2 AEROSPACE AMERICA FEBRUARY 2012

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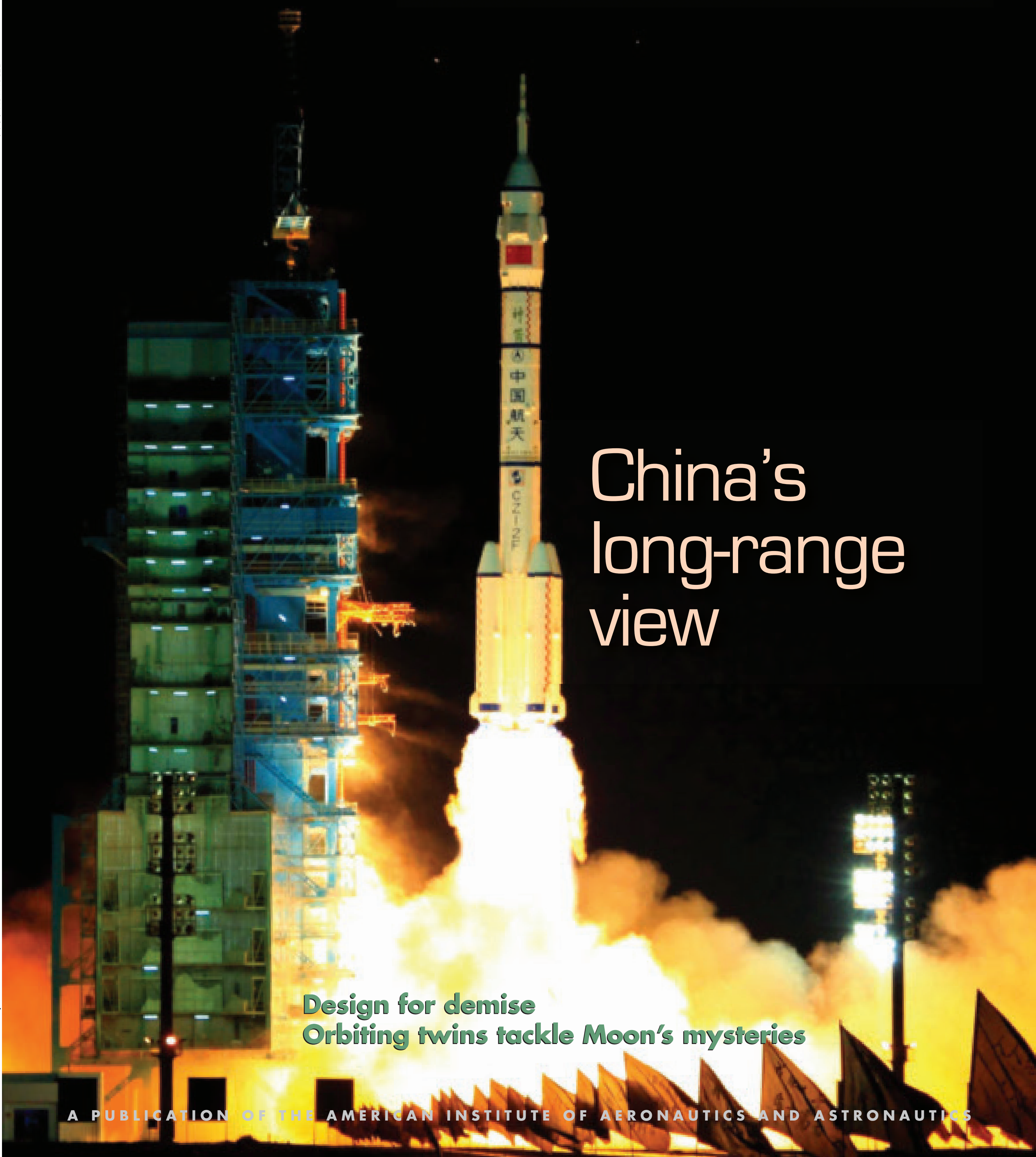

China's long-range view

Design for demise

Orbiting twins tackle Moon's mysteries

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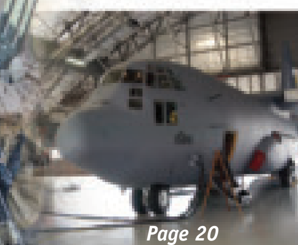
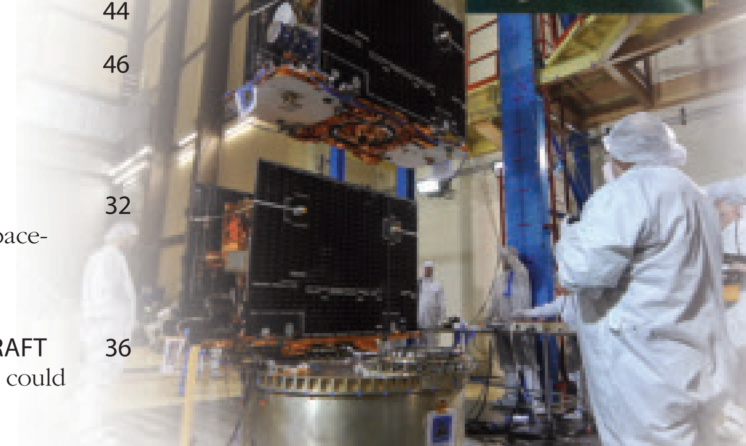


Page 12



Page 32

Page 36

DEPARTMENTS

FEATURES

BULLETIN

COVER

A Long March CZ-2F carrying the unmanned Shenzhou-8 blasts off from the Jiuquan Satellite Launch Center on a mission to dock with China's first unmanned space module Tiangong-1. To read more about China's growing space efforts, turn to page 8.

Aerospace America (ISSN 0740-722X) is published monthly, except August, by the American Institute of Aeronautics and Astronautics, Inc. at 1801 Alexander Bell Drive, Reston, Va. 20191-4344 [703/264-7500]. Subscription rate is 50% of dues for AIAA members (and is not deductible therefrom). Nonmember subscription price: U.S. and Canada, $163, foreign, $200. Single copies $20 each. **Postmaster: Send address changes and subscription orders to address above, attention AIAA Customer Service, 703/264-7500.** Periodical postage paid at Herndon, VA, and at additional mailing offices. 40,000 copies of this issue printed. This is Volume 50, No. 2.

AEROSPACE AMERICA®

is a publication of the American Institute of Aeronautics and Astronautics

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February 2012, Vol. 50, No. 2

AIAA
American Institute of Aeronautics and Astronautics

Editorial

The power option

Two Voyager spacecraft were launched in August and September of 1977. They spent more than 11 years exploring the outer planets before heading off toward interstellar space in 1989. Each Voyager has three radioisotope thermoelectric generators (RTGs). Although their power output has declined over time, the RTGs will allow operations to continue until at least 2020.

Pioneer 10 and Pioneer 11 were launched in April 1973 to study the asteroid belt, the environment around Jupiter and Saturn, solar wind, cosmic rays, and eventually the far reaches of the solar system and heliosphere. The twin probes each used four SNAP-19 RTGs. In September 1995, NASA announced the end of the mission, but said the agency would continue to listen for transmissions until late 1996.

Galileo was launched in October 1989 and reached Jupiter on December 7, 1995, to begin its two-year mission. On December 7, 1997, its mission was extended, and was finally terminated six years later by crashing the spacecraft into Jupiter on September 21, 2003. Galileo was powered by two RTGs.

The Cassini space probe was launched in October 1997, and after a long interplanetary voyage it entered an orbit around Saturn on July 1, 2004. The primary mission for Cassini ended on July 30, 2008, but on April 18, 2008, NASA announced a two-year extension of the funding for ground operations of this mission. This was again extended in February 2010 until 2017. The Cassini orbiter is powered by three RTGs.

And the Mars Science Laboratory Curiosity Rover, launched on November 26, 2010, is carrying multiple scientific instruments powered by an RTG. It seems that for satellite programs that you hope will outlast their life expectancies, and continue to deliver good science, RTGs are the way to go. But RTGs are made from Pu-238, a radioactive isotope of plutonium. Production of this isotope has ceased in the U.S., and at present it is unclear how much, if any, Pu-238 is held by the Dept. of Energy. For a while the U.S. has purchased stock from Russia, but whether that nation will continue to generate the isotope, or sell it to the U.S., is unclear.

As it stands, this would mean that Curiosity might be the last long-lifetime or deep-space mission launched by the U.S. for years to come.

Late last year, there appeared to be a breakthrough, when NASA officials offered a bit of good news about plans to restart Pu-238 production, splitting the costs evenly with the DOE. However, Congress allocated funds to NASA but did not do the same for the DOE.

The American Astronomical Society points out that even if production were restarted immediately, there would be a five-year gap in Pu-238 supplies. And the committee that prepared the National Research Council's latest Planetary Science Decadal Survey expressed concern about the availability of the isotope. "Without a restart of plutonium-238 production, it will be impossible for the United States, or any other country, to conduct certain important types of planetary missions after this decade," the report stated.

It seems we should, as a nation, decide whether we are willing to abandon the exploration of the universe or if we want to rely on the whims of another nation to continue to do so. Neither of those options holds much appeal, especially if it is within our means to do better.

Elaine Camhi
Editor-in-Chief

High-speed rail will impact airliner markets

In December 2011 India's Railway Ministry selected a Japanese-led consortium to conduct a feasibility study on establishing a high-speed rail (HSR) link across the south of the country. It is one of six new HSR lines being planned, and the Indian government is setting up a National High-Speed Rail Authority to manage the nationwide program. Systra, a French company, has already completed a feasibility study of the 650-km Pune-Mumbai-Ahmedabad line, and other consultants have been chosen for the 991-km Delhi-Patna line and the 135-km Kolkata-Howrah-Haldia lines.

HSR networks are being developed rapidly across Asia. China plans to lay down 10,000 mi. of high-speed track by 2020. "Taiwan is extending its network, there's talk in Thailand of developing a national system, and South Korea's KTX is successful and being extended," according to Ken Harris, editor of *Jane's World Railways*. "Despite the current difficulties, China will forge ahead with its program, because the demand and the money are there."

Other industry experts are equally bullish about the Asian HSR market. Of the 17,000 mi. of planned HSR track implementations worldwide, nearly 10,000 are allocated for Asia, according to New York-based industry forecaster SBI.

In the Middle East, new HSR programs are also being developed. Planing is under way for an HSR to link the states of the United Arab Emirates in a 1,200-km network as early as 2018, and a wider network to link all six Gulf Cooperation Council member states is under consideration as well. Saudi Arabia is planning a line to carry 200-mph trains between the holy cities of Mecca and Medina.

Asian countries are likely to spend around $172 billion between 2010 and 2020 on high-speed rail projects, according to a recent survey by Frost & Sullivan. This is a long way behind the $338 billion earmarked for HSR developments in Europe, according to the company. In North and South America the investment figure is likely to be $137 billion.

Global, growing market

Globally, HSR is a huge, growing market that is likely to develop further with new competitors, from China for example, and new faster trains. Last December, Spain's CAF began the first trials of its 220-mph Odaris high-speed train on the Madrid-Seville track.

The distance between Madrid (with a population of 5.7 million people) and Seville (population 750,000) is 335 mi. Before the HSR link was established between the two cities at the start of the 1990s, the mix of air/rail passengers was 67%/33% air to rail. After the HSR link, that changed to 16%/84% in favor of rail and will rise to 13%/87% in favor of rail by 2020, according to Frost & Sullivan forecasts.

The story is the same throughout Europe: HSR links are being developed or expanded between key trading centers at the expense of airline travel. As HSR services are established on key routes—London-Paris, London-Brussels, Barcelona-Madrid, Paris-Lyons—airlines have either pulled frequencies, reduced aircraft sizes, or departed from the routes altogether. By 2020 a new high-speed line will be built between Paris and Barcelona, cutting journey times on the 514-mi. route from 8 hr to 4.5 hr. This will be just the start of a new interconnected France-Spain HSR jointly operated network, managed along the same lines as the U.K.-France Eurostar HSR system. By 2020 most of Europe's major trading centers will be interconnected via an HSR network.

It is not just in Europe that aviation is losing out to rail. At the end of March 2011 all airline services between Nanjing and Wuhan in China were canceled following the establishment of an HSR link between the two cities, offering a cheaper and competitively fast link on the 284-mi. journey. The introduction in 2007 of the 209-mi. Taiwan High Speed Rail link be-

South Korea's high-speed rail system has been deemed a success and is being expanded, which may further depress the demand for new aircraft for the domestic market.

tween Taipei and Kaohsiung has reportedly cut domestic airline services by 50% in the past three years.

Some believe that competition between rail and air has only just begun.

"The impact of the HSR industry and rail in general on air networks has not been as great as it could have been because of the commercial management of the rail system, which is still broadly government controlled," says Ian Lowden, principal with the U.K. aviation consultants LowdexxAviation Consulting. "Airlines, in general, have developed far more flexible and advanced management systems. The rail industry lacks a global distribution system as effective as the airlines' Amadeus system—but that could come. As air travel's competitive advantages have been eroded through fuel price increases and taxes, the airline industry needs to up its game to face a potentially more aggressive and competitive rail system."

So what impact will these developments have on the market for civil aircraft worldwide, especially as HSR links become available in the dynamic air traffic growth regions of China, India, and the Middle East?

Complex calculations

The underlying mathematics to the supply and demand of aircraft on high-density routes where air passenger numbers become eroded by the advent of new fast train services is highly complex. This is especially true when factors such as subsidies, road alternatives, size of linked conurbations, business/leisure traffic mix, airport capacity, and ease of access to an airport from the downtown are factored in.

For example, two-thirds of Japan's population, or almost 100 million people, live in a narrow, densely populated corridor along the south shore of Honshu Island between Tokyo and Fukuoka—an ideal demographic for proponents of HSR services. According to a recent paper from the Transportation Research Board of the National Academies in Washington, D.C., airlines and train companies fight a fierce, competitive, but mutually profitable battle for business along this narrow corridor, which for some sectors sees airlines gain the upper hand (Tokyo-Fukuoka), while in others (Tokyo-Osaka), rail is the clear winner. Distance is a factor, but other competitive issues, such as the frequencies offered, are also important.

Odaris high-speed trains have begun their trials on the Madrid-Seville track.

But Japan is unique. The demographics favor HSR, and the solution provided by airlines in the form of high-density Boeing 747s for short-haul operations are found nowhere else in the world.

Fear of subsidies

HSR can clearly offer cheaper, more frequent, and more comfortable alternatives to air services in certain markets—HSR has 86% of the Osaka-Tokyo travel market; the cities are 325 mi. apart—on a relatively 'level' competitive playing field such as Japan's.

But aircraft manufacturers and operators are worried that if governments appear to be heavily subsidizing HSR systems for environmental or other reasons, air will start to lose out to rail, and fewer aircraft will be needed.

Mike Ambrose, director general of the European Regional Airlines Association, said in September 2011 at the association's annual general meeting, "For too long, politicians have favored rail over air as a solution to many of the problems facing intra-European transport, including congestion, environmental impact, and investment programs. That high-speed rail is seen by key European decision-makers as a preferred alternative to air transport is more a result of doctrine than rational and transparent analyses."

In 2011 the association produced a study that showed annual government subsidies for rail in the 27 countries of the EU are 125 times higher than state aid granted to air transport.

This factor, coupled with the growth in megacities in Asia and the movement of populations from the less densely populated regions (where airlines are often the only practical form of fast transport links), may put pressure on the long-term market drivers for single-aisle aircraft.

Countervailing factors

Some estimates are suggesting the impact could be more short term. According to a study by the Centre for Asia Pacific Aviation on the implica-

HSR SERVICES IN EUROPE

Country	Population, 2010 (millions)	Area (km²)	High-speed lines in operation, 2011 (miles)	Rail passenger use, 2009 (million passenger km)
France	64.7	547,660	1,185	88,610
Germany	81.8	348,630	803	81,206
Italy	60.3	294,140	577	49,524 (2008)
Spain	46.0	499,110	1,285	23,056
U.K.	62.0	241,930	71	52,765

Sources: Eurostat; World Bank; Union Internationale des Chemins de fer; U.K. House of Commons Library.

In Japan, the airlines' response to the HSR is to use overstuffed 747s for short hauls.

tions of HSR growth in aviation in China: "Some estimates put the loss in revenue for China's aviation industry from reduced traffic and price pressure at up to CNY10 billion ($1.5 billion) in 2012, or 3-4% of the total. Li Jiaxiang, director of the Civil Aviation Administration of China, stated some 50% of flights less than 500 km in length could become unprofitable as a result of competition from high-speed trains, and around 20% of flights of between 800 and 1,000 km could also run at a loss for the same reason. But sectors above 1,500 km are not likely to be threatened, he added....Guotai Junan Securities recently predicted that high-speed rail could capture between 1.3% and 5.3% of domestic airline passengers [per annum] by 2014.

"First Capital separately forecast that airline revenues would decline by between 3% and 7.9% due to shrinking demand," the study continues. "China Minzu Securities, while downplaying the impact of high-speed railways on airlines, stated up to 9% of passengers could shift from air to rail transport by 2016."

However, the impact of new HSR services on the demand for single-aisle aircraft may be less than many in the aviation industry fear.

The plans are ambitious, but economic and other issues have slowed down HSR plans in many countries. The recent European economic issues have delayed HSR plans in Poland by up to 20 years, according to recent reports. The crash in July 2011 of two high-speed trains in Wenzhou, Zhejiang Province, China, with the loss of 40 lives, prompted the government to postpone many of the major HSR developments it had planned. China's railway has also been under increasing financial pressure. At the same time, the country plans to build 70 airports between now and 2020, suggesting that it is building its aviation services in parallel with, rather than instead of, its fast train system.

