of the Iron Curtain, he became instrumental in bringing numerous U.S.-based businesses to Hungary including the Gallup Organization and *Reader's Digest*. As the chief advisor to General Electric in Hungary, Dr. Völgyes also assisted in bringing six of GE's 10 global core businesses, along with more than $1 billion in investment. Dr. Völgyes died in an airplane crash in June 2001.

CELEBRATING 50 YEARS OF THE IAS-ARS MERGER

At 12:00 a.m. on Friday, 1 February 1963, the American Rocket Society (ARS) and the Institute of the Aerospace Sciences (IAS) both ceased to exist. In their place was a new organization, the American Institute of Aeronautics and Astronautics. They had operated independently for 33 years (the ARS) and 31 years (the IAS), but ultimately faced the fact that they would do better together.

In 2006 AIAA celebrated its 75th anniversary, based on the when its two predecessor organizations began, and this year we celebrate 50 years of this successful alliance. For the next few months, we will take a look at what happened in the time leading up to the merger, and some of the activities of the early AIAA.

This month, we examine the early discussions by the two organizations about the aerospace community at the time and their interactions with it. The following is an excerpt from *Rocketeers and Gentlemen Engineers: A History of the American Institute of Aeronautics…and What Came Before* by Tom D. Crouch.

The Merger

By the late 1950s the IAS and the ARS had evolved into organizations that were headed for a collision. They were in competition for members, corporate support, and recognition as the principal technical society representing professionals at the cutting edge of aerospace enterprise. The ARS, which was still growing, could afford to ignore the situation for a time. The IAS could not.

In December 1960, S. Paul Johnston prepared a memorandum summarizing the problems posed by multiple organizations attempting to represent technical professionals in a single industry. "Under such conditions," he remarked, "there is little wonder that the Aerospace Industries are putting up loud and continuous complaints of 'too many societies,' 'too many meetings,' 'too many demands.'" In short, there was no reason why industry leaders should choose to support two organizations when one could provide all of the professional services required.

The problem grew worse as both the IAS and ARS sought increased advertising to expand and spruce up their competing magazine, *Aero/Space Engineering* and *Astronautics*. To complicate matter, burgeoning interest in space flight and missilery led to the introduction of new commercial competitors like *Missiles & Rockets*. Then there was the American Astronautical Society's *Journal of Astronautics*. Even the West Texas–New Mexico section of the ARS created problems inside the organization when they attempted to expand their local publication into a national magazine.

In July 1958, IAS President Ed Wells appointed a long-range Planning Committee to develop recommendations that would guide the Council as they directed the course of the Institute into the future. A discussion of the problem with Harry Guggenheim in the spring of 1959 led to a Guggenheim Foundation study of Technical Meetings in the Flight Sciences, which only confirmed the seriousness of the problem. With all of that in mind, Johnston prepared a memorandum laying out three broad options for the Council and the Planning Committee.

The first possibility was to create a national Council of the Aerospace Sciences, a sort of "United Nations" forum in which all societies would come together to make mutually binding decisions regarding programming and national meetings. Although all of the organizations would maintain their own sovereignty and traditions, the decisions of the Council could "…reduce the demands for technical and financial support against industry which result from irresponsible competition."

At the opposite end of the spectrum was the possibility of creating a quasi-governmental National Academy of the Aerospace Sciences. In this case, "all prior interests, loyalties, commitments … could be submerged and all existing assets pooled for the common welfare." There would be divisional units devoted to specific fields, but all activity would be funneled through a Board of Governors functioning for the whole organization.

Option three called for a straightforward merger of the IAS and the ARS. In spite of what can only be described as gut-level-opposition to such as event, this was the approach that made best sense. It followed the pattern established in 1957, when the Institute of Radio Engineers and the American Institute of Electrical Engineers merged to form the Institute of Electrical and Electronic Engineers (IEEE) to solve a very similar problem in their industry. The IAS and ARS were already beginning to collaborate. In November 1960, a joint committee of the two organizations had met in Los Angeles to begin planning a collaborative space program for the IAS summer meeting the following year.