Second, airlines have successfully reacted to HSR competition by increasing frequencies and introducing new regional services where HSR rail simply cannot compete.

"Low cost carriers might respond to the emergence of a high speed rail alternative by increasing the frequency of service," according to a 2009 study, *Competitive Interaction between Airports, Airlines and High-Speed Rail,* by the Organisation for Economic Cooperation and Development and the International Transport Forum. "A similar improvement on the rail side would be very expensive given the cost of trains, and this would reduce rail's market share and profitability.

"In addition, low cost carriers can provide services between regions instead of cities (so avoiding the need to acquire expensive slots at centrally located airports). This is effectively what happened after the high speed rail service between Paris and London opened. The potential strategic responses from low-cost carriers reinforce the view that high speed rail may be justified where densely populated origin destination pairs exist, but is not a general model for interurban and interregional transport."

The effect of HSR competition on northern European routes between London, Paris, Amsterdam, Brussels, and Frankfurt has been to open up slots at heavily congested airports, a phenomenon most airlines have welcomed as they have been able to replace short-haul services with more profitable long-haul routes. In this scenario, integrated air-rail HSR networks allow fast trains to become 'feeder services' to an airport hub, encouraging network carriers to develop their global services using larger aircraft.

But there is a downside to this. Some European politicians now see HSR as an alternative to airline services, rather than a parallel, if con-


The July 2011 crash of two high-speed trains prompted the Chinese government to postpone many of the major HSR developments it had planned.

nected, transport system. In the U.K., for example, the government has declared it will not build any more runways in the southeast but will promote new HSR lines, potentially depressing the number of aircraft required by U.K. airlines.

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Although the potential for HSR developments to eat into the market for single-aisle aircraft is real, the evidence so far is that its impact will probably be less than originally estimated. The demand for new aircraft for domestic routes in South Korea, Taiwan, and France has already been depressed, and further reductions as a result of new fast rail competition should be expected from the cities of the Pearl River Delta in China and from reduced demand on routes between France and Spain.

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Events Calendar

FEB. 15-16
Fifteenth Annual FAA Commercial Space Transportation Conference, Washington, D.C.
Contact: 703/264-7500

MARCH 3-10
2012 IEEE Aerospace Conference, Big Sky, Montana.
Contact: David Woerner, 626/497-8451

MARCH 20-21
Congressional Visits Day, Washington, D.C.
Contact: Duane Hyland, 703/264-7558; duaneh@aiaa.org

MARCH 21-23
Nuclear and Emerging Technologies for Space 2012, held in conjunction with the 2012 Lunar and Planetary Sciences Conference, The Woodlands, Texas.
Contact: Shannon Bragg-Sitton, 208/526-2367; shannon.bragg-sitton@inl.gov

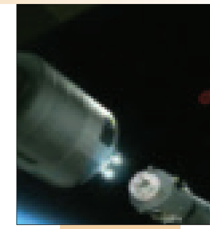
MARCH 26-28
3AF 47th International Symposium of Applied Aerodynamics, Paris, France.
Contact: Anne Venables, 33 1 56 64 12 30; secr.exec@aaaf.asso.fr

MARCH 26-28
Tenth U.S. Missile Defense Conference and Exhibit (SECRET/U.S. ONLY), Washington, D.C.
Contact: 703/264-7500

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

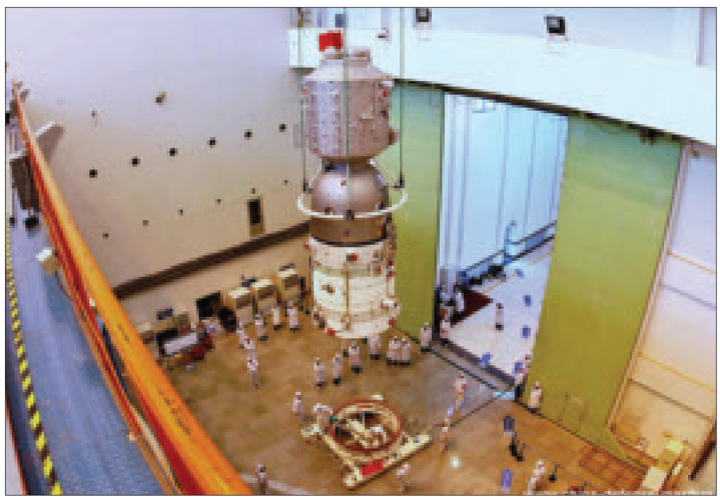
MAY 14-18
Twelfth Spacecraft Charging Technology Conference, Kitakyushu, Japan.
Contact: Mengu Cho, 81 93 884 3228; cho@ele.kyutech.ac.jp

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



China's long-range view

The noise surrounding China's use of an Australian space tracking station in November threatened to overshadow what the country achieved when it managed to run two unmanned spacecraft through two dockings in quick succession. What was really achieved was China hauling itself up to the level of space transport roughly equivalent to where the U.S. was during the Gemini program in 1966.



A Shenzhou successfully docked twice with the Tiangong 1.

That's not to say it was not a real achievement. The U.S. had been galvanized by competition from the then-Soviet Union with the 'Sputnik moment' (the first satellite, in 1957) and the first manned spaceflight, in 1961. It has taken China a little longer, but from a far lower technical baseline—it has jumped from its first manned, orbital spaceflight with a crew of one in 2003 to three-crew vehicles, space walks, and now a docking system in just eight years.

Setting, and meeting, goals

In 2003 the China National Space Administration issued a white paper stating its intentions. For the short term, these were:

- Developing an Earth observation system.
- Building an independent satellite telecommunications network.
- Setting up an independent satellite navigation and positioning system.
- Offering commercial satellite launch services.
- Building a remote sensing system.
- Studying space science topics such as microgravity, space materials, life sciences, and astronomy.
- Planning for exploration of the Moon.

Scientists and engineers have managed various levels of success in most of these areas, some of which in any case are obviously continuing fields of endeavor.

For the longer term, the nation's targets are:

- Improving its standing in the world of space science.
- Building a manned space station.
- Sending manned missions to the Moon.
- Establishing a manned lunar base.

Progress in these goals is proceeding, with the first certainly achieved and the second now firmly in sight, though of course nothing is certain in high-tech projects except that there will be surprises and, very possibly, tragedies. In the history of manned spaceflight so far, and making a possibly large assumption about negative information being widely available, the *Encyclopaedia Astronautica* says there have been five crews lost, involving about 2% of manned missions.

The saving grace for China is that its scientists have not been sprinting ahead at breakneck speed to push people into space. The plan for the space station, for instance, envisages manned docking tests starting in 2012 and completion of a relatively small 60-ton station by 2020.

The pace of the November docking experiments makes the point. The docking target was a sample module of the future station, called Tiangong 1 (Heavenly Palace 1), in this case intended to survive in space for only two years while testing continues. An unmanned spacecraft called Shenzhou 8 (Divine Craft 8) was launched on September 29 and rendezvoused with Tiangong 1 on October 31.

After various checks were carried out, the vehicles docked for the first time on November 2, then orbited together until separation and a second docking on November 14. Shenzhou 8 contained two mannequins in spacesuits, but at least one of the two future docking trials this year is expected to have human crew aboard.

The capsule returned home as planned, on November 17. Having proved that the Shenzhou capsule can rendezvous and dock automatically with the target craft, the docking ring and associated technology have been shown to work properly. This is both a step ahead of U.S. equipment (which has not done this automatically) and a step behind, because it has yet to be done by humans.

Next is to prove that cargo-carrying rockets can also dock autonomously, as the means of resupplying a space station. Whether this will happen before Shenzhou 9 and 10 are launched to do a manned docking and enter the Tiangong 1 module has not been announced, but it would seem logical. Nor has it been said whether Shenzhou 9 will have a crew of two or three—some suspect the cautious approach will be used for the first manned docking in case of problems, as two people need less oxygen and supplies than three. The Tiangong 1 module is fairly small, so logistics matter.

Space station and lunar base

When the space station is eventually set up, it is to comprise three modules grouped around a ‘docking center,’ with at least four docking ports at right angles to each other. First is the core module, about 18 m long—the ‘house’ of the station containing living space and controls for power supplies and communications. On each side and connecting to the docking center is an experiment module 14.4 m in length and, like the core module, having a maximum width of 4.2 m. Each module weighs 20-22 tons, for a total station weight of about 60 tons, compared with the international space station at 419 tons.

Opposite the core module will be a supply rocket that will dock automatically, while behind the core module a Shenzhou spacecraft will be docked to transport crew to and from the Earth.

Work is proceeding in parallel on lunar missions—an unmanned lunar mission may be launched this year as a follow-on to two lunar probes launched in 2007 and 2010.

Not that China sticks so rigidly to the plan—first announced in 1992—that it is incapable of changing according to circumstances. Problems developing a rocket with enough thrust to cater to the lunar missions have brought about a delay and a readjustment of intended payloads. It is now intended that an automated lunar rover vehicle be sent in 2013, to be followed in 2017 by an automated landing and a return with surface samples. A manned landing followed by the setting up of a lunar base are intended for 2025-2030.

Keeping track

That China tends to stick to what it says it will do, and that much of this information has been in the public domain for a long time, made it all the more surprising that media leapt on the fact of China using an Australian tracking station during the Tiangong 1 docking experiments as if it were indicating some nefarious guile.

The station at Dongara, about 200 miles north of Perth in western Australia, is owned by the Swedish Space Corporation (SSC), which in turn is owned by the Swedish government. SSC has worked with China’s space scientists and engineers openly in relation to agreeing to help set up a meteorological satellite ground station at Esrange in northern Sweden in 2011 and a project to build an antenna system near Santiago, Chile, in 2010.

SSC also established an extension of one of its Dongara sections for China as ‘ITAR-free’ (clear of restrictions under the International Traffic in Arms Regulations, the U.S. rules that govern exports and imports of defense-related items). None of this was secret—all three of these items were announced in an SSC newsletter in June last year.

Through separate subsidiaries, SSC operates two distinct Dongara ground stations—Dongara West and Dongara East. Dongara West is owned, operated, and maintained by SSC’s U.S.-based subsidiary, Universal Space Network (USN). It has been in operation since 2001, eight years before USN’s purchase by SSC. USN operates under U.S. government approval and oversight and mainly serves U.S.-government and commercial customers.

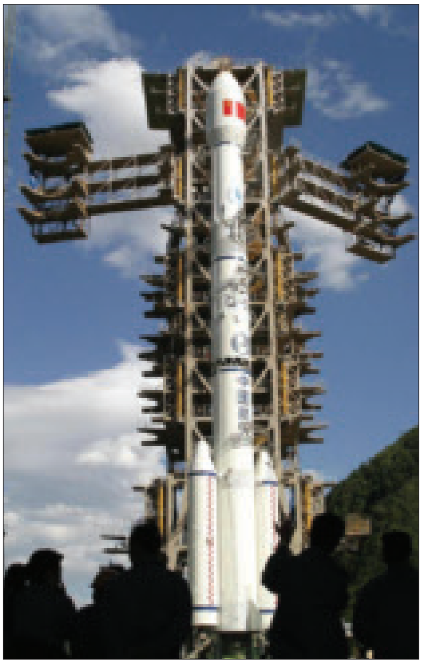
Dongara East is a new facility that is owned and operated by SSC. It provides spacecraft-related services to European, Asian, and other civil space agencies and commercial space companies. It was used by SSC to support the docking between Shenzhou 8 and Tiangong 1.

Each of the facilities has its own control center and separate antennas and ground equipment, and SSC and USN maintain what SSC describes as “separate and distinct capabilities between its Dongara West and Dongara East ground stations.”

The docking target for the November effort was a sample module of the future Chinese space station, called Tiangong 1.

The fact that Australia is a strong U.S. ally had nothing to do with China’s need for another ground station (or as many as it can get), which is a product of simple physics. The Tiangong 1 target was in a low Earth orbit, limiting the ‘visibility’ of any single point on the ground to its sensors to about 15-20 min. Its time for each orbit was about 90 min, so each time it came around to the same latitude the Earth had moved eastward by about 1,350 nautical miles. Communications between the satellite and the ground are therefore limited to places covered by a circle below the satellite of 4,800-3,600 nautical miles in diameter, a circle that is apparently moving southward at more than 14,000 mph. A spread of ground stations is therefore needed to maintain contact with the spacecraft; but even then, coverage is incomplete.

China has in the past used four ground stations, in Pakistan, Namibia, Kenya, and Chile, as well as its domestic tracking stations and a fleet of ships equipped with large dish antennas. For Shenzhou missions, the three Yuanwang (Long View) ships have previously been deployed to the Yellow Sea in the western Pacific, the South Atlantic, and the Indian Ocean off the coast of western Australia. The use of Dongara near Perth thus frees one ship to be deployed elsewhere,



The first Tianlian data relay and tracking satellite was launched on Long March 3C in April 2008.

extending coverage of communications with the spacecraft.

In addition, although it may have been necessary for political reasons to use the ships, they are necessarily moving points of reference and so inherently less accurate in orbital measurements than ground stations or other satellites referenced to ground stations.

There are also two Tianlian (Heavenly Link) tracking and data relay satellites, the second of which was launched in July, before Shenzhou 8's docking mission. According to the Internet magazine *Spaceflight Now*, the ground stations provided only about 12% coverage of each orbit; the Tianlian satellites in geostationary orbits have increased this to more than half of each orbit.

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The simple fact is that China is proceeding with its space projects and is gaining ground in its quest for knowledge and ability at its own pace. It is not in a race with the U.S., unless the race is a marathon. Nor is it in any hurry to cooperate with U.S. space efforts. Why would it, when U.S.-inspired export controls are aimed at it?

Having been kept out of U.S. space activities for some years, China has had to develop at its own rate and find its own solutions—whether or not these are 'borrowed' from other countries' technologies is another story.

This has led to a situation whereby now, if a Chinese spacecraft were—in theory—asked to rescue people from the international space station, it would be unable to help because its docking equipment does not match that of the ISS or the Russian spacecraft that now resupply it.

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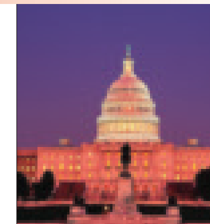


'New' defense strategy takes center stage

To announce what was billed as a new defense strategy for America (although some critics saw little change), President Barack Obama went to the Pentagon itself on January 5 and spoke to reporters. No one in Washington can remember any president ever before having stood at a podium in the Pentagon.

Obama said the U.S. is "turning a page" after having killed Osama bin Laden, ended the war in Iraq, and begun winding down in Afghanistan. "Our military will be leaner, but the world must know the United States is going to maintain our military superiority," said the president, who stood beside Defense Secretary Leon Panetta and Army Gen. Martin Dempsey, chairman of the Joint Chiefs of Staff.

Congress has declared an official 'end date' for the war in Iraq—December 15, 2011. The declaration has legal significance for veterans' benefits. Obama said his administration would not repeat mistakes made after WW II and Vietnam, when defense reductions left the military poorly prepared. "As commander in chief, I will not let that happen again," he said. "Not on my watch."

It was not the first time Obama had gone to some length to function in his capacity as commander in chief. He was very much involved in the special operations mission that killed the al-Qaeda leader, even to the point of deciding at the last minute how many helicopters should be used.

The administration says the military was due for reshaping and that a downsizing of the Army and Marine Corps, which is key to the plan, would have come whether or not the nation faced a fiscal crisis. Nevertheless, in a letter to lawmakers that accompanied his presentation, Obama wrote, "We must put our fiscal house in order here at home and renew our long-term economic strength."

As a companion to the Obama announcement, the Pentagon released new strategic guidance, "Sustaining U.S. Global Leadership: Priorities for 21st Century Defense." The paper is the product of an internal review ordered by Obama last April, following his direction to cut at least $400 billion from the military over the next 12 years. That figure has since been increased to $450 billion by administration fiat, and could rise by a further $500 billion if a mandated process called sequestration kicks in next January. Although the paper speaks to U.S. dominance in the Pacific, acknowledging a need for greater preparedness in the region where China is strongest, it also looks to a sharply reduced U.S. presence on land and sea elsewhere in the world.

Critics were divided between those who thought that the president's announcement contained too little real news and those who thought it contained too much.

Almost immediately after Obama's statement and follow-up remarks by Panetta, Rep. Howard 'Buck' McKeon (R-Calif.) called the president's plan "a lead-from-behind strategy for a left-behind America." Reflecting the view of many conservatives that defense should be exempt from budget cuts, McKeon said, "The president has packaged our retreat from the world in the guise of a new strategy to mask his divestment of our military and na-

President Barack Obama walks with Secretary of Defense Leon Panetta and Gen. Martin Dempsey, chairman of the Joint Chiefs of Staff, to a briefing at the Pentagon on January 5. DOD photo by Erin A. Kirk-Cuomo.

tional defense." McKeon warned that if the U.S. steps back, "someone will step forward," another reference to China, which is maintaining robust armed forces.

According to analyst Winslow Wheeler of the Center for Defense Information, 'winners' under the new strategy are ISR (intelligence, surveillance, and reconnaissance), special operations forces, cyber warfare, science and technology, and 'weapons of mass destruction,' meaning the nation's strategic nuclear forces. The 'losers,' indicates Wheeler, are ground forces, bases in Europe, personnel benefits except for pensions, and the F-35 Lightning II JSF. Wheeler says the focus on Asia reemphasizes the roles of the Air Force and Navy at the expense of the Army and Marine Corps.

Rep. Howard McKeon

Sorting it out

When we went to press, the Obama administration was promising to reveal details about its strategy in late January. This would include the number of soldiers and Marines to be cut, whether the Navy will mothball one of its 11 aircraft carriers, and whether DOD will implement an expected slowdown in JSF production. Before the president's announcement, the Army was already slated to drop from 570,000 to 520,000, and speculation now revolves around a possible end strength as low as 470,000. U.S. forces are already smaller than they were at the time of Pearl Harbor, and critics on both sides of the aisle say the Pentagon has focused too much on counterinsurgency and too little on 'peer' warfare with a modern nation-state like China or Iran.

The National Defense Authorization Act makes a significant change in the ground rules governing the Joint Strike Fighter, which has been vexed by scheduling and technical delays.

Even before the president's announcement, key figures in industry, on Capitol Hill, and in the White House had begun trying to sort out the prospect of dramatic cuts in defense and aerospace programs. "A climate of uncertainty is hanging over everything," said Rep. Steny Hoyer (D-Md.) prior to the president's Pentagon appearance. In the wake of the announcement, doubts persist that any meaningful spending cuts will come after the November 6 election.

The sequestration process, which is set to take effect next January under existing law, will dictate across-the-board federal spending cuts of $1.2 trillion, with half the cuts coming from defense expenditures. Sequestration will be sudden and painful, Washington observers say. The process has been likened to carpet bombing—unfocused and indiscriminate.

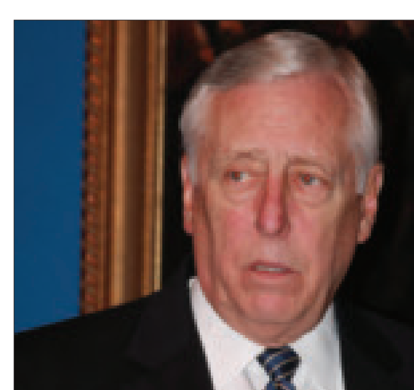
And even though sequestration will cut much more deeply than Obama's plan, some economists say it still will not be enough to ease the dangers posed by ongoing deficits and the national debt.

When Obama announced the new strategy, lawmakers were already—and belatedly—finalizing existing defense spending plans for the current fiscal year and hinting at major changes for the next. Jason MacDill, a former Capitol Hill staffer, commented that this calendar year is likely to be the last "in which things are done more or less normally."

On December 31, Obama signed an FY12 spending bill that authorizes $662 billion for military people and weapons, the war in Afghanistan, and nuclear weapons work in the Dept. of Energy.

The president signed the bill but did not like some of it. The National Defense Authorization Act (NDAA) was controversial enough for Obama to express "serious reservations" about provisions that regulate the detention, interrogation, and prosecution of suspected terrorists. Using military commissions rather than civilian courts to conduct trials of detainees who are alleged al-Qaeda terrorists has been a hotly debated topic in Washington. The NDAA would give commissions and prosecutors greater powers. Critics say the measure undermines civil liberties and, in an extreme case, could permit the government to apprehend anyone off the street without suspicion, charge, or indictment.

The rest of the NDAA contained no surprises for the nation's defense and aerospace industries, which are pessimistic about federal spending on major programs in the years immediately ahead.



Rep. Steny Hoyer

Lance Cpl. Lance Souders shows an Afghan police officer how to use a metal detector while conducting a partnered patrol around the precinct Faslodeen in Afghanistan. During his January 5 briefing, the president noted that the war in Afghanistan is winding down. DOD photo by Lance Cpl. Ammon W. Carter.

The bill made what some say is a significant change in the ground rules governing the JSF, which has been beset by scheduling and technical delays. In a bid to curb cost overruns, lawmakers inserted language that requires contractor Lockheed Martin to absorb certain costs if they exceed a negotiated ceiling in a forthcoming Pentagon contract.

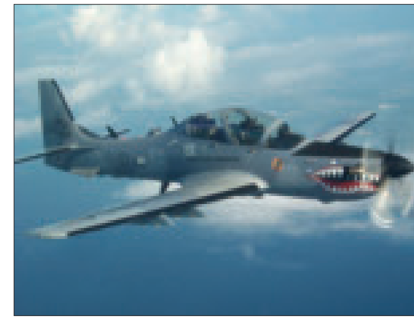
In a Capitol Hill gesture that MacDill calls “a drop in the bucket” in the context of the nation’s financial ills, the NDAA gives the Pentagon $27 billion less than the administration sought and $43 billion less than last year’s legislation provided.

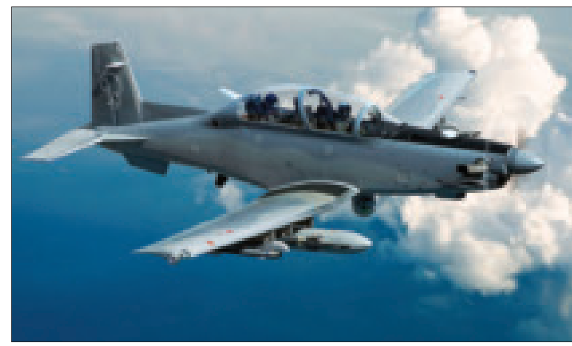
Perhaps the most important aspect of the defense authorization bill—and what it has in common with the newly announced strategy—is that it contains no major cuts of any military programs. The Army will continue to recapitalize its fleet of tactical vehicles, which was tailored for roadside bombs in Iraq and is not well suited for future conflicts. The Navy is continuing to examine its 11-deck aircraft carrier fleet and the cost of operating its carriers and carrier air wings. A discussion of prematurely retiring the aircraft carrier George Washington as an economy move is ‘on hold’ under the NDAA, and Panetta is said to oppose it as part of the new strategy. The Air Force is continuing to develop a new bomber.

The Air Force also intended under the NDAA to move ahead with a purchase of 20 light armed aircraft, the Brazilian-designed Embraer EMB-314 Super Tucano, for its Light Air Support (LAS) program for counterinsurgency in Afghanistan.

The selection of this aircraft for LAS, made on December 22, became known at 5:00 p.m. on Friday, December 30, when a routine roster of federal contracts was released at the end of a slow day in a slow week during the holiday season. It happened a month after the Air Force ruled out the U.S.-built Hawker Beechcraft AT-6B Texan II as a candidate in the LAS effort. Despite its name, the Texan II is manufactured in Wichita, and the unannounced revelation that the Super Tucano was being picked infuriated the Kansas congressional delegation.

Sen. Pat Roberts (R-Kansas) called the selection “impossible to understand.” On January 5 the Air Force announced it was suspending the $355-million contract because of a lawsuit by Hawker Beechcraft—although there appeared little doubt the reason for the suspension was the reaction by Roberts and his colleagues.



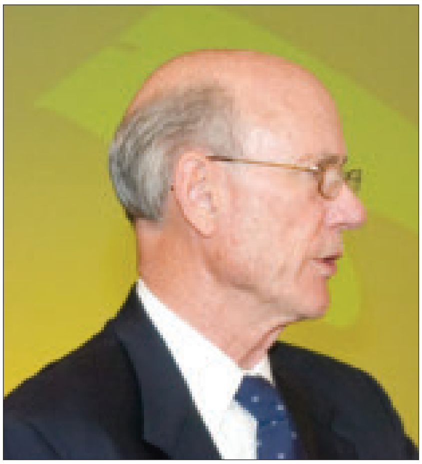


The Air Force planned to purchase EMB-314 Super Tucanos (top) for its Light Air Support program, a plan that was challenged by the manufacturers of the AT-6B Texan II.

The defense authorization measure increases sanctions against Iran at a time when Washington is buzzing with rumors of a possible military strike by Israel or the U.S. against Iranian nuclear facilities, and when naval jockeying is taking place in the Strait of Hormuz.

The law includes language that allows the president to waive the sanctions if he determines they would threaten national security. This is considered a gesture toward those in the nation’s capital who want to negotiate with moderate elements in Iran rather than confront the radicals in power in

Naval jockeying continues in the Strait of Hormuz. Navy photo by Mass Communication Specialist 3rd Class Kenneth Abbate.



Sen. Pat Roberts opposed the selection of Brazil's EMB-314, and on January 5, the Air Force announced it was suspending the contract.

that country. When Iran tested a surface-to-surface cruise missile near the Strait of Hormuz on January 2 and threatened to block shipping in the strait that accommodates at least 20% of the world's petroleum shipping, it was a setback for those in Washington who favor a moderate approach.

Administration's 2013 plan

With the ink barely dry on FY12 documents, the Pentagon is working to craft an administration proposal for FY13, which now will follow details of the new strategy.

Although Panetta took office last year with a reputation as a budget cutter, ever since he arrived at the Pentagon he has vigorously defended military programs and cautioned against dramatic reductions. The math is very difficult for Panetta: Even without the certainty of sequestration, there is no easy way to achieve the defense cuts that are already planned.

In a November letter to Senators John McCain (R-Ariz.) and Lindsey Graham (R-S.C.), the secretary wrote that the administration's planned cuts "are difficult and will require us to take some risks, but they are manageable." However, he continued, the larger cuts mandated under sequestration, "would tie [the Defense Department's] hands."

Walter Pincus of the *Washington Post* wrote that because of preoccupation with the budget crunch, Panetta will have difficulty wielding decisions on the war in Afghanistan, the postwar period in Iraq, Iran's nuclear ambitions, Israeli issues, U.S.-Pakistan relations, and China's growing military. It seems fairly certain that deficits, debt, and dollars will remain the focus not just of everyone in Washington but of the electorate in the U.S. heartland as well.

Robert F. Dorr
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John Gedmark

What is the Commercial Spaceflight Federation?

Our members are companies and other organizations that are focused on commercial human spaceflight. The Commercial Spaceflight Federation was formed to allow the industry to present a united front to policymakers and regulators, and to do inner-industry coordination.

Describe the commercial spaceflight industry.

It's made up of different types of organizations: companies developing suborbital vehicles, companies developing orbital space transportation, and those involved in developing and building spaceports; those three core types are now joined by suppliers as well. The core members came together to form the Commercial Spaceflight Federation in 2005. The driving force was the first X Prize, in 2004. The federation was structured so that its voting members are the initial core group of companies, and they direct organizational matters and policy.

What is that policy?

It is based on the vision of our core group, a vision of where they want to be and where they want the commercial spaceflight industry to be 10, 20, 30 years down the road. Everyone who works with us has a good understanding of what that vision is, and it's not going to change.

Talk about your vision. What is your main goal?

It's really all about opening up space to everyone. That is our vision, our ultimate goal, to get as many people as possible flying in space, and on as many vehicles as possible, and to create the largest possible market for commercial space ventures. The necessary first step in making space available to everyone is to get launch costs down and get reliability up. If we can achieve high reliability and low cost for space launch and space transportation, we will fundamentally change the game. High flight rates are the silver bullet, our key to success.

Why is that?

The more flights we have, the better off everyone will be. High flight rates mean lots of players, lots of competition, greater availability, and lower costs. Having many ways of getting into space reliably, quickly, and frequently will result in the largest possible market for these companies.

Where do you stand currently, and what is the immediate focus of your companies?

Several of our member companies are already building reusable vehicles for suborbital spaceflight. Meanwhile, several companies are developing vehicles to access low Earth orbit, and they are supporting NASA in developing that technology.

The federation seems to be growing into something big. How much has it grown since its inception?

It has expanded quite a bit. We now have over 50 member compa-

John Gedmark is the founding executive director of the Commercial Spaceflight Federation. He previously served as the first director of operations for the X Prize Cup.

For both the 2005 and 2006 X Prize Cup events, Gedmark managed a diverse array of rocket launches, including the first-ever public flight of a vertical takeoff/vertical landing rocket vehicle, conducted by Armadillo Aerospace before a crowd of 20,000.

Previously, Gedmark worked for TRW, Ball Aerospace, and Aerojet in a number of areas, including spacecraft design and rocket engine development.

Gedmark holds a bachelor of science degree from Purdue University and a master of science degree from Stanford University, both in aerospace engineering. At Purdue, he received the Herbert F. Rogers Scholarship, awarded each year to the most distinguished graduating senior of the Purdue School of Aeronautics and Astronautics. While at Stanford, Gedmark cofounded the Roosevelt Institute, a nonpartisan public policy think tank for students. The institute is now active on more than 80 university campuses nationwide.

Interview by James W. Canan

"If we can achieve high reliability and low cost for space launch and space transportation, we will fundamentally change the game."

nies, including Pratt & Whitney Rocketdyne, Aerojet, United Launch Alliance, SpaceX, Bigelow, Virgin Galactic, Blue Origin, Sierra Nevada, and many more. Our members also include suppliers, service providers, and the like. Basically, any company or organization that wants to support the commercial spaceflight industry is welcome.

How does the Boeing/Lockheed Martin/ULA joint venture come into play?

ULA is providing launch service on its Atlas and Delta rockets for a number of our member companies. ULA plays a huge role, because so many of these companies want to launch on ULA rockets. SpaceX has its own Falcon rockets, of course.

Are your companies involved in developing this new super-heavy-lift rocket?

No. That's a NASA program for a rocket to provide heavy lift beyond LEO. It's separate from what our member companies do. SpaceX's Falcon 9 and ULA's Atlas 5 will allow crew and cargo vehicles to service the ISS.

Much of the general public seems to associate commercial space with space tourism. Sort that out for us.

It is important for people to recognize that space tourism is just one piece of what our industry wants to achieve. For example, Robert Bigelow has said that he is interested in partnering with other countries, and he has a business model that is based on what we call 'sovereign flights': providing space transportation for the astronauts of other countries—European countries, Canada, Japan, South Korea, for example. This is all the more important now that the space shuttle has been retired and the Russian Soyuz is having problems. Many nations have spent a lot of time and money on training their own astronauts, and now they have no way of flying them into space.

Scientific research missions have high potential for your companies too, don't they?

We have been doing a lot of work with the science community on reaching several goals in suborbital research missions. Everything from space science, Earth science, and heliophysics to biomedical research, developing microgravity research, those kinds of things. There are all these things that we can do with suborbital vehicles that simply could not have been done before. The U.S. hasn't had a suborbital vehicle since the X-15. So having that capability now is very important.

Suborbital flight seems to have been an afterthought in recent years.

Certainly after the Apollo program ended, the focus became orbital space launch and then beyond-LEO exploration. So we're really getting back to basics here. We're starting with smaller incremental steps and will work our way up. The country went down the path of big systems that you throw away every time you launch them. Now we're saying that what we really want is spaceliners, reusable vehicles that will fly us to space and fly us back down, spaceliners that we can refuel and launch again and again. So why not start with suborbital vehicles as our first step and try to build re-usability into them and learn how to operate them, focus on how to fly and operate them as much and as frequently as we possibly can?

So how's it going?

Several of these companies have been making great progress in developing suborbital vehicles: Virgin Galactic, XCOR, Masten Systems, Armadillo Aerospace, and Blue Origin, for example.

How would you describe their progress in, say, just the past year?

Once the X Prize was won, I think people expected that these kinds of vehicles would be up and flying fairly quickly. The X Prize was a race to accomplish very specific objectives. But then companies took a step back and decided that what they really wanted was to build their vehicles to service the space market as an ongoing business concern, as opposed to running another [technology] race.

The main thing was to take their time and get it right, and make sure that the vehicles would be as safe as they could possibly be. And that, of course, resulted in their development taking longer than might have been expected.

"...what we really want is spaceliners, reusable vehicles that will fly us to space and fly us back down, spaceliners that we can refuel and launch again and again."

Is the slower pace frustrating?

A great many people are very anxious to get into space. I understand their impatience. I also am impatient to get into space; however, taking our time and getting it right is extremely important.

So you don't see the slower pace as a sign of weakness or lack of resolve—or money.

Not at all. And people have to realize that these companies for the most part are not seeking outside investments. They have all of the investment and funding in hand that they need to see things through. That is very important and reassuring.

Some people may ask why your member companies are seeking and accepting funding from NASA.

The answer is quite simple: NASA has a very urgent need to find a way to fly U.S. astronauts to the space station. And it is now the official policy of the United States government, and of NASA, that the commercial taxis being developed by these companies will be the primary means by which NASA will get its astronauts to the space station. That is a really big deal, when you think about it. And by funding these companies, NASA can accelerate their development of crew capsules and winged vehicles to fly to space on existing launchers.

Which companies are involved at the moment?

Four companies are currently under agreement with NASA to begin that work: SpaceX, Sierra Nevada, Boeing, and Blue Origin. Boeing is partnered with Bigelow Aerospace. SpaceX will launch its crew capsule on its Falcon 9. The others will launch on Atlas 5. Atlas 5 and Falcon 9 have already flown successfully into orbit.

There must be some problems. Can you talk about that?

The fundamental problem has been the national space policy, determining which direction NASA will be headed. I think we've seen everyone moving toward a consensus now on how to move forward, on deciding details like what sort of vehicles to build and how the program should be run. This is a major sea change recently from the way things were done in the past.

How does your organization fit into all that?

The Commercial Spaceflight Federation has worked very closely with NASA and with Congress to put together these new programs—the commercial crew-and-cargo transportation program and various space technology programs—and to determine how those will be structured and what their funding will look like. We're proud to say we've seen a lot of success there. Just a few years ago, it would have been unheard of for NASA to be relying on commercial space companies. NASA will be the anchor customer, but not the only customer. Other customers will also be buying rides into space.

"The fundamental problem has been the national space policy, determining which direction NASA will be headed. I think we've seen everyone moving toward a consensus now on how to move forward..."

Such as?