If the forces of history and national policy seemed to be moving the IAS and ARS together, it would still not be a match made in heaven. The basic problem standing in the way of such a merger would be the instinctive competitive stance that the two organizations had adopted toward one another. The leaders of the ARS tended to see the IAS as a stodgy organization that retained too much of the elitist spirit with which it had begun and was less than fully responsive to the needs of its members.

The leaders of the IAS did see themselves as an elite organization that brought real estate holds and a rich endowment to the table. They feared "a dilution of membership standards" and opposed national membership drives, preferring that "membership in the IAS should grow because of more and better services supplied to members."

Finally, there were those within the IAS who charged the ARS with fiscal irresponsibility, "… in trying to offer too many services without have the necessary income to cover their obligations." There was, they claimed, "no sign that the ARS finance group is ready to adopt the type of sound fiscal policy under which the IAS has successfully operated." ARS Executive Secretary Jim Harford would have countered by arguing that the ARS was turning out a better magazine, was doing a better job with business operations, and offered better service to members and the public.…

Next Month: Hammering out the details: Can everyone be happy?

Important Announcement
New Editor-in-Chief Sought for the *Journal of Guidance, Control, and Dynamics*

AIAA is seeking an outstanding candidate with an international reputation for this position to assume the responsibilities of Editor-in-Chief of the Journal of Guidance, Control, and Dynamics. The chosen candidate will assume the editorship at an exciting time as new features and functionality intended to enhance journal content are added to Aerospace Research Central, AIAA's platform for electronic publications.

The Editor-in-Chief is responsible for maintaining and enhancing the journal's quality and reputation as well as establishing a strategic vision for the journal. He or she receives manuscripts, assigns them to Associate Editors for review and evaluation, and monitors the performance of the Associate Editors to ensure that the manuscripts are processed in a fair and timely manner. The Editor-in-Chief works closely with AIAA Headquarters staff on both general procedures and the scheduling of specific issues. Detailed record keeping and prompt actions are required. The Editor-in-Chief is expected to provide his or her own clerical support, although this may be partially offset by a small expense allowance. AIAA provides all appropriate resources including a web-based manuscript-tracking system.

Interested candidates are invited to send letters of application describing their reasons for applying, summarizing their relevant experience and qualifications, and initial priorities for the journal; full résumés; and complete lists of published papers, to:

Heather Brennan
Manager, Content Acquisition and Editorial Policy
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
Fax: 703.264.7551 • E-mail: heatherb@aiaa.org

A minimum of two letters of recommendation also are required. The recommendations should be sent by the parties writing the letters directly to Ms. Brennan at the above address, fax number, or e-mail. To receive full consideration, applications and all required materials must be received at AIAA Headquarters by 15 April 2013, but applications will be accepted until the position is filled.

A selection committee appointed by the AIAA Vice President–Publications, Vigor Yang, will seek candidates and review all applications received. The search committee will recommend qualified candidates to the AIAA Vice President–Publications, who in turn will present a recommendation to the AIAA Board of Directors for approval. All candidates will be notified of the final decision. This is an open process, and the final selection will be made only on the basis of the applicants' merits. All candidates will be notified of the final decision.

AIAA CHINA LAKE SECTION CELEBRATES 50TH ANNIVERSARY

The February 15th, 1963 edition of the *Rocketeer*, the base newspaper for the China Lake Naval Ordnance Test Station in Ridgecrest, CA, listed the formation of a new local organization from the merger of two other societies:

First Meet Held By AIAA Group

The newly formed American Institute of Aeronautics and Astronautics by the merger of the local American Rocket Society and the local chapter of the Institute of Aero-Sciences held its first meeting Tuesday evening in Michelson Lab.

Temporary by-laws were adopted by the group and a slate of officers was elected to serve until July 1.

Officers who will guide the group for the intervening months are: Ed Price, president; Lewis Stevens, vice-president; Allen (Temp) Robinson, secretary; and James Crump, treasurer.

Named as Board of Directors were Haskell G. Wilson, Ray Van Aken, Robert McAlexander, Foy McCullough, Jr., Frank Knemeyer, and Howard R. Kelley.

Peter W. K. Dietrichson was named Program and Publicity Chairman while Donald G. Nyberg will serve as Membership Chairman.

Merger of the two groups gives the AIAA approximately 77 members.

Fifty years later, the AIAA China Lake section is still going strong with 46 members. In fact, out of over 20 at one time, AIAA is the only organization still in existence at China Lake. Pictured below are members of the current council: Dr Ying-Ming Lee,Section Chair; Steve Goad, Section RAC Representative and Public Policy officer; Randy Sturgeon, Section TAC Representative; Ed Jeter, Section Secretary; Randall Drobny, Section Vice Chair and Programs; and Jeff Scott, Section Treasurer. The picture was taken outside of the China Lake Armament Museum. China Lake Naval Ordnance Test Site was designated as an AIAA Historic Aerospace Site in 2006.

SUSTAINED SERVICE AWARD RECIPIENTS ANNOUNCED

AIAA is pleased to announce that Sustained Service Awards will be presented to the following members during 2013, and sincerely thanks them for their dedication and service. The Sustained Service Award recognizes significant service and contributions to AIAA by members of the Institute.

Region 1

Jason Hui, New England Section, "For sustained and significant contributions to the Guidance, Navigation and Control Technical Committee, and for dedicated service to AIAA."

Paresh Parikh, Hampton Roads Section, "For 30 years of continuous service to AIAA and the Hampton Roads Section, including organization of the "Future In Aerospace" scholarship program and service as a Section Officer, Committee Chair, and Council Member."

Balu Sekar, Dayton/Cincinnati Section, "For 30 years of participation in AIAA technical and section activities."

Kenneth Yu, National Capitol Section, "For sustained service and leadership to the AIAA Propellants and Combustion Technical Committee, to many AIAA conferences and to AIAA publications as an author and associate editor of the *Journal of Propulsion and Power*."

Region 2

Gerald Lutz, Central Florida Section, "For significant service and dedicated contributions to the interests of the Institute."

Region 4

Robert Malseed, Albuquerque Section, "For significant leadership and dedicated participation in the AIAA Albuquerque Section, including 20 years of continuous service as a Section Treasurer."

Region 5

David Riley, St. Louis Section, "In appreciation of continued dedication to AIAA at the section and national levels in demonstrating technical and leadership excellence."

Region 6

James Horkovich, Tucson Section, "For professional commitment and leadership, for education and mentoring of scientist engineers, and for distinguished contributions to science and innovation of directed energy systems."

Nominations for the AIAA Sustained Service Award may be submitted to AIAA no later than **1 July** of each year. For more information about the AIAA Honors and Awards program or the Sustained Service Award, please contact Carol Stewart at 703.264.7623 or at carols@aiaa.org.

OBITUARIES

AIAA Senior Member LaKous Died in July

Edward J. LaKous, Jr., a 35-year member of AIAA died on 20 July 2012.

In 1942 Mr. LaKous began his college education, but it was interrupted by his enlistment in the Navy. When World War II ended, he went to Texas A&M, graduating in 1949. LaKous relocated to Seattle and began work for Boeing. As an aeronautical engineer he worked several projects including the SST and the 747 shuttle transport vehicle. Retirement came after 41 years in 1990.

AIAA Senior Member Jessen Died In August

Rear Admiral (Ret.) George E. Jessen died on 11 August 2012. He was 84.

RADM Jessen had an exceptionally distinguished career as Naval aviator and aeronautical engineer. He received a congressional appointment to the Naval Academy from Minnesota. At the Academy, he was a member of the 32nd Company.