Sovereign nations and the science community, among others. We are expecting customers from the world of entertainment—sponsorship dollars, TV advertising, for example, and celebrities flying in space, to the space station or to a Bigelow space habitat. Also private individuals who have always wanted to fly in space and have been tremendously successful in one business or another, and have the resources to enable them to do that. With all those potential markets, we do see a bright future for commercial spaceflight.

Have you had any overtures, any feelers, from the science community, for example?

Oh yes. We work very closely with the science community. Every year we help organize a conference that is focused on science. Several hundred people attend each one, including people who are developing new technologies at NASA. A big part of their work is proving out their technology by flying it in space, and so they are very interested in using these commercial vehicles. The space shuttle system was set up in such a way that it took a very long time for anyone to get a payload onto the shuttle, a multiyear effort. We think the private sector can bring that time down and at the same time lower the costs for spaceflight experiments. We are really excited about the prospects.

Which science experiments in space hold the most promise?

There are some science microgravity experiments that researchers want to get at very quickly after the vehicle returns from space. If they are growing cultures in space, they need to have access to them very soon after the space vehicle returns into gravity.

The success of commercial space enterprises depends upon the successful development of reusable vehicles, doesn't it?

Ultimately it will, yes. That's where we have to go.

Is a single-stage-to-orbit vehicle in the cards? Or is it tangential to what your commercial spaceflight companies are trying to achieve?

We certainly hope to get there some day, but a single-stage-to-orbit vehicle is not required right now. Our member companies don't need technology breakthroughs in developing their current vehicles. From a business standpoint, their goal is to build space vehicles and systems that get costs down and get reliability up as much as possible. This may result in a single-stage-to-orbit vehicle some day, or it may not. The real key, the ultimate goal, is reusability—multiple reusable stages and vehicles.

Give us a recent example of tangible progress in fulfilling the economic promise of commercial spaceflight.

Spaceports. Not long ago, we had the ribbon-cutting ceremony for Spaceport America in New Mexico, for the big new hangar facility there. Virgin Galactic is the leading player in that spaceport. It's a really big deal. From what we've seen so far, the spaceports that will serve our industry will provide huge economic opportunities for the regions and the communities around them.

What is in store for commercial spaceports?

We're still in the early stage of figuring out how it is all going to work, how the operations will work. Some of the spaceports will be airports as well, so we have to develop an air traffic control system for aircraft and spacecraft using the same facilities. Dual use is great, because it means lower costs all around. We will also continue working on the regulatory framework.

So you expect a number of spaceports to begin taking shape over the next few years?

That is correct. In the next few years, test flights of suborbital vehicles and orbital vehicles will begin ramping up. It will be exciting; there will be so much going on. Space enthusiasts among the general public will have something new to see and experience every week.

Will that rekindle the public imagination and optimism about the role and future of our country in space?

Absolutely, and especially when it comes to our young people. There are few things that can get young people more excited about science and technology, I believe, than watching a rocket launch. There are very few activities that are so dynamic and stimulating—the sound, the light, watching this marvel of engineering lift up into the sky. The more space launches and flights our students can see and learn about, the more progress we're going to make and the more we will get our young people interested in space and in science again.

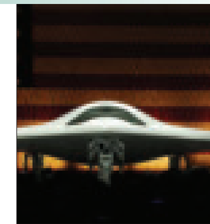
Your own excitement and enthusiasm are obvious. You seem to have a big personal stake in getting through to young people, to students, and in making space beckon to them once again.

I do. My background is in aerospace engineering. I was a Purdue undergrad in the early 2000s, before the Columbia accident. The halls of Purdue's aerospace engineering building were decorated with pictures of impressive-looking space vehicles. The problem was that none of them had ever flown. They had been designed and developed as X vehicles or as replacements for the shuttle. Billions of dollars were spent on them, but they were all canceled before they were ever flight tested. That was very frustrating to me. It made me wonder whether the aerospace industry was doomed to be stuck in a rut forever. So that was a low point for me.

"The real key, the ultimate goal, is reusability—multiple reusable stages and vehicles..."

And then what happened?

Then came the X Prize, and what it did—certainly for myself and, I would have to think, for thousands of people and students across the country—was offer hope that we were going to get out of the rut, that we were going to start flying cool new space vehicles again, focusing on innovation, trying out new things, new designs, and new technologies, getting many people and businesses involved and being competitive. So it has been a real privilege for me, being able to see all that unfold and to be a part of it over the past few years.



Man vs. machine: The future of electronic attack

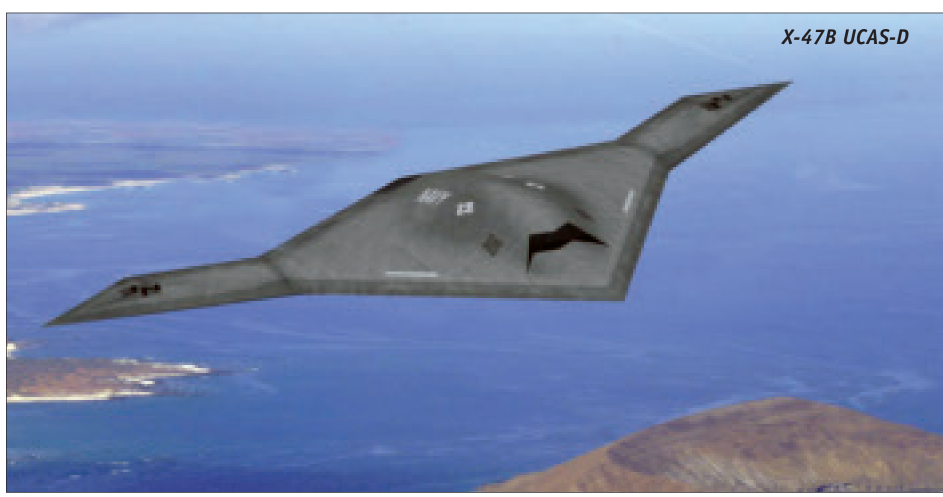
WHO OWNS THE FUTURE OF ELECtronic attack? With manned aircraft likely to dominate the military fighter market for decades, and UAVs increasingly tasked for intelligence, surveillance, and reconnaissance, which will control the middle ground of radio frequency (RF) electronic attack—piloted or robotic aircraft? Which platforms will win the battle of electronic jamming? Will we cringe as hundreds of stealthy unmanned combat air vehicles (UCAVs) jam the too-few F-35s and tear through the infrastructure of human life? Let's take a look at some future programs—still uncontracted to developers or producers—and the likely outcomes for a number of the newest human and machine RF and electronic attack (EA) systems.

Stealthy UCAVs, stealthy programs

The Air Force had been the world's pioneer in UCAV technology, planning one of the first missions of its Block 10 X-45 UCAV as a lethal suppression of enemy air defenses (SEAD) platform. But in 2006 the service canceled this program and seemingly lost interest in UCAVs. It is now clear that classified developments continued. Lockheed Martin's RQ-170 Sentinel is one definite indication of this, but there are likely several other programs as well, perhaps aimed at both tactical strike and long-range requirements.

A tactical program might be meant to provide SEAD in a more hostile future air defense environment, and long-range stealthy UCAVs have been proposed for future nuclear bombers. (The author, for one, hopes these vehicles remain classified—stealthy robot bombers armed with nukes and controlled by wikihackers are not a calming prospect.)

The Navy has been more public (and less ominous) about its plans. In March 2010 it released an RFI for UCLASS (unmanned carrier launched surveillance and strike), a next-generation follow-on to the current Northrop Grumman X-47B UCAS-D, which began a series of 49 weekly flight tests in February 2011. A UCLASS RFP was expected this year, and "the Navy wants UCLASS in the fleet in 2018," according to Boeing. In June 2011, however, Boeing received only a $480,000 pre-Milestone-A study contract from the Navy. Even with an RFP this year, 2018 would reflect an extremely short development period, considering that the UCAS-D demonstration will not be completed until 2013, and carrier tests will only begin this year.



X-47B UCAS-D

Regarding sensors, major development funding has not been made public, and attention has recently focused on expanding the flight envelope and autonomous capabilities. But UCAS-D was to incorporate a derivative of Raytheon's AN/ALR-69U electronic support measures (ESM) system, as had been planned for the J-UCAS before it, with four upper and four lower antenna locations to satisfy the Navy's coverage requirements.

The Marine Corps continues to insist it will not buy any manned F/A-18E/F/G Super Hornets, including the EA-18G Growler, leaving an urgent need for a new tactical EA aircraft. The planned Prowler replacement has long been a version of the JSF, but in 2009 the Marines also began to look actively at UAV systems, based on a 'Tier III' UAV with 14-30-hr endurance, a radius of 350-450 mi., and a 1,500-lb payload. A UAV jammer would have the strong benefit of not putting live crew in harm's way for close-range jamming missions.

However, it may be significant that the UCLASS designation has added 'surveillance' to 'combat' and 'strike,' and the Navy now seems to be stepping back from extreme stealth requirements, instead emphasizing endurance and carrier capabilities. This could decrease the utility of a SEAD UCAV, but Teal Group believes funding for UCAV EA will grow steadily through the decade, for both classified and unclassified programs. Teal's UCAV EW (electronic warfare) forecast is highly speculative, and includes both EA and ESM systems. Any single major procurement program, classified or unclassified, would likely make our numbers look conservative.

For the less stealthy

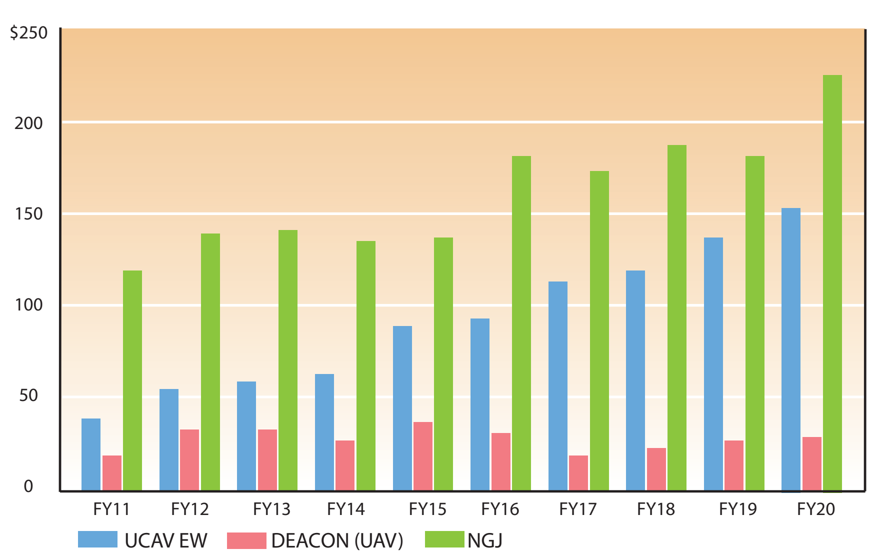
Outside the stealth realm, the USAF is looking for "a low-cost, rapidly field-able countercommunications system" in a pod that can be integrated on UAVs and medium and large manned aircraft (possibly A-10s and C-130s). Up to four 18-month technology development contracts were planned for late 2011 for the new $200-million DEACON (disruptive EA of communications networks) program, possibly leading to an EMD award in early 2013, a production decision in the second quarter of FY15, and fielding in 2016.

In November 2010, the Air Force awarded contracts to Argon ST (a division of Boeing), BAE Systems, ITT, and Raytheon to develop technologies for DEACON, intended to operate in an irregular warfare environment and counter nonintegrated air defense targets, especially communications and remote-controlled improvised explosive devices. DEACON is still funded in the USAF B-52 stand-off jammer (SOJ) funding line, despite being intended for a new Block 5 MQ-9 Reaper with greater power generation capability. The Army has expressed interest in a similar counterinsurgent EA pod for its Gray Eagle (Predator) UAV.

C-130

However, after the robust failures of the B-52 SOJ and core component jammer programs, the decision of the Air Force to finally prepare a future system for 'the last war' instead of the next may or may not prove a production winner in a few years. In any case, capability and funding have both shrunk considerably for DEACON versus the earlier manned B-52 jammers—SOJ was tagged as a $7-billion program—leaving more suspicions about classified USAF system funding.

RDT&E PROCUREMENT
FY11 $Millions



There have been continuing solicitations and awards for other minor EA development programs, many for unmanned aircraft, but funding levels and futures for most of these are very limited. For example, in mid-2010 the service solicited for a "cognitive jammer" that is "adaptive, multifunctional (communications, radar, navigation, etc.) and employ[s] multilayer attacks depending on the threat, situation, and scenario." That sounds like a major effort, but the four-year contract with two option years is valued at only $2.45 million.

The Marine Corps' AN/ALQ-231 Intrepid Tiger II communications jamming pod has been funded for $0.3 million in FY11 and $6.6 million in FY12. And the Army's CEASAR (communications EA with surveillance and reconnaissance) prototype pod is not yet a program of record and has received only minimal funding.

DARPA's advanced electronic warfare program (formerly PreEW, or precision electronic warfare) is developing a system for highly precise communications jamming. This program has received moderate funding ($13 million in FY10 and $10 million in FY11), and is planned for transition to the services, but it is still very minor compared to the myriad projects and the hundreds of millions of dollars in funding for manned programs such as Compass Call, Growler, or JSF.

Manned EA at risk: Next-generation jammer

Funding began in FY09 for development of the Navy's next-generation jammer (NGJ), intended to replace or possibly upgrade the AN/ALQ-99 jammer on EA-18G Growlers somewhere in the 2015-2020 time frame. In addition, a new NGJ could be procured by the Marine Corps for mounting on a JSF or a UAV, which would then replace Marine Prowlers.

Marine Corps plans for several years have involved the possibility of the JSF as the follow-on EA platform when EA-6B Prowlers are retired later this decade. But realistically, considering delays in just getting JSF in the air, and the greater delays with baseline software and mission systems development, it is very unlikely a JSF jammer aircraft will be ready in time. Earlier, the hope was to use the JSF's AN/APG-81 radar as a primary standoff jammer, but unless massive classified development has already occurred, this capability is more likely a development for the next decade or later.

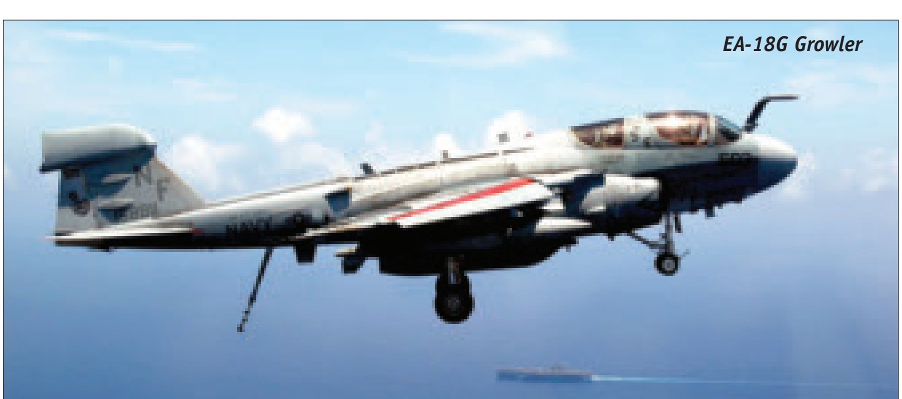
Much has been written about potential NGJ technologies, especially the need for multiple high-FOV (field of view) broadband phased-array antennas to cover a much broader frequency range and field of regard than AESA radars, whose flat-array antennas typically provide only a 120-deg FOV. The Navy also hopes to incorporate 'network invasion,' such as that being tested for the USAF's EC-130 Compass Call aircraft, to inject invasive algorithms into the antennas of various electronic systems (not just air defenses). The Navy so far has kept four NGJ development teams in the game, hoping to cherry-pick the best technologies for an eventual RFP, rather than working with a more typical initial program specifications list.

Joint Strike Fighter

The FY12 budget planned 'primary hardware development' awards for NGJ to four different companies, each due to receive $25.9 million in 2011: ITT, BAE Systems, Northrop Grumman, and Raytheon. Each has already received about $22 million for NGJ from the Navy.

But with EA-18G Growlers still in production—with brand-new ICAP-III EA suites—Teal Group sees it as unlikely that the Navy will get even newer NGJs for these aircraft in the next 10 years. And given expected budget cuts, the more sensible plan to add the NGJ to the JSF for the Marines now also rests on a knife-edge, as the Pentagon has delayed major RDT&E milestones and looks close to consigning the program to technology development status for this decade. In 2009, the Marines anticipated NGJ initial operational capability in 2018, aligned with the Block 5 JSF. Both schedules have now slipped.

And even if it is funded, in 2010 Rick Martin, director for EW at Boeing's Phantom Works, pointed out that EA-18G development took six years and $1.2 billion, despite starting with a stable Super Hornet Block 2 configuration (and preexisting ALQ-99 pods). "To develop a platform, a complete electronic attack suite [for F-35] in eight years violates mathematics," he said. Practical advice, coming from a source who wants the contract as much as anyone.



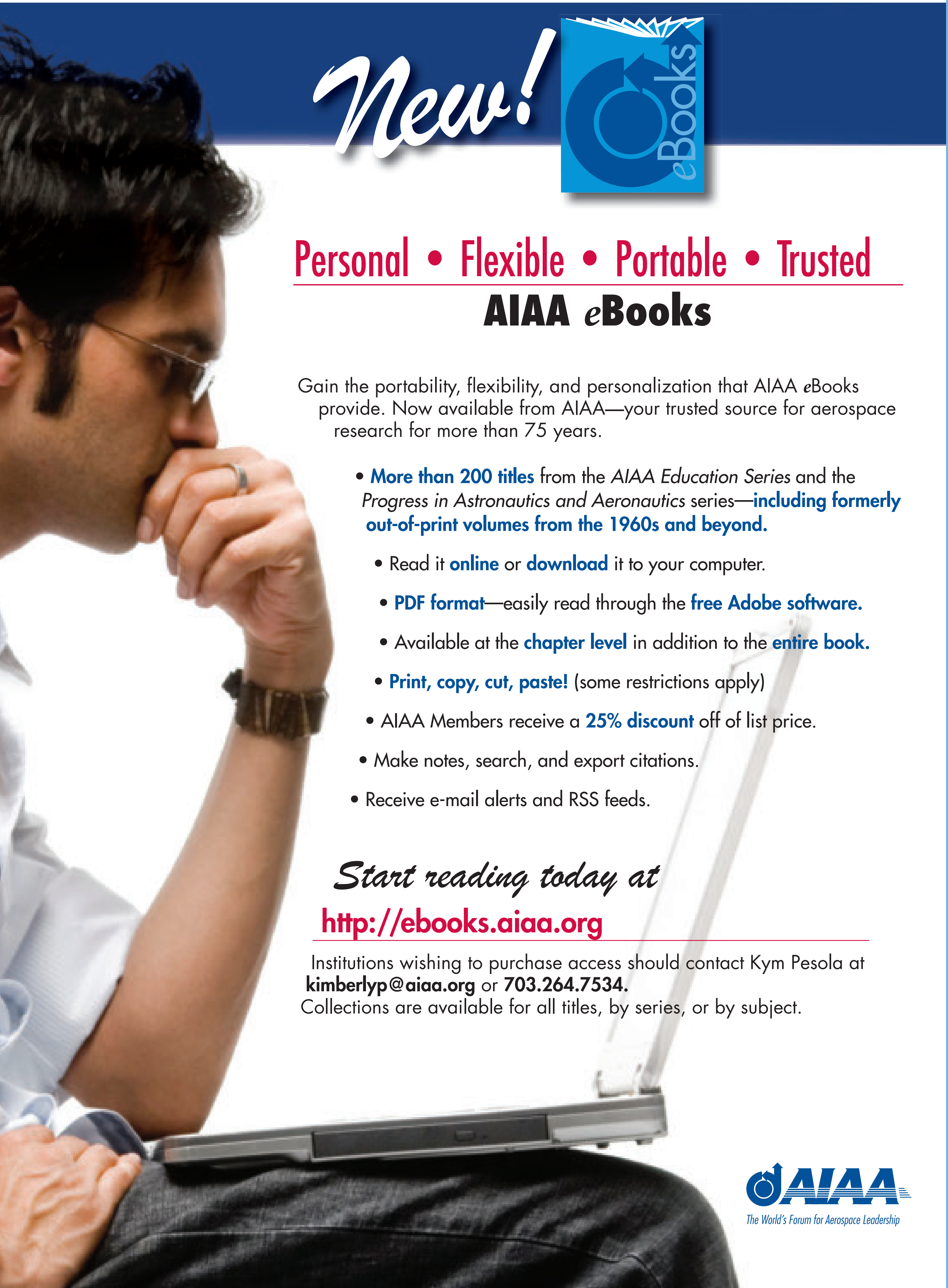
EA-18G Growler

✈✈✈

In short, our speculative forecasts for these new manned and unmanned EA programs show substantial future funding for both sides, and good opportunities for developers and manufacturers. However, if we include major ongoing programs such as Prowler and Growler, and the USAF C-130-mounted manned Compass Call program, manned EA will continue to dominate for at least the next decade.

After 2020, robots may be better placed to terminate the manned advantage, as will man himself, perhaps.

David L. Rockwell
Teal Group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Science spacecraft learn self-control

ONE OF THE MONEY-SAVING IDEAS percolating at NASA is to make even greater use of automated control and multimission operations for scientific spacecraft.

Since May, for example, computerized telemetry and control have enabled NASA to leave the vaunted Hubble Space Telescope unattended after 5 p.m. and on weekends, although the telescope retains its own control center. "The command and control center is empty evenings, nights, and weekends, but can also be largely empty during the day," says NASA's Patrick Crouse, the Hubble operations project manager, in an email relayed through a spokesman.

Still, automation and the bolder step of controlling multiple spacecraft from a single control room have not gained full traction within the agency. The reasons for this are either cultural hesitation or wise engineering, depending on who's doing the talking.

Scripted control

Among the strongest advocates for automation and multimission control are executives at Honeywell, NASA's prime contractor for Mission Operations and Mission Services, or MOMS. Through this contract, Honeywell helped NASA establish Goddard's Multi-Mission Operations Center, known as the MMOC. Over the span of five years, Honeywell engineers worked with NASA's spacecraft developers to write computerized scripts to replace human keystrokes for such command tasks as contacting the spacecraft, preparing for maneuvers, and receiving science data. The procedures were carefully tested before full control of NASA's Advanced Composition Explorer, or ACE, and Wind spacecraft were formally shifted to the MMOC in early 2010. The question for NASA remains whether additional spacecraft will be controlled there, and which ones.

Even the strongest advocates of automation say there are limits. "One of the golden rules is, if you are burning thrusters or doing some kind of attitude control maneuver, you have to do that manually," says Ed Nace, Honeywell's space sciences mission operations manager at Goddard. Nace oversees 65 engineers, some of whom help run the MMOC. Others are helping the agency automate missions controlled elsewhere.

This caution is necessary because a mistake made during a maneuver could expose an instrument to sunlight, throw the craft out of thermal balance, or shift the angle of its solar arrays, causing a dangerous drop in power. Someone must be on hand to abort the event if necessary.

Nace says pauses are programmed into the automation to allow human operators to step in temporarily to oversee maneuvers but that preparations such as acquiring a spacecraft's signal can be automated.

After all the years of figuring out how to automate operations safely, Honeywell wants to prod the agency, but without offending an important customer. After an initial interview with *Aerospace America,* D.J. Johnson, Honeywell's vice president for space, networks, and communications, sent a clarification via a spokesman: "Automation decisions are based on a balance of where it's practical to reduce cost, and in a way that will not adversely impact mission objectives."

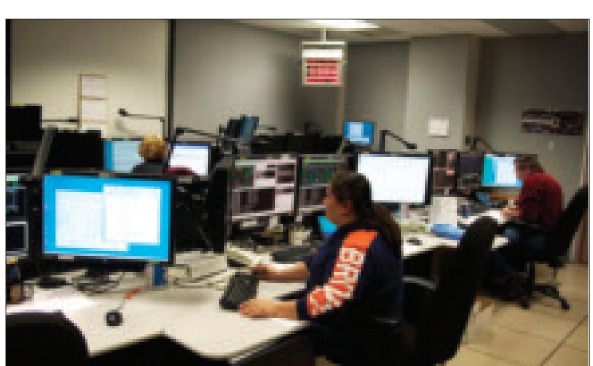
For his part, Nace describes the MMOC as an underutilized asset. It is equipped to control up to 10 spacecraft, he says, but following an operational readiness review in March 2010, it now controls just two very old craft. The first, Wind, was launched in 1994 to study solar wind particles and is now orbiting at the L1 libration point. The other, ACE, carries six high-resolution sensors and three monitoring instruments to sample low-energy solar particles and high-energy galactic particles. Launched in 1997, it has a collecting power 10 to 1,000 times greater than its predecessors, according to NASA. Wind is now the backup for ACE.

A third spacecraft, TRACE (Transition Region And Coronal Explorer), was decommissioned last year after conducting its final observation of the Sun in June 2010.

Old school method

Why are no Earth sciences missions controlled at the Goddard MMOC? "Well," says Nace, "there you get into some politics—the 'not invented here' syndrome."

He points out that NASA's funding for Earth sciences and space sciences, including studies of the Sun, is divided between the two basic mission categories. In Nace's view, the major Earth sciences missions—Aqua, Terra, Aura—have not been subject to the budget pressures that drove NASA managers to place ACE, Wind, and TRACE into the MMOC. Over a five-year period through 2010, he says, annual operating costs were reduced from $20 million to $12 million. "We went from



HST flight controllers work at their consoles in the HST Mission Operations Room at NASA Goddard. Photo by Ed Campion.

three huge MOCs [mission operations centers] to one MOC. We went from about 250 work station-type computers to Red Hat Linux PCs, which are virtually $500 PCs."

There is no reason something like this could not be done in other areas, Nace says. "Earth sciences people have their own idea about where they want to go. They are still in what we call the old school of flight operations, where they have continuous people coverage 24 hours a day."

Honeywell is pushing, but NASA officials say multimission control and additional automation must be considered very cautiously. A manager in the Earth Observing Systems branch says there are sound technical reasons for keeping human operators on hand and maintaining separate control areas for the major Earth monitoring spacecraft. Aqua, Terra, and Aura are controlled at the same Goddard facility, but each has its own control area within that facility.

"The larger EOS missions are extremely complex and may not be fair to compare with Wind and ACE," Goddard's Eric Moyer writes in an email. Moyer is deputy project manager for technical matters in the Earth Science Mission Operations office.

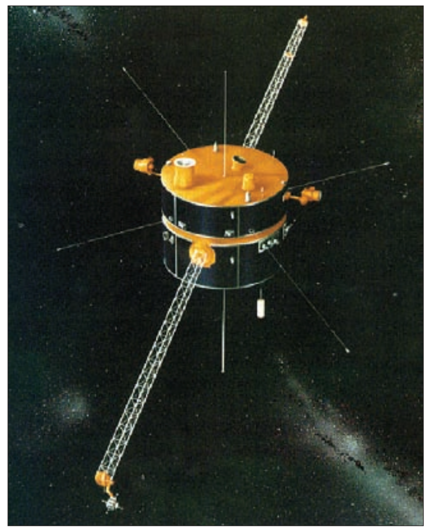
Wind and ACE send their data collections to Earth once a day. "Terra requires the data to be played back every orbit [99 min], or science data will be lost," Moyer says. A person must be on hand to troubleshoot.

In the MMOC, there might not be enough 'reaction time' to fix a problem and avoid loss of data, he says.

A loss of data from Terra or the other environmental satellites could reverberate among global warming researchers around the world, notes another NASA official.

Nace says the staff at the MMOC has thought about this. Automated scripts, he says, can be written with the ability to pause and to alert human operators in the event of trouble.

"You can virtually look on your BlackBerry and see the process you're going through. And if you get a long message that says, 'I'm out of limits,'



Right now, the Wind (above) and ACE (below) satellites are the only ones being managed by the MMOC.

or 'this command didn't go through,' you'll be paged," he notes. "This allows fewer people to do more work. Even during the day, even though we have people here, they may be in the back room doing something else, and you are going through this automatic script to command your spacecraft. If something goes wrong, it alerts them. They can walk into the next room and take charge," he adds.

Even if NASA were willing to risk losing some Earth sciences data on an orbital pass—after all, the environmental changes being measured play out over months and years—managers are unconvinced of the technical and financial sense of turning to multimission control.

"Switching to another command and telemetry system for the EOS missions would require significant hours to reproduce the procedures, plots, and display pages, as well as reverify and revalidate," Moyer says. "Unfortunately, this also would add risk, as many of the critical contingency procedures developed were tested with the spacecraft during prelaunch exercises and cannot be accurately tested against the high-fidelity simulators."

A new focus?

NASA managers have no plans to shift control of the major Earth sciences missions to the MMOC, but this does not mean that they dislike automation, or that they are not trying to learn lessons from the MMOC. Last year, NASA engineers modified the data processing algorithms and logic on board Aqua and Aura to play back science data automatically, says Moyer.

More automation might be possible, but for the past several years NASA has focused on modernizing the ground systems for the EOS missions.

"With this multiyear ground system refresh nearing completion for the EOS missions, the focus is turning toward enhancing automation," Moyer explains.

For now, "human involvement is still required" to meet the science requirements and respond quickly to malfunctions or anomalies that could threaten the life of the spacecraft or instruments, he adds. Before launch, Moyer says, the spacecraft were programmed to respond automatically to malfunctions or human errors that could threaten the missions. Fixing less severe problems still requires human intervention on the next contact with the spacecraft.

Engineers are "evaluating how these responses can be automated from modifications to onboard flight software code or ground system scripts," says Moyer.

Though mission managers are hardly flocking to the MMOC, NASA officials have reviewed the processes

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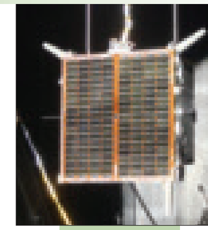


The greening of satellite propulsion

Twelve years ago, energy efficiency advocates Amory Lovins, L. Hunter Lovins, and Paul Hawken published *Natural Capitalism*, which argued that a new industrial revolution is coming, based on the reengineering of everything from automobiles and paper products to the design of homes, commercial buildings, and city cores. A key contention of the book, which has prompted energetic discussion in the environmental and engineering communities, is that waste in products can be radically reduced, and that society can benefit from new approaches to the way products are made and services managed, thus creating a positive new business model across industrial sectors.

Previous pieces in this series on green engineering have highlighted innovative, environmentally benign approaches to rocket propulsion, jet fuel, and the air oxygen and water regeneration systems onboard the ISS. We now turn to Sweden, famed for its green approach to product design, to introduce the concept of high-performance green propulsion (HPGP) for satellite operations.

A head-to-head competition

A year after the publication of *Natural Capitalism*, the government-owned Swedish Space Corporation (SSC) and Volvo Aero founded ECAPS to develop green-propulsion-based products for space applications. This followed five years of studying new propulsion concepts for small satellites with the objective of reducing cost and risk.

In August 2011, ECAPS (now a subsidiary of SSC) and Moog's Space and Defense Group (Moog is one of ECAPS' two U.S. providers of HPGP technology; ATK is the other provider) announced the results of a year-long series of in-space tests comparing their HPGP propellant, LMP-103S, and a

Prisma is mounted on the adapter and final electrical tests are performed. Image courtesy of SSC.

standard hydrazine propulsion system. LMP-103S—a relatively benign blend of ammonium dinitramide, water, methanol, and ammonia that mainly decomposes into water vapor—won the head-to-head in-space competition against the hydrazine propellant, demonstrating greater performance and improved ground processing characteristics. From an environmental perspective, hydrazine, although a proven propellant for satellite operations for more than 50 years, is classified by the EPA as a Group B2, probable human carcinogen.

As a result of the test, the HPGP system achieved technology readiness level (TRL) 7, which the U.S. government defines as actual demonstration of a system prototype in space, deeming it ready for implementation on future missions. This first in-space head-to-head competition between an HPGP system and hydrazine is an important step in the development of green propulsion.

Other companies, including Boeing, Aerojet, Northrop Grumman, Ogden Engineering & Associates, and Busek Advanced Space Propulsion, have conducted significant research on green propulsion systems for space applications as well, both in Earth orbit and in human and robotic planetary exploration.

Strong in-space performance

The HPGP and hydrazine propellants were tested aboard the Mango satellite, part of a joint SSC/Swedish National Space Board project called Prisma. Its purpose was to test new technologies on two small satellites, Mango and Tango, launched in June 2010 aboard a Ukrainian Dnepr rocket from Yasny, Russia.

After analyzing the on-orbit performance of the HPGP technology and hydrazine systems, Kjell Anflo and Ben Crowe of ECAPS reported on the results at the 25th Annual AIAA/Utah State University Conference on Small Satellites in August 2011: "HPGP technology has emerged as an enabling technology for improved performance, enhanced volumetric efficiency, reduction of propellant handling hazards, and significantly shorter launch preparation operations," they said.

Moreover, according to their report, engineers found that the HPGP technology achieved, on average, an 8% higher specific impulse than hydrazine for steady-state, single-pulse, and pulse-mode firings. They also found that the increase in specific impulse combined with the HPGP propellant is 24% denser than hydrazine, and the HPGP system is able to offer about 32% more propellant than hydrazine for any mission delta-V.

A NASA analysis posted on its Ask the Academy website says that in comparison with hydrazine and bipro-

ECAPS' 1-N engine (HPGP) is tested on Prisma. Image courtesy SSC.

pellant systems, “the HPGP system falls between the two regarding the ability to change a spacecraft’s velocity without increasing its complexity or the cost of the overall system.” Engineers measured specific impulse onboard Mango with the help of accelerometers, GPS, and precision propellant gauging.

Ground processing benefits

The benefits of processing HPGP on the ground were also significant. While ground fueling of the more toxic hydrazine propellant required a crew of five using protective gear, supported by 20 specialists, and evacuating the fueling hall for two days, HPGP fueling required only a three-person crew, with no need for special protective gear or halting of other mission-related work. Furthermore, HPGP fueling took one-third of the time needed for hydrazine fueling. In addition, HPGP can be stored for up to 20 years.

Faster, easier fueling is important, notes Paul King, engineering manager for spacecraft fluid controls at Moog’s Space and Defense Group. “For example,” he says, “when you start getting into applications like an ESPA [EELV secondary payload adapter] ring, where you are populating a bus with six satellites that are all propulsive, you don’t want several days of not being able to do things in parallel while you are doing the propellant loading.”

King also points out the significance of the HPGP flight test from the in-space performance level: “It’s one thing to state you have a green technology, but unless you can actually provide meaningful performance, the green part of it will be kind of thrown aside, because there’s a technology out there right now, hydrazine, that provides a certain level of performance accepted by the industry. They [ECAPS] had to find that balance point of saying, ‘Hey, we can not only offer you something that’s green, but it also can perform to a level equal to or better than hydrazine.’”