Upon graduation with the Class of 1950, he was first assigned to the PHILIPPINE SEA (CV-47). Realizing his true calling, he opted for Wings of Gold. After receiving his wings, in 1952, he flew P-2V Neptunes with land-based squadrons VP-871 and VP-19. Following a fleet training tour as an anti-submarine warfare instructor in 1955, he attended the Naval Post Graduate School (receiving a second BS degree in Aeronautical Engineering and an MS degree). He attended the Oak Ridge School of Reactor Technology, with the intent of eventually adapting it to aeronautical propulsion. In 1958, he returned to sea duty, flying A-3 Sky Warriors with VAH-3 and VAH-5. His next tour with VAH-7 was deployment on Enterprise in the first Mach 2 A-5A Vigilante squadron. Jessen logged over 4,000 flight hours in various land- and CV-based mission variations.

In 1962, Jessen began the first of a long series of technical assignments in 1962 at the Engineering Office at the BuWeps Representative Office, Columbus, OH, where the RA5C was being developed. In 1965, he was transferred to the Bureau of Naval Weapons to serve as the Project Officer for the infamous F-111B, where he earned the Navy Commendation Medal. In late 1966, he was selected to be the Special Assistant for Air to the Assistant Secretary of the Navy (R&D), for which he received a meritorious service medal. Beginning in 1969, he spent two years as the Aircraft Material Officer for the Naval Air Systems Command Representative, Atlantic. In 1971, he assumed command of the Naval Air Rework Facility, Pensacola, FL, for which he received a second meritorious service medal. He returned to Washington, DC, and the Naval Air Systems Command in 1973 and became project manager for the S-3A Viking, for which he earned the Legion of Merit. This assignment culminated in the successful fleet introduction of the world's most capable antisubmarine warfare weapon system. In 1976, he assumed a post as Assistant Commander for Systems and Engineering, Naval Air Systems Command where he made lasting contributions to the mission and accomplishments of that command. He was awarded the Gold Star, in lieu of a second legend of merit for "exceptionally meritorious service".

In 1980, Jessen retired from the Navy with 30 years of distinguished service. He continued his career within the aerospace industry as VP of Advanced Development, Rockwell International (North American Aerospace). In 1986, he joined Northrop Aviation where he was the Northrop/McDonnell Douglas Program Manager for a proposed Navy variant of the Advanced Tactical Fighter. After fully retiring in 1989, he continued to be a part-time aerospace consultant for the Navy.

AIAA Associate Fellow Rankin Died in August

Dr. Charles C. Rankin died on 11 August 2012.

Dr. Rankin worked for Lockheed Martin Space Systems Company for 31 years prior to joining Rhombus Consultants Group in 2003. He was the principal technical developer for the STAGS nonlinear finite-element program since 1985. Dr. Rankin's contributions to the structural mechanics field include an objective corotational scheme for treating large rotation nonlinearities, numerical techniques for modeling post-buckling in collapsing shell structures, and prediction of crack propagation in shell structures exhibiting nonlinear response. For the latter, Dr. Rankin received a NASA Group Achievement Award as a member of the NASA LaRC Advanced Subsonic Technology Aging Aircraft Program Team. His activities with Rhombus Consultants Group addressed generic large-strain material models, failure initiation and propagation in composite and metallic materials, and advanced finite-element technologies. Dr. Rankin received his Bachelor's degree from the University of North Carolina, Chapel Hill, and his Ph.D. from the University of Chicago in molecular physics.

Dr. Rankin was known for his salient fundamental contributions over more than 30 years to the field of solid and structural mechanics. All of these contributions have been formulated by Rankin and implemented into his general-purpose nonlinear static and dynamic finite element code called STAGS (STructural Analysis of General Shells), widely used especially at NASA Langley Research Center. Dr. Rankin was no mere programmer implementing into a code the mechanics theories of others; he developed these theories mainly by himself. Many of his fundamental contributions are now finding their way into the most widely used commercial structural computer programs such as MSC_NASTRAN, ANSYS, and ABAQUS. In this way his important original contributions will for the foreseeable future have a major impact on research and engineering in academia, government, and industry.