King goes on to explain that leading up to the test, “The two fundamental things that were developed were a new fuel that balances the green aspects vs. performance, and a thrust chamber and catalyst that would be able to use that fuel. These went hand in hand. Because HPGP operates at a higher temperature, a new thrust chamber had to be developed, and a new alloy was brought into play to handle the higher temperatures; a new catalyst was also developed to be able to decompose it and operate at those high temperatures.”

ECAPS definitely believes the market niche for green satellite propulsion technologies is promising. Anflo notes that the “Swedish National Space Board is particularly interested in low TRL developments that have the potential to be a game changer, in terms of cost reduction in the long run, for users of space infrastructure. HPGP fits well with this ambition.”

Anflo adds that while the Mango HPGP propellant had a small, 1-N-thrust capability, “development and hot firing tests of 5-, 22-, 50-, and 220-Newton HPGP thrusters have been ongoing for several years, and they have reached various TRL levels. The development of a 400-N thruster is currently being assessed [for maneuvers requiring large thrust by geosynchronous satellites]. As the propellant has been formulated and verified to be compatible with most hydrazine commercial-off-the-shelf components, there are no major issues with respect to using existing equipment.

“Discussions with several potential users are ongoing to establish flight opportunities for these thrusters.” King says that qualification of a 5-N thruster can be expected within the next 18 months, with a 22-N thruster soon to follow. Both are now at a TRL of 4 or 5. “That puts us into a near-term focus on smaller satellites on the order of, say, 40 kg up to maybe 1,000 kg.”

A more ‘European-centric’ reason for ECAPS’ interest in HPGP, observes Anflo, is that the “European Chemical Agency, the driving force among regulatory authorities in implementing the EU’s chemicals legislation for the benefit of human health and the environment, has identified hydrazine as one of 53 substances to be of high concern. This will lead to severe restrictions and a possible ban for using hydrazine in the future, especially if an alternative exists.”

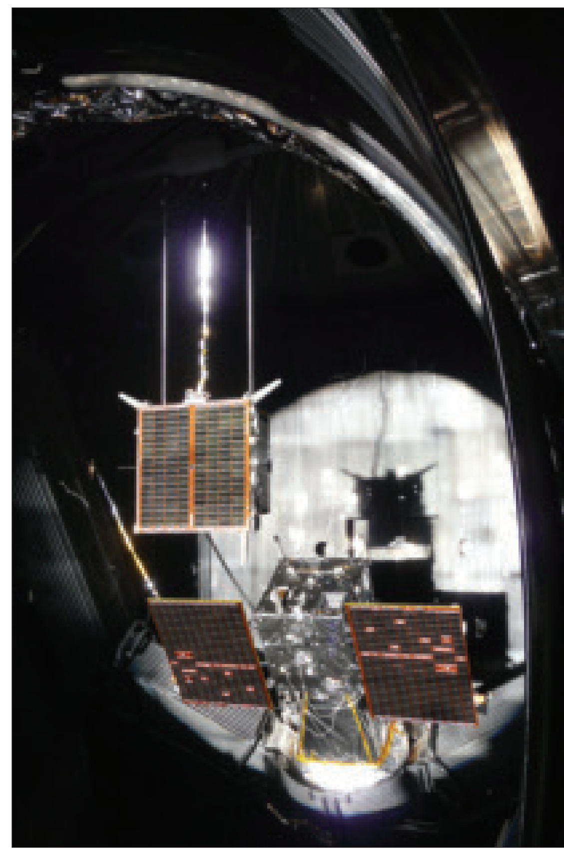
NASA interest

In the U.S., NASA's Office of Chief Technologist, Crosscutting Technologies Division, is funding a study of HPGP technology at Ames. "NASA is interested in green propulsion technologies," says Hugo Sanchez, aerospace engineer for flight systems at Ames. "Based on the study, HPGP has the simplicity of a traditional monopropellant, equal or greater ISP, and a higher density. For the same mass or volume, you can create more thrust, more delta-V. We know how traditional monopropellants react, and we know how to handle them, but they are hazardous. By studying green propellant technology, NASA may open doors for other institutions such as universities and small businesses that just can't afford to invest money in hazardous propellant management."

Future uses

Future applications of HPGP will include its use on Proba-3, the third in ESA's series of formation-flying satellite missions for validating developments of new space systems. ECAPS' 1-N engines are baselined in the design of two satellites for the commercial Cicero atmospheric and surface remote-sensing mission. King has said that since the successful PRISMA test, several satellite prime contractors and government agencies, including NASA and the DOD Operationally Responsive Space (ORS) Office, have shown interest in HGPG for technology demonstration missions and multisatellite constellations. "ORS is interested in HPGP because this is another piece of the puzzle that can help them get to a faster response for getting payloads into orbit," says King.

As to the prospect of greater federal investment in the technology, he says, "It would definitely help if there were programs pushing for it. We've done it in Europe, but playing in the U.S., you've got to find that first foothold, someone saying, 'Yes, we're going to fly that here as well.' It will probably be a technology demonstrator the first time out. NASA's Office of the Chief Technologist is studying the potential demonstration of HPGP on a mission called Planetary Hitch Hiker under the agency's Edison program.



Mango and Tango shine in the sunbeam of the space simulator in early 2009. The test's main purpose was to calibrate the thermal mathematical model, but also to check system functions. Image courtesy SSC.

"Developing green propellants could change the tide," says Sanchez. "You can affect not only the agency's future, but potentially the industries' future, hopefully for the better. It's an exciting first step. As soon as that mission is realized, it's exciting to think about the potential applications that will be enabled in the future."

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(Continued from page 25)

there as part of a study examining how the agency might make greater use of automation.

Economics

Crouse, the Hubble operations manager, is one of NASA's multimission and automation pioneers, having led the MMOC development effort before moving over to the HST program. He says NASA needs to look closely at the technical risks and economics of moving systems into the MMOC.

"I believe that it is possible to incorporate additional missions into the MMOC and reduce their individual recurring costs of operations," he says.

But which missions? NASA officials cite reasons not to move many of those currently in space. The Solar Dynamics Observatory, launched in 2010 to provide near-continuous observations of the Sun, is not a possibility, because of its 24-hr data requirement. The Earth sciences missions are considered too complex, as are larger observatories like Hubble.

Another problem is that money must be spent in order to save money. Moving the control of an existing spacecraft would require enlisting engineers who understand precisely how that specific craft works. Commands that could inadvertently damage an instrument must be completely understood and avoided in the automation processes.

Next, scripts must be written for the tasks that can be performed safely by computers. As a confidence-building measure, the old control center might have to be run in parallel with the portion of the MMOC dedicated to the transferred mission, as with the ACE, Wind, and TRACE missions.

On top of that, network security must be closely considered in this era of cyber attacks and hacking.

The bottom line, one official says, is that a mission needs to have a lot of life left to justify the transition costs.

"I would expect that a better opportunity for a return on investment would be, for new missions in development, to baseline the MMOC for their operations from the outset," says Crouse.

Nace agrees that multimission control should be designed in from the beginning of new missions. "A lot of the startup cost for a new mission is typically in the $30 million-$40 million for an MOC. We have an existing MOC with an existing architecture," he says.

Among the perceptions Nace is working hard to dispel is that a multimisson center must control similar satellites—for example, different versions of GPS satellites—and that only new spacecraft can be incorporated.

Anticipating multimission control from the start of a project is wise, he says, but this does not mean it is impossible to adapt existing spacecraft. With ACE, Wind, and TRACE, "we're talking about missions that were 10, 12, 15 years old and were very manual," he says. "It's pretty easy to put a brand new mission into an automated environment when you build it with that in mind."

Lessons learned

Nace points to several lessons from his team's experience. The first is to bring in the spacecraft engineers.

"Within our team we did not have a group of software gurus do this. The best people to do this job, we thought, were the people who knew enough about the spacecraft and ground system," he says.

Another lesson, says Nace, is that it makes sense to produce spacecraft in-house—at Goddard, for example—so that the same engineers who make them also become the ones who oversee the automation.

"We have a great opportunity here, where Goddard actually builds some spacecraft in-house," Nace says. "We get to work alongside the Goddard engineers as they develop instruments and put them onto the main bus. Those people will turn into the post-launch flight engineers, which is a great advantage over a mission [where the spacecraft] is built by some other company and we are then taught how to fly it. You just don't know the intricate workings of the spacecraft the way you do when you help build it and test it."

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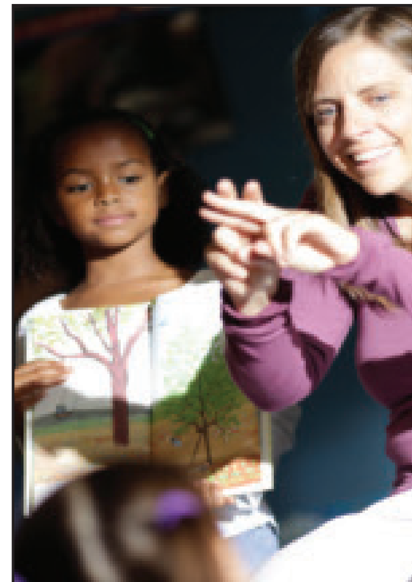

The aircraft is only a transport mechanism for the payload, and all design decisions must consider payload first. Simply stated, the aircraft is a dust cover. *Fundamentals of Aircraft and Airship Design, Volume 1— Aircraft Design* emphasizes that the aircraft design process is a science and an art, but also a compromise. While there is no right answer, there is always a best answer based on existing requirements and available technologies.

This book is a revision and expansion of the 1975 classic aircraft design textbook that has been used worldwide for more than 30 years. Completely updated with the latest industry processes and techniques, it will benefit graduate and upper-level undergraduate students as well as practicing engineers.

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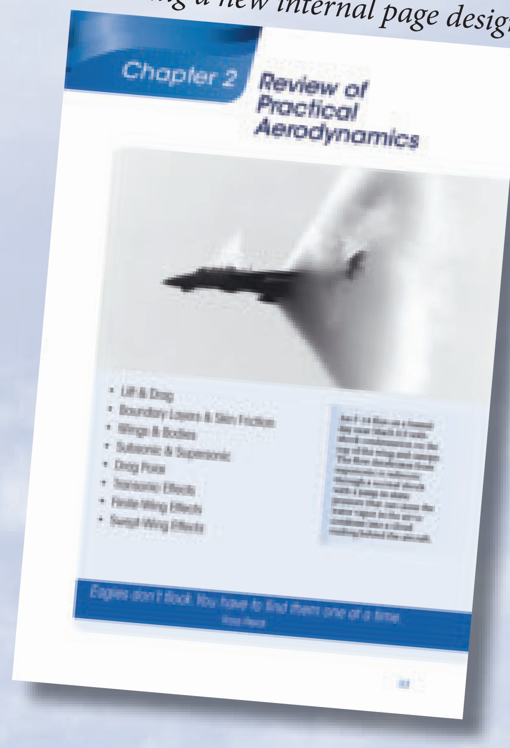

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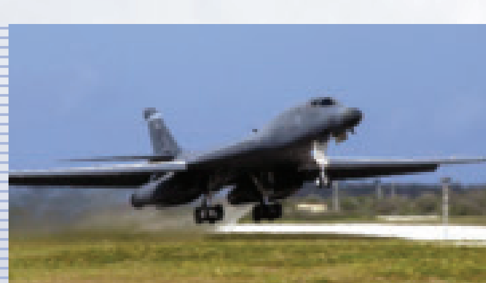


Twin NASA spacecraft called GRAIL (gravity recovery and interior laboratory) are poised to begin mapping the Moon's gravitational field with unprecedented precision. The data they gather will open a new window into the early geology not just of the Moon but of the Earth and the other terrestrial planets as well.

by Craig Covault
Contributing writer

The second GRAIL spacecraft is hoisted above the circular Delta II launch vehicle adapter, already occupied by the first GRAIL. Credit: Lockheed Martin.

Orbiting twins

tackle Moon's mysteries

The $696-million GRAIL twin spacecraft mission to lunar orbit will gather and use extremely precise gravity data as a window for looking billions of years into the past. The new gravity data are expected to reveal the earliest geological secrets of the Earth, the Moon, and other terrestrial planets and their moons.

The two identical craft are in lunar polar orbits circling the Moon at altitudes as low as 30 mi., and flying in trail as if on the same railroad track.

The mission will create the most accurate gravitational map of the Moon to date, improving our knowledge of near-side gravity by 100 times and of far-side gravity by 1,000 times, according to NASA.

The gravitational map, especially when combined with a comparable resolution topographical field map, will enable scientists to deduce the Moon's interior structure and composition. This will also yield insights into its thermal evolution—that is, the history of its heating and cooling, which opens the door to understanding its origin and development.

Accurate knowledge of the Moon's gravity will be an invaluable navigational aid for future lunar spacecraft as well. In addition, GRAIL will help provide a broader understanding of the evolutionary histories of the other rocky planets in the inner solar system: Mercury, Venus, Earth, and Mars, say NASA geologists.

Twin GRAIL spacecraft with covers removed are tended by two Lockheed Martin Space Systems technicians in a thermal/vacuum chamber near Denver, Colorado. Credit: Lockheed Martin.

Ultrafine tuning

The science work of GRAIL's mission will not start until March. The objective now is to carefully tweak each twin's orbit and make the spacing between them so precise that by March the differences in lunar gravity, reflected in tiny changes to spacecraft separation, can be measured to within the

A technician checks the bottom side of a solar panel, revealing the colorful internal components of the spacecraft. The horn-shaped feature at the center is the swiveling star tracker. Credit: Lockheed Martin.

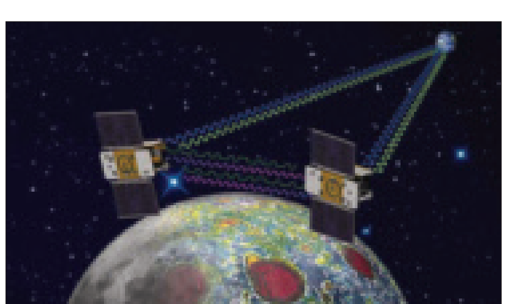
diameter of human hair, says principal investigator Maria Zuber of MIT. GRAIL-A entered lunar orbit on January 31; GRAIL-B followed the next day. Each spacecraft weighs 677 lb and measures 3.5x3.1x2.5 ft on a side.

That 'human hair' level of precision for the data collected over the entire lunar surface will reveal the Moon's deep interior structure. The data should also provide insight about the great bombardment of asteroids and large meteorites that took place after the initial planetary surfaces had solidified. Many of those mountain-sized objects now lie buried, producing strong gravity signatures.

Outreach and education

The two Lockheed Martin/JPL spacecraft were launched from Cape Canaveral on September 10, 2011, by a ULA Delta II Heavy. They were originally christened GRAIL (gravity recovery and interior laboratory) A and B, but feedback to NASA's outreach program found GRAIL to be such a bland name that NASA decided to hold a national student contest to rename the craft. The winning names: Ebb and Flow.

Another educational facet of the mission involves four low-cost cameras attached to each satellite. Called MoonKAMs, they form a digital video imaging system that is used as part of the education and public outreach activities for GRAIL. Each MoonKAM system consists of a digital video controller and four camera heads—one pointed slightly forward of the spacecraft, two directly below it, and one slightly backward. The digital video controller serves as the main interface to the craft and provides storage for imagery acquired by the camera heads. Images or video of the lunar surface can be taken at the rate of up to 30 frames per second.



A graphic depicting the GRAIL spacecraft also shows the lumpy lunar surface gravity map and the twin spacecraft exchanging data with each other and with Earth. Credit: JPL.

The MoonKAM system, from Ecliptic Enterprises in Pasadena, California, is operated by undergraduate students at the University of California at San Diego under the supervision of members of the faculty and in coordination with Sally Ride Science, a company founded to provide classroom materials and programs for K-12 educators. Middle school students from around the country will have an opportunity to become involved with MoonKAM imaging by selecting which lunar features to image and determining which camera can view the feature and when.

Science goals

According to Zuber, the main science objectives of the flight are "determining the structure of the lunar interior, from crust to core, while also advancing understanding of the thermal evolution of the Moon; then applying the data gained from the Moon to other terrestrial planets."

"GRAIL's gravity observations will be used to support six scientific investigations," she says. These are to map the structure of the crust and lithosphere; understand the Moon's asymmetric thermal evolution; determine the subsurface structure of impact basins and the origin of mascons (subsurface regions of high density); ascertain the evolution of crustal molten lavas; assess the effects of tidal forces on deep interior structure; and place limits on the size of a possible solid inner core.

The GRAIL mission will obtain the lunar gravity field by measuring the precise instantaneous relative range-rate between the two spacecraft while they are separated by about 107-140 mi., at a mean altitude of 30 mi. in lunar polar orbit.

Moving into position

GRAIL's transit to the Moon was 3.5 months. This was unusually long because mission planners wanted extra time set up for an extremely precise lunar orbit insertion using very little propellant to keep the spacecraft small.

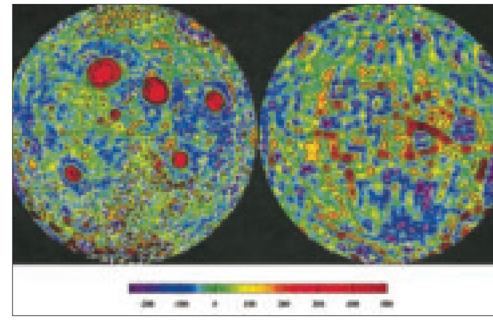
The GRAIL spacecraft's 2.5-million-mi. trajectory to the Moon was by way of the L1 Earth/Sun Lagrangian point. There the two spacecraft could essentially linger, taking time to move into position after cruising on separate paths to their location a million miles beyond the Moon. This resulted in the pair flying several weeks beyond the Moon and then curving back slowly toward it again, approaching by way of a flight path under the lunar south pole, where they executed a 38-min lunar orbit insertion maneuver. That put them on an elliptical path with an orbital period of just over 11.5 hr. Each spacecraft made those maneuvers using cold gas helium thrusters. There are 234 lb of highly pressurized helium on each satellite.

Another series of maneuvers then reduced the orbits to become nearly circular, with a 34-mi. altitude. The 82-day science phase is divided into three 27.3-day mapping cycles.

During the science phase, beginning in March, the Moon will rotate three times underneath the GRAIL orbit. The collection of gravity data over one complete rotation (27.3 days) is called a mapping cycle. Following the science phase, a five-day decommissioning period is planned, after which the spacecraft will impact the lunar surface in approximately 40 days.

The slow approach was timed to ensure that the spacecraft arrived in lunar orbit on December 31 and January 1 with low relative velocity. This requires a smaller engine firing to reduce their speed enough for them to enter an orbit around the Moon.

Another process that required extra transit time was the outgassing of the GRAIL spacecraft. When a craft enters the vacuum and zero-*g* of space, small amounts of gas are vented from its materials and structures. Those gases would have enough force to interfere with precise gravity measurements in lunar orbit. The hope was that during the longer cruise time, all the gases would be vented. To aid this process, the vehicles were rotated so the Sun could speed the venting of these gases.



A lunar gravity map compiled from earlier spacecraft missions shows bright red strong gravity features on the lunar nearside (left) located at major basins formed by the impacts of mountain-sized asteroids. The far side has a complex gravity signature but fewer giant impacts. Credit: JPL.

Benefiting from GRACE

The GRAIL spacecraft have direct heritage from the XSS-11 Earth orbit technology satellite flown about 10 years ago. GRAIL's purpose is also very similar to the Earth orbit gravitational mission of GRACE (gravity recovery and climate experiment), which is still in progress. "What we're trying to do is measure the gravity," says David Lehman, GRAIL project manager at JPL, "but there are nongravitational accelerations that look like gravity to the instruments.

"On GRACE they developed models to decipher out the nongravity accelerations, so we were able to use those models, tweaked a little bit. Basically we had to model the attitude control thrusters firing, and the effect of the Sun pushing on the spacecraft, the effect of the reflected moonlight pushing on it. All these had to be modeled, and we were able to derive a lot of the models from the GRACE program," Lehman says.

Helping that work along were several engineers from the GRAIL development team who had participated in producing the models used on GRACE.

The lunar mission, however, is far different from the Earth gravity mission, because Earth's gravity concentrations change almost daily as storms deposit heavy rains in some places and not others. The Moon's gravity has stayed fixed for most of the last 3 billion years, says NASA.

Mapping cycles

During mapping cycle 1, the mean separation distance between the two GRAIL space-

(Continued on page 42)

Design for *demise*

Protection from falling spacecraft

The probability that falling spacecraft could do harm on Earth is very low, but it is not negligible. The risk will only increase as more satellites reach the end of their lives and reenter Earth's atmosphere. To minimize danger to populated areas, NASA is calling for spacecraft components to be designed not to survive reentry.

The heavens deliver tens of tons of man-made refuse into the Earth's atmosphere each year. While there is a very low probability that a bystander on terra firma will suffer injury from falling space clutter, the risk cannot be disregarded.

Last year brought several reminders that uncontrolled reentries of spacecraft, possibly over populated areas, can produce public consternation and stir an uptick in media coverage.

In 1995 NASA established a human ca-

The GPM satellite was designed from the beginning with its end in mind.

sualty risk threshold of 1 in 10,000 per reentry event for its spacecraft, booster stages, and related hardware. That risk threshold has been adopted by the U.S. government and other leading space agencies.

But it turns out that breaking up is hard to do—specifically in the case of spacecraft and launch vehicle orbital stages. Components that have high melting temperatures—titanium, stainless steel, and beryllium, for example—have been found to 'beat the heat' of reentry and could pose a danger to people on Earth. Surviving objects that commonly make it through reentry have included propellant and pressurant tanks, pieces of solar array drive mechanisms, and elements of reaction wheel assemblies.

Stepping up to this challenge is a NASA program called 'design for demise,' or D4D.

'Demisable' hydrazine tank

A plan of action now under way as an iterative process brings two worlds into collision: satellite designers and reentry survival assessment specialists. The plan urges a push toward new practices for designing space vehicles—practices that take into account reentry hazards from the very start.

by Leonard David
Contributing writer

"This is the right thing to be doing," says Nicholas Johnson, chief scientist for orbital debris at NASA Johnson in Houston. "We certainly hope to use design for demise on future NASA missions, and we're trying to get the word out to other folks," he tells *Aerospace America*.

An example is the joint mission of the global precipitation measurement (GPM) spacecraft, to be launched by NASA, JAXA, and other international partners in 2014. The craft will set new worldwide standards for precipitation measurements, a key climate factor, using a network of satellites united by the GPM core observatory.

But an issue for GPM cropped up in 2002. An analysis had identified the spacecraft's titanium tank—to be topped off with more than 500 kg of hydrazine—as a significant reentry risk. Thanks to a NASA-sponsored effort, a flight-qualified equal-capacity aluminum tank and an all-aluminum internal propellant management device were successfully fabricated. This reduced the reentry risk for the tank to zero, and also saved weight in the tank.

"NASA did invest a modest amount of resources into the design and development of this 'demisable' hydrazine tank," says Johnson. "Hydrazine tanks are one of the problems that we run into routinely. We did it for GPM understanding that this is an investment that will pay dividends for future missions."

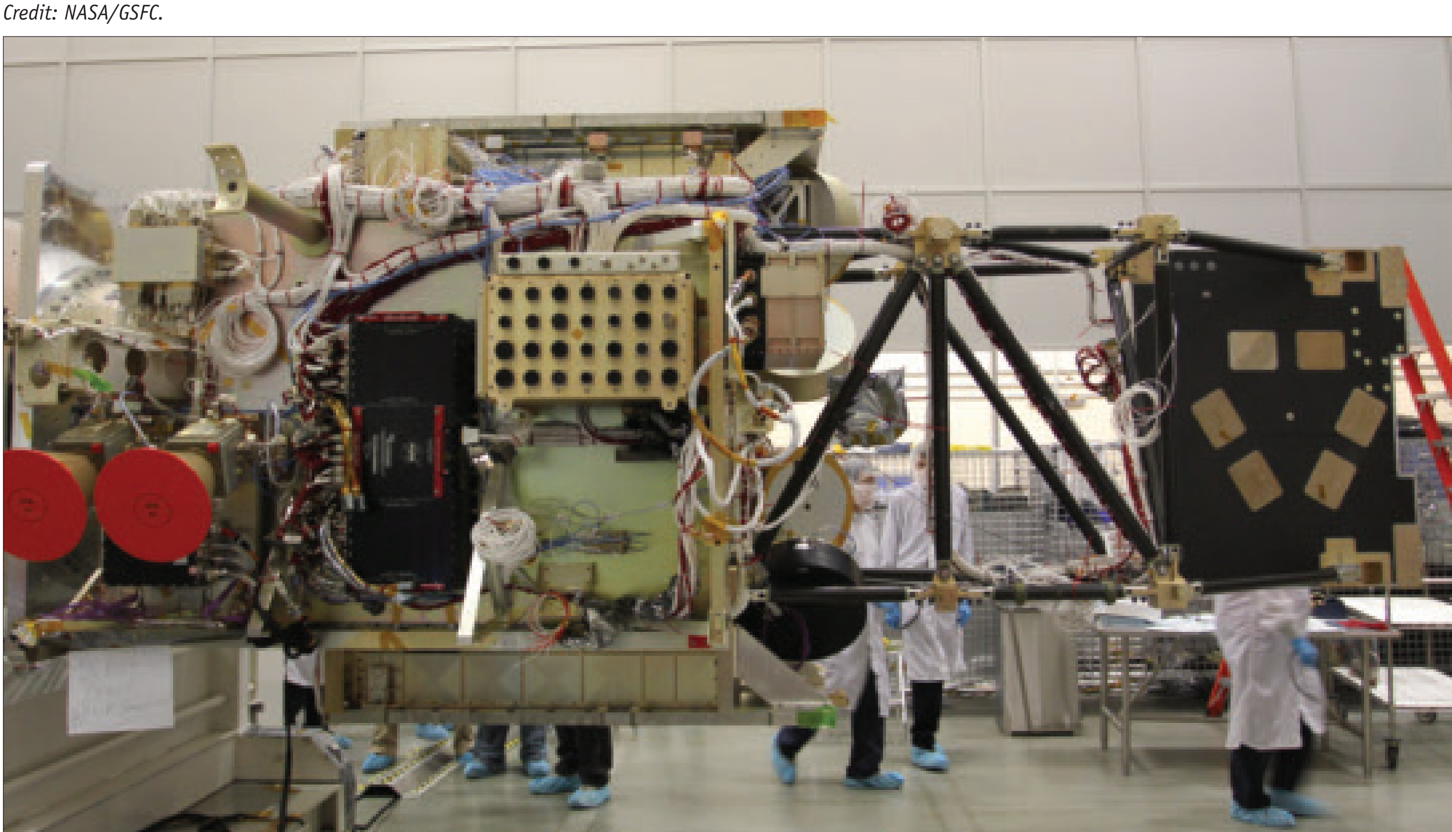
Threshold guidelines

Along with the hydrazine tank changes for GPM, the satellite's solar array panels were crafted with demisability in mind. So too was the spacecraft's scientific payload: a U.S. microwave imager and a JAXA dual-frequency precipitation radar.

GPM engineers also incorporated a new reaction wheel assembly design, one that posed no risk to people on Earth. That design was adopted on NASA's lunar reconnaissance orbiter. As Johnson points out, interplanetary spacecraft that tote large hydrazine tanks are being evaluated for demisability. "We have to worry about launch malfunctions, like a Mars probe in low Earth orbit where its booster doesn't fire and it falls back to Earth."

The first set of human casualty risk threshold guidelines, issued in 1995, included a 25-year postmission disposal rule. Basically the rule requires that any future mission and its associated debris must have an orbital lifetime equal to or less than 25 years. Johnson stresses that NASA, along with other major space agencies and the U.N., agreed to this rule.

The GPM satellite, now under construction, is fitted to the bed of the high capacity centrifuge for spin testing. This spacecraft has undergone a 'design for demise' overhaul. Credit: NASA/GSFC.



"So we had to go look at this for the first time from a programmatic standpoint," says Johnson. "One of my cardinal statements is that the vast majority of objects will always survive or always demise."

A bottom line for Johnson is that in the requirements phase, NASA and vendors need to do a better job of stating what is acceptable or not acceptable. "It just takes time," he says. "This is not one of those things where you have to solve it overnight." There is an educational aspect to demise by design, a need to engage vendors who provide spacecraft buses and other satellite components.

"It's been like this for virtually all the orbital debris mitigation measures. It takes a while to educate people…to determine what's cost effective and then implement it. So we're in that process with demisability," Johnson explains.

Hot on the trail

Also hot on the trail of information on how objects respond to the severe conditions of reentry is William Ailor, director of the Center for Orbital and Reentry Debris Studies at The Aerospace Corporation in El Segundo, California.

Ailor has led development of the reentry breakup recorder (REBR), a small, autonomous device built to record temperature, acceleration, rotational rate, and other data during a spacecraft's dive to Earth. These devices have flown already, inside JAXA's Kounotori 2 H-II transfer vehicle, and in Europe's second automated transfer vehicle (ATV), the Johannes Kepler. Both vehicles took their turns at making self-destructive plunges last year after performing resupply duties at the space station.

Each REBR includes a heat shield that protects instruments and the collected data accumulated during reentry.

Years of work on the REBR have been aided by the Air Force and NASA Goddard, Ailor says. Boeing supplied the heat shields and NASA Ames provided in-kind support of the self-stabilizing heat shield design.

Microinstruments, tiny sensors, and ultrasmall cellphone technology are what made it possible to create the REBR, notes Ailor. The compact unit is basically a satellite phone with a heat shield, he says. Rather than broadcasting data during the breakup event, REBR records the data and transmits information after the reentry has effectively ended but before the data recorder actually impacts Earth.

A reentry breakup recorder includes a heat shield to protect tiny instruments that gather information on how space hardware reacts during a fiery reentry into Earth's atmosphere. Credit: The Aerospace Corporation.

'Black box' systems

The REBR assembly—including housing and interface adaptor—weighs all of 8.6 kg and is 36 cm in diameter and 28 cm long. REBR itself, the instrument package and heat shield assembly, weighs a modest 4 kg and is 30 cm in diameter and 23 cm long.

At present, REBR instrumentation includes two three-axis accelerometers; a rate gyro that captures angular rates about the three REBR axes; a sensor that measures REBR's internal pressure; a GPS receiver that captures REBR's altitude, velocity, and

UARS: Uncontrolled tumble to Earth

NASA's decommissioned Upper Atmosphere Research Satellite fell back to Earth in September. Deployed on orbit in 1991 during the STS-48 space shuttle mission, UARS was the first multiinstrumented spacecraft to observe numerous chemical components of the atmosphere to improve scientists' understanding of photochemistry.

Six years after the end of its productive scientific life, the 6.5-ton UARS broke into pieces during an uncontrolled reentry, with most of it disintegrating within the atmosphere. Twenty-six satellite components weighing a total of about 1,200 lb were assessed as possibly being able to survive the fiery reentry and strike the Earth's surface.

Prior to this uncontrolled demise, NASA explained that because the satellite's orbit was inclined 57 deg to the equator, any surviving components of UARS would land within a zone between 57 deg north latitude and 57 deg south latitude. It was impossible to pinpoint just where in that zone bits and pieces of the satellite would drop. NASA reentry experts estimated that the debris footprint would be about 500 mi. long.

As reported by the Joint Space Operations Center (JSpOC) at Vandenberg AFB in California, the satellite entered the atmosphere over the Pacific Ocean. The location was over a broad, remote ocean area in the southern hemisphere, far from any major land mass. The debris field was somewhere between 300 mi. and 800 mi. downrange, or generally northeast of the reentry point. NASA advised the public in a final post reentry statement that it was not aware of any possible debris sightings from this geographic area.

With the school-bus-sized spacecraft auguring its way through Earth's atmosphere, a number of satellite components likely made it through the fiery fall. Those may have included a high-gain antenna gimbal, fuel tanks, batteries, and reaction wheel rims. The projected surviving pieces added up to 26 components, totaling an impact mass of over 530 kg.

"This was not an easy reentry to predict because of the natural forces acting on the satellite as its orbit decayed. Spacefaring nations around the world also were monitoring the satellite's descent in the last two hours, and all the predictions were well within the range estimated by JSpOC," Johnson reports.

UTC (coordinated universal time) during its descent after release from the host vehicle; and sensors designed to capture temperatures at several locations within the REBR heat shield.

As the host vehicle reenters and breaks apart, data from these sensors are collected and recorded for several minutes. When the REBR's velocity approaches and continues to decrease below Mach 1, an Iridium modem is activated and REBR makes a call to the Iridium system to download recorded data as it falls into ocean waters. No attempts are made to recover the gear.

During last year's Japanese HTV2 reentry, says Ailor, the REBR performed well and returned data. Unfortunately, after the European ATV2's reentry, no data were received. The most likely reason for this is that the REBR was damaged during ATV2's breakup, he says, which may have presented a more severe challenge than the demise of HTV2.

According to Ailor and Michael Weaver, also of Aerospace Corporation, one way to minimize the expense of space hardware disposal is to design satellites and launch stages in a way that minimizes the possibility of survival for large, hazardous debris fragments—again, adopting a 'design for demise' philosophy.

Confidence that such design features will have the desired result requires accurate modeling of reentry breakup, and possibly a means for directly testing the breakup characteristics of candidate hardware designs. Hence, REBR offers considerable utility, with future versions perhaps serving as prototype 'black box' systems for space transportation vehicles, Ailor suggests.

Small but estimable risk

NASA Goddard is home base for building and managing a large number of missions, most of which are in Earth orbit. "We therefore have a large potential to generate, and get affected by, orbital debris. Many of those missions, particularly those in low Earth orbit, will eventually reenter the Earth's atmosphere. Although most of the

ROSAT's reentry into Bay of Bengal

Following in the reentry wake of UARS was Germany's Roentgen satellite, an astronomical X-ray observatory lofted into Earth orbit in June 1990. In its highly successful astronomy mission, the roughly 3-ton ROSAT cranked out science for nearly nine years. It was turned off in February 1999. The project was a collaborative venture by Germany, the U.S., and the U.K. and was developed, built, and launched on behalf of and under the leadership of DLR, Germany's space agency.

During the satellite's operating life, more than 4,000 scientists from 24 countries took advantage of the opportunity to request observations. Many hot, high-energy processes in the universe were first observed with ROSAT.

Like UARS, however, ROSAT did not carry a propulsion system. Thus it was not feasible to maneuver the craft into a controlled reentry at the end of its mission. Furthermore, the satellite was adrift in space, circling Earth in deaf and dumb mode. Spacecraft communications between ROSAT and DLR's control center in Oberpfaffenhofen were not possible.

An early reentry study of ROSAT indicated that nearly 2 tons of satellite leftovers could make it down and strike the Earth's surface. According to DLR, the satellite's X-ray optical system—replete with mirrors and a mechanical support structure made partly of carbon-fiber-reinforced composite —could tumble to Earth. Any of the ROSAT scraps were predicted to strike our planet at speeds reaching 280 mph.