Specifically Dr. Rankin's technical contributions include the formulation and implementation into STAGS of 1) a finite-element-independent corotational theory that has now become an important standard in computational mechanics the world over, 2) an arc-length method that permits the traversal of limit points from pre-buckling to post-buckling, 3) an algorithm to determine multiple bifurcation eigenvalues and eigenvectors from nonlinearly determined pre-buckled equilibrium states, 4) a solution strategy that permits the successive introduction of a sequence of buckling modal imperfections into a nonlinear equilibrium analysis, 5) a strategy that permits successive smooth transitions from nonlinear static to transient and from nonlinear transient to static analyses, 6) a strategy that permits the simulation of unzipping of a through crack in a shell possibly with multiple crack tips and turning of a crack during loading, 7) a "sandwich" finite element that efficiently accounts for soft, shear-deformable cores and stiff face sheets, and 8) unique nonlinear material models in separate "material modules" that are independent of the rest of the software. Dr. Rankin was a great man, loved by many for his great sense of humor, respected by many for his towering intellect and superb accomplishments in the field of structural mechanics. He will remain forever in the minds and hearts of his many friends and colleagues.

AIAA Senior Member Curran Died in September

Peter F. Curran died on 24 September 2012. He was 76.

Mr. Curran received his B.S. degree in Electrical Engineering from Manhattan College and was an aerospace engineer. He began his career working for the Bendix Corp., in Teterboro, NJ, and worked at the same location until his retirement in 2001. When Mr. Curran retired the company was then owned by Allied Corp, which eventually merged with Honeywell Corp.

AIAA Senior Member Cicchetti Died in October

George J. Cicchetti, Jr., age 65, passed away on 13 October 2012.

Mr. Cicchetti had a long and distinguished career in engineering, particularly in the aerospace field, where his skill contributed to such projects as SkyLab and the Hubble Telescope, among many others.

AIAA Associate Fellow Novick Died in December

Dr. Allen S. Novick, 70, passed away on 8 December 2012.

In 1960 Dr. Novick began to attend Purdue University, from where he received his bachelor, master, and doctorate degrees in Aeronautical Engineering.

In 1972, he joined the Allison division of General Motors (now Rolls-Royce), where he progressed through many different assignments. Dr. Novick retired in 2009 as the Vice President of Marketing Intelligence and Support.

During his distinguished career, Dr. Novick received many accolades, including the Purdue University Distinguished Engineering Alumni Award in 2006. He was nominated by Regional Airline World for a Lifetime Achievement Award in 2004.

Recently, Dr. Novick served as an Honorary Industry Professor for Purdue's School of Aeronautics and Astronautics. He remained active in the aerospace industry, consulting with suppliers and speaking at industry engagements. He enjoyed mentoring those he worked with and encouraging those embarking on a career in engineering.

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.

CALL FOR NOMINATIONS

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

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

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

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

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

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

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

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

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

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

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

Missile Systems Award

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

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

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

Summerfield Book Award is named in honor of Dr. Martin Summerfield, founder and initial editor of the Progress in Astronautics and Aeronautics Series of books published by the AIAA. The award is presented to the author of the best book recently published by AIAA. Criteria for the selection include quality and professional acceptance as evidenced by impact on the field, citations, classroom adoptions and sales.

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

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

31st AIAA International Communications Satellite Systems Conference (ICSSC) and the 19th Ka and Broadband Communications, Navigation and Earth Observation Conference

14–17 October 2013
Florence, Italy

Abstract Deadline: 31 March 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. Papers are solicited for the conference in the following areas:

- Advanced broadcasting satellite systems, services and technologies
- Advanced fixed satellite systems, services and technologies
- High capacity broadband satellite systems, services and technologies
- Next-generation L/S/K-band GEO/MEO/LEO mobile satellite systems, services and technologies
- Hybrid satellite/terrestrial mobile systems
- Advanced data relay and backbone systems, services and technologies
- Dual-use satellite communication systems, services and technologies
- Satellite-aided localization systems, technologies and applications

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Colloquium Chairs
Xavier Lobao, ESA/ESTEC, The Netherlands
Alberto Ginesi, ESA/ESTEC, The Netherlands

- Search and rescue satellite systems, technologies and applications
- Automatic identification systems, technologies and applications
- Satellite/terrestrial hybrid localization systems, technologies and applications

- Optical communications for planetary and interplanetary missions
- Communications protocols and networks
- Advances in satellite payload architectures and equipment
- Payload and ground segment technologies for Ka, Q/V, and W-band
- Flexible satellite resource allocation architectures, design tools and technologies
- Digital payload architecture, technologies and equipment
- Techniques and technologies for next-generation satellite remote-sensing high-speed downlinks
- On-board navigation receivers for LEO/MEO and GEO satellites
- Satellite bus technologies
- Advances in Earth terminals and stations architectures and equipment
- Propagation and fading modelling and fading mitigation techniques
- Integration and interoperability of systems
- Integrated services for disaster relief
- Effective support of interactivity via satellite
- Domestic security applications and architectures
- User applications

Conference Deadlines

Abstracts required: 31 March 2013
Authors are notified of paper acceptance: 10 May 2013
Preliminary program published: 30 June 2013
Final paper submitted: 31 July 2013

Student Sponsorship

In order to encourage student participation in the ICSSC Conference, the AIAA Communications Systems Technical Committee will award $500.00 to up to 12 full-time students who prepare and present a paper. The student must follow the standard abstract and paper submission procedures. The abstract submission date will be used to identify students if more than 12 student papers are accepted and presented at the ICSSC Conference.

Note that in case of a no show at the conference, the paper will be removed from the conference proceedings. More information can be found at: **http://www.icssc2013.org**.

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

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

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

Introduction to Computational Fluid Dynamics

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

Advanced Computational Fluid Dynamics

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

Computational Fluid Turbulence

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

Introduction to Space Flight

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

Fundamentals of Aircraft Performance and Design

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

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

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

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

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

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

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

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

*Includes a one-year AIAA membership

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

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

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

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

*Includes a one-year AIAA membership

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

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

4–5 March 2013

The following standalone course is being held at the National Aerospace Institute in Hampton, Virginia.

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

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

*Includes a one-year AIAA membership

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

This course builds on your general understanding of flight mechanics, but requires no prior knowledge of tensors. It introduces Cartesian tensors, reviews coordinate systems, formulates tensorial kinematics, and applies Newton's and Euler's laws to build the general six degrees of freedom equations of motion. For stability and control applications, the perturbation equations are derived with their linear and nonlinear aerodynamic derivatives. After taking the course you will have an appreciation of the powerful new "tensor flight dynamics," and you should be able to model the dynamics of your own aerospace vehicle.

6–7 April 2013

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

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

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

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

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

15–16 April 2013

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

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

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

*Includes a one-year AIAA membership

A Practical Introduction to Preliminary Design of Air Breathing Engines **(Instructor: Ian Halliwell)**
The objective of the course is to present an overview of the preliminary design of air-breathing engine systems that is determined primarily by the aircraft mission, which defines the engine cycle—and different types of cycle are investigated. Preliminary design activities are defined and discussed in the context of the overall engine development process and placed in perspective. Some basic knowledge of aerodynamics and thermodynamics is assumed so the mathematical material that appears in many good textbooks is minimized and the question "What do you actually do as an engine designer?" is addressed. The practical means and pro-

cesses by which thermodynamic concepts are turned into hardware are covered and some design techniques are demonstrated. Finally, the fact that an air breathing engine is much more than the flowpath component is discussed and the future of engine design methods is raised. Class participation is encouraged throughout. This is your course; please try to get from it whatever you want!

15–16 April 2013
The following standalone course is being held at The Ohio Aerospace Institute in Cleveland, Ohio.

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

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

*Includes a one-year AIAA membership

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

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

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

	Early Bird by 10 May	*Standard (11 May–3 Jun)*	*On-site (4–10 Jun)*
AIAA Member	$950	$1075	$1175
Nonmember*	$1070	$1195	$1295

*Includes a one-year AIAA membership

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

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

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

	Early Bird by 10 May	*Standard (11 May–3 Jun)*	*On-site (4–10 Jun)*
AIAA Member	$995	$1125	$1220
Nonmember*	$1115	$1245	$1340

*Includes a one-year AIAA membership

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

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

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

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

*Includes a one-year AIAA membership

Introduction to Space Systems **(Instructor: Mike Gruntman)**
This two-day course provides an introduction to the concepts and technologies of modern space systems. Space systems combine engineering, science, and external phenomena. We

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

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

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

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

*Includes a one-year AIAA membership

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

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

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

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

*Includes a one-year AIAA membership

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

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

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

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

*Includes a one-year AIAA membership

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

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

22–23 June 2013
The following Continuing Education courses are being held at the AIAA Fluid Dynamics and collocated conferences in San Diego, CA. Registration includes course and course notes; full conference participation: admittance to technical and plenary sessions; receptions, luncheons, and online proceedings.

To register for one of the Fluid Dynamics 2013 courses, go to **www.aiaa.org/fluids2013.**

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

Verification and Validation in Scientific Computing
(Instructors: William Oberkampf, Engineering Consultant, WLO Consulting and Chris Roy, Aerospace and Ocean Engineering Department, Virginia Tech)
The performance, reliability, and safety of engineering systems are becoming increasingly reliant on modeling and simulation. This course deals with techniques and practical procedures for assessing the credibility and accuracy of simulations in science and engineering. It presents modern terminology and effective procedures for verification of numerical simulations and validation of mathematical models that are described by partial differential equations. While the focus is on scientific computing, experimentalists will benefit from the discussion of techniques for designing and conducting validation experiments. A framework is provided for estimating various sources of errors and uncertainties identified both in simulations and in experiments, and then combining these in total prediction uncertainty.

Application examples techniques and procedures are taken primarily from fluid dynamics, solid mechanics, and heat transfer. This short course follows closely the instructors' book *Verification and Validation in Scientific Computing* (Cambridge University Press, 2010).

Fundamentals of Hypersonic Aerodynamics (**Instructor: Dr. John D. Anderson, Curator for Aerodynamics, National Air and Space Museum**)
This is a course on the fundamental principles of hypersonic aerodynamics. It is a self-contained course for those students and professionals interested in learning the basic physical aspects of hypersonics. It assumes no prior familiarity with the subject. If you have never worked extensively in the area, or never studied hypersonics, this course is for you. It is a cohesive presentation of the fundamentals, a development of important theory and techniques, a discussion of the salient results with emphasis on the physical aspects, and a presentation of modern thinking on the subject. The course is organized around the classic textbook by the instructor: *Hypersonic and High Temperature Gas Dynamics* (originally published by McGraw-Hill; reprinted by AIAA).

18–19 July 2013

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

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

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

Liquid Propulsion Systems - Evolution and Advancements (**Instructors: Alan Frankel, Business Development, Moog-ISP, Space and Defense Group; Dr. Ivett Leyva, Combustion Devices Group, AFRL/RZSA; Patrick Alliot, Senior Technical Expert, Space Engine Division of SNECMA**)
Liquid propulsion systems are critical to launch vehicle and spacecraft performance, and mission success. This two-day course, taught by a team of government, industry, and international experts, will cover propulsion fundamentals and topics of interest in launch vehicle and spacecraft propulsion; non-toxic propulsion; microsat and cubesat propulsion; propulsion system design and performance; and human rating of liquid engines. In keeping with the theme of the 2011 JPC, "Turning Propulsion Ideas into Reality," lessons learned from development and flight of components and systems will be discussed.

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

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.

Standard Information for all AIAA Conferences

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

On-Site Check-In

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

Photo ID Needed at Registration

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

Certificate of Attendance

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

Conference Proceedings

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

Young Professional Guide for Gaining Management Support

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

Journal Publication

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

Timing of Presentations

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

Committee Meetings

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

Audiovisual

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

Employment Opportunities

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

Messages and Information

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

Membership

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

Nondiscriminatory Practices

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

Restrictions

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

International Traffic in Arms Regulations (ITAR)

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