Before ROSAT's fall, DLR noted that all areas under the dead spacecraft's orbit—which extended to 53 deg northern and southern latitude—could well be affected by its reentry. The bulk of the debris would impact near the ground/ocean track of the satellite. However, isolated fragments could descend to Earth in a 50-mi.-wide swath along that track.

DLR underscored that while the time and location of reentry could not be predicted exactly, the likelihood of ROSAT's diving into an inhabited area was exceedingly low.

On October 23, ROSAT reentered the atmosphere over the Bay of Bengal. DLR said, "It is not known whether any parts of the satellite reached Earth's surface. Determination of the time and location of reentry was based on the evaluation of data provided by international partners, including the USA."

Following the plummet of ROSAT, Johann-Dietrich Wörner, chairman of the DLR executive board, announced: "With the reentry of ROSAT, one of the most successful German scientific space missions has been brought to its ultimate conclusion. The dedication of all those involved at DLR and our national and international partners was exemplary…they are all deserving of my sincere thank-you."

Last year, the Inter-Agency Space Debris Coordination Committee (IADC) conducted an official reentry test campaign for the fall of both UARS and ROSAT. The IADC is an international governmental forum for worldwide coordination of activities and issues involving man-made and natural space debris. The purpose of these campaigns, which it has carried out since 1998, is to improve prediction accuracy via data-sharing among IADC members, particularly in the case of high-risk reentries.

Other targets used for past IADC reentry initiatives include Russian Cosmos satellites, various upper stages, and even the fall from space of an EAS, or early ammonia servicer—equipment purposely jettisoned from the ISS by spacewalkers in July 2007.

NASA's Upper Atmosphere Research Satellite fell to Earth last year. During its uncontrolled reentry, the multiton satellite broke into pieces, most of which disintegrated within the atmosphere. According to an assessment, however, 26 components, weighing a total of about 1,200 lb, could have survived the fiery reentry to strike the Earth's surface. Credit: NASA.

spacecraft components typically are expected to burn up, there are often at least a few predicted to survive reentry and reach the Earth's surface," says Scott Hull, an orbital debris engineer at Goddard.

While Earth's global commodity is water, and much of the remainder is uninhabited, Hull observes, uncontrolled reentries can still pose a small but estimable risk to the human population.

"A risk greater than 1 part in 10,000 for any reentry is considered by NASA to be unacceptable, and measures are taken to reduce that risk. One approach is to design the spacecraft so that it can perform a controlled reentry into the open ocean at the end of the mission. Another approach is to redesign some of the surviving components so that they are likely to burn up during reentry heating," he tells *Aerospace America.*

It is that other approach that was first dubbed design for demise, or D4D, by Goddard orbital debris specialists.

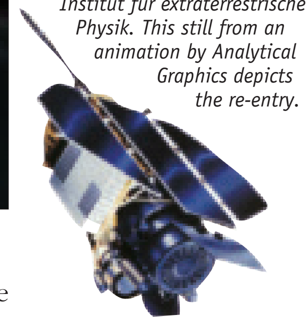
D4D involves first identifying which of the components likely to survive reentry could most reduce the reentry risk by demising instead. This could be either a very large component—say, a propulsion tank—or a large quantity of a single surviving component type. Large numbers of surviving objects have a higher likelihood of causing injury, somewhat analogous to a shotgun blast compared to a rifle bullet, says Hull, "so it is beneficial to address any objects that could survive in high quantity."

Heat of fusion

Implementing D4D involves a variety of approaches, including spacecraft material substitutions; altering the shape of a component; redesigning to use multiple smaller components; switching to a different technology; or simply bundling many small items into a single surviving object.

"One of the main drivers for determining whether a component survives reentry heating is the heat of ablation for the primary material in that component," Hull explains. "The heat of ablation is the total amount of heat required to raise the temperature of the component to its melting temperature…then overcome the heat of fusion to allow the object to actually melt."

There is a list of common spacecraft materials that can thwart high heats during the ablation process. These include titanium, stainless steel, glass, ceramics, and beryllium. On the other side of the heat load are graphite-epoxy composites, aluminum, and polymers—all generally have low heat of ablation.



Germany's ROSAT, an astronomical X-ray observatory, made its uncontrolled reentry in October 2011, tumbling through the atmosphere over the Bay of Bengal. Image credit: Max-Planck-Institut für extraterrestrische Physik. This still from an animation by Analytical Graphics depicts the re-entry.

"In consultation with component designers, it is often possible to redesign a titanium component using graphite-epoxy, for example," notes Hull. It will "retain approximately the same thermal expansion coefficient," but burn up on reentry, he says.

Last March a hiker in Moffat County, near the NW corner of Colorado, heard a high-pitched sound he could not identify. A short time later, he noticed a 30-in.-diam. object in a crater about a foot deep. The object was later identified as a spherical titanium tank from a Russian upper-stage rocket launched in January. A follow-up search found another, smaller sphere 34 mi. to the northeast. Courtesy of Elizabeth Campbell/NRC study, Limiting Future Collision Risk to Spacecraft: An Assessment of NASA's Meteoroid and Orbital Debris Programs.

"Of course, all material properties must be taken into account, since titanium may have been selected initially for its chemical properties or strength, which the new material might not meet. Aluminum can be a handy substitution material because it not only has a low heat of ablation, but also experiences generous oxidation heating/burning to generate even more heat during reentry, especially at lower altitude," Hull points out.

He says it is sometimes possible to redesign a component to a different shape that will enable it to reenter faster, thus generating more heat during reentry. "We had one support flange that was initially designed with flat legs, which presented high drag during reentry. By redesigning these supports to use square tubular legs, the component retained its strength, but was more likely to burn up while falling through the atmosphere," Hull says.

In another case, spacecraft designers looked at balance weights that might survive and potentially injure people. "By redesigning to a cluster of very small pieces," they made the weights "small enough that they would not cause a serious injury, even in the unlikely event that one would hit a person," says Hull.

Cost and schedule challenges

Yet another plus in reducing the reentry risk for most new missions is the growing use of lithium-ion battery technology in spacecraft. Hull says stainless steel and Invar pressure vessels used in nickel-hydrogen batteries have often been replaced by a thin stainless steel or aluminum case, with highly demisable materials inside. While the choice of battery technology is generally a result of other factors such as power usage rates, he adds that there have been cases where the demisability of the battery was a factor in this decision.

In summing up D4D techniques, Hull stresses that there are challenges, including cost and schedule impacts. There is also the qualification of a new design.

"By employing these techniques early in the process, the cost and schedule impacts can be minimized," Hull says. "Unfortunately, though, high survivability objects are often not noticed or added into the spacecraft design until late in the design process, when D4D is more difficult and costly to implement."

Hull adds that that there is always reluctance to move away from a heritage design approach, even when other benefits are shown. The proven success of a design that has 'always been done this way' is difficult to argue with in the face of an elevated—but still very small—risk of something that might happen decades from now. "The increased reentry risk must be dealt with at design, though, since there are no existing options for retrieving a spacecraft before it reenters," he concludes. ▲

GRAIL

(Continued from page 35)

craft is designed to increase from approximately 62 mi. to 140 mi., says NASA.

A very small orbit trim maneuver executed near the end of mapping cycle 1 will then be used to change the separation drift rate. After this, the mean separation distance will decrease from 140 mi. (225 km) to approximately 40 mi., at the end of mapping cycle 3 (the end of the science phase).

The change in separation distance is needed to meet the GRAIL science objectives. The data collected when the orbiters are closer together will help to determine the local gravity field. When they are farther apart, the data they gather will be more useful for detection and characterization of the lunar core, according to Zuber and other GRAIL geologists.

Instrumentation

The telecom subsystem for GRAIL consists of an S-band transponder, two low-gain antennas, and a single-pole, double-throw coaxial switch used to alternate between two antennas. The low-gain antennas enable the two spacecraft to communicate with each other and are also the mission team's principal means of contacting them.

The primary science payload on each spacecraft is the lunar gravity ranging system (LGRS), which sends and receives the signals needed for precisely measuring the changes in range between the two orbiters as they fly over lunar terrain of varying density. The LGRS consists of an ultrastable oscillator, a microwave assembly, a time transfer assembly, and the gravity recovery processor assembly.

The ultrastable oscillator provides a steady reference signal that is used by all the instrument subsystems. The microwave assembly converts the oscillator's reference signal to the Ka-band frequency, which is transmitted to the other orbiter. The time transfer assembly provides a two-way time transfer link between the spacecraft, to both synchronize and measure the clock offset between the two LGRS clocks.

The time transfer assembly generates an S-band signal from the ultrastable oscillator's reference frequency and sends a GPS-like ranging code to the other spacecraft. The gravity recovery processor assembly combines all the inputs received to produce the radiometric data that will then be downlinked to the ground. ▲

25 Years Ago, February 1987

Feb. 6 The USSR launches the TM-2, the first manned version of the Soyuz TM, with full TV coverage. TM-2 docks with the Mir space station the following day. Col. Yuri Romanenko and Alex Laveikin (the 200th person in space) are the crewmembers. Romanenko will spend 326 days in space and conduct three spacewalks totaling over 8 hr before he returns to Earth on TM-3 in November 1987. UPI, *"Two Soviets Launched Into Space,"* Feb. 6, 1987.

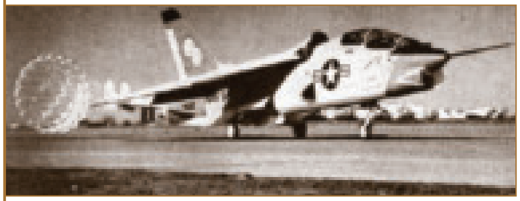
50 Years Ago, February 1962

Feb. 1 The first turbofan-powered Boeing 707-320B long-range aircraft makes its maiden flight from the company's plant at Renton, Wash. The 320B features Pratt & Whitney JT3D-3 turbofan engines of 18,000 lb of thrust each and has an improved system of high-lift flaps. *The Aeroplane*, Feb. 8, 1962, p. 138, and Feb. 12, 1962, p. 49.

Feb. 4 British Capt. J.M. Furnival, a pioneer in air radio, dies. In 1917, during WW I, Furnival took part in the first demonstration of aircraft telephony and is believed to be the first man to have heard intelligible speech from a ground transmission while flying in a heavier-than-air machine. In 1919, he joined Marconi's Wireless Telegraph to help establish an aircraft department. In 1934 he was appointed the first manager of the Aircraft Wireless Establishment. *The Aeroplane*, Feb. 15, 1962, p. 161.

Feb. 5 A Sikorsky HSS-2 sets a world helicopter record by averaging 210.6 mph over a 19-km straight-line course, between Milford and New Haven, Conn. The previous record was 199.4 mph, set by a Russian Mi-6. *The Aeroplane*, Feb. 15, 1962, p. 162; *Aviation Week*, Feb. 12, 1962, p. 30.

Feb. 6 A Chance Vought two-place F8U-1T Navy trainer makes its first test flight, reaching Mach 1.4 near Dallas, Texas. The prototype was converted from an F8U2NE by having two standard cannons and ammunition boxes removed to make way for the second seat. *Aviation Week*, Feb. 12, 1962, p. 27.



Feb. 8 A Delta rocket launches the 285-lb Tiros 4 weather satellite, which attempts to photograph snow and ice areas in the St. Lawrence Gulf. Because snow clouds hide much of the target area, the satellite does not succeed. However, the Tiros series is still considered NASA's most successful program, with all four spacecraft providing a wealth of data and photos of Earth's weather patterns. The satellites use TV cameras developed by RCA. Tiros 4 is to provide data for the upcoming Project Mercury MA-4 flight. *Aviation Week*, Feb. 12, 1962, p. 37, and Feb. 19, 1962, p. 27.

Feb. 10 Capt. Francis Gary Powers, the U.S. pilot whose U-2 spy plane was shot down during a reconnaissance flight over Soviet airspace on May 1, 1960, causing an international incident, is unexpectedly released from captivity by the Russians. One of Powers' objectives on the flight was to photograph the major Soviet launch site of Baikonur. It is later learned that Powers and a U.S. student were released in exchange for America's release of the captured Soviet KGB Col. Vilyam Fischer (also known as Rudolf Abel). *The Aeroplane*, Feb. 15, 1962, p. 160.

Feb. 12 A French army patrol discovers the body of famed early British aviator William Newton 'Bill' Lancaster in the Sahara desert, in a mummified state. In 1933, between April 11 and April 22, Lancaster had flown an Avro Avian Southern Cross Minor, attempting to beat the hotly contested England-to-South Africa speed record, then crashed on the latter date and sent his last known radio message. Lancaster's diary and personal effects survived intact and his diary is later published. The wreck is recovered in 1975 and later placed on exhibit in the Queensland Museum in Brisbane, Australia. *The Aeroplane*, Feb. 22, 1962, p. 190; "William N. Lancaster" file, NASM.

Feb. 13 The last Atlas-E flight is successfully completed from Cape Canaveral, Fla., and delivers a dummy reentry test warhead 7,000 mi. down the Atlantic Missile Range. *Aviation Week*, Feb. 19, 1962, p. 37; *The Aeroplane*, Feb. 22, 1962, p. 190.

Feb. 23 A Douglas DC-8 jet transport claims to make the longest flight yet by a commercial airliner when it flies from Tokyo to Miami, a distance of 8,705 mi.,

Past

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

carrying 49 passengers. This same airplane is one of two to be turned over to Philippines Airlines. *The Aeroplane*, March 8, 1962, p. 242.

Feb. 26 The Project Mercury Friendship 7 MA-6 (Mercury-Atlas) space capsule is launched into a successful three-Earth-orbit mission with Marine Lt. Col. John H. Glenn Jr. aboard, making this America's first orbital spaceflight. Glenn attains an apogee of 158.85 mi. and a perigee of 97.69 mi. for 88 min 29 sec, then lands 166 mi. east of Grand Turk Island, in the North Atlantic Ocean, 6 mi. from the destroyer Noa. Interestingly, nearly 500 years earlier, Christopher Columbus first made landfall at Grand Turk on his initial voyage to the New World in 1492. Some time after Glenn's historic flight, a replica of the Friendship 7 is placed on display at the entrance to the Grand Turk Island airport. *Aviation Week*, Feb. 26, 1962, pp. 26-29.

And During February 1962

—Flightsail, a Rogallo wing glider built in a month for $100 by engineers Thomas H. Purcell Jr. and Mack G. Bass in their spare time, makes a successful test flight. The plane, which has a 0.004-in.-thick polyethylene wing, is flown as a towed glider behind a car and reaches a 30-ft altitude at 35 mph. *Aviation Week*, Feb. 26, 1962, p. 103.

75 Years Ago, February 1937

Feb. 7 The Blackburn Type B-24 prototype (K5178), called the Skua, makes its first flight at Brough, Yorkshire. The airplane is the British Fleet Air Arm's first dive bomber of British construction. A. Jackson, *Blackburn Aircraft Since 1909*, pp. 219-220.

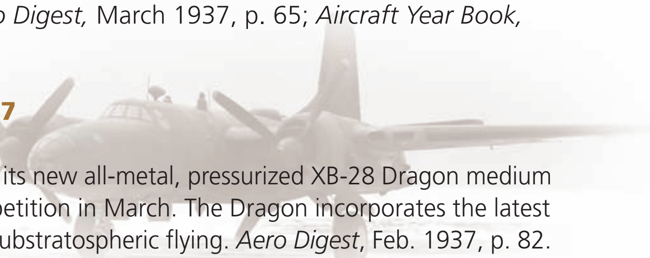
Feb. 11 Eight twin-engined Martin bombers based at Langley Field, Va., make a 4,000-mi. round-trip flight from Langley to Airbrook Field, Panama. This is the first time a squadron of U.S. Army landplanes crosses a large body of water without water landing equipment. The flight, under the command of Maj. J.K. McDuffie, is undertaken to prove it is unnecessary to maintain a large air force in the Canal Zone for its defense against attack. *Aero Digest*, March 1937, p. 158.

Feb. 18 Britain's Imperial Airways takes its Class C flying boat Caledonia on a nonstop 2,222-mi. test flight from Southampton to Alexandria, Egypt, averaging 184 mph in 13 hr 35 min. This is several hundred miles farther than the Atlantic route from Ireland to Newfoundland, which the Caledonia is to inaugurate with two other planes later this year. *Aero Digest*, March 1937, p. 158.

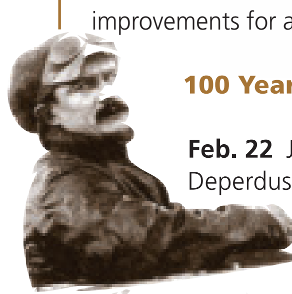
Feb. 22 The German firm of Junkers sends a Ju 86 aircraft to Australia to start commercial air service there. The company has named the plane the Lawrence Hargrave for the late l9th-century Australian aeronautical pioneer who built and tested various aircraft, including steam-powered types that attained flights of 300-400 ft horizontally. He also built a rotary aeromotor in 1889 and a series of successful man-carrying kites in the 1890s. *The Aeroplane*, March 3, 1937, p. 259.

Feb. 28 Howard Hughes is awarded the Harmon Trophy for 1936 by the American Section of the Ligue Internationale des Aviateurs for his outstanding contributions to aviation. Pioneering aviator Clifford B. Harmon sponsors the award in memory of the Lafayette Escadrille of WW I. Jean Batten also wins the trophy in the outstanding woman flier category. *Aero Digest,* March 1937, p. 65; *Aircraft Year Book, 1938*, p. 408.

And During February 1937



—North American Aviation tests its new all-metal, pressurized XB-28 Dragon medium bomber for the Air Corps Competition in March. The Dragon incorporates the latest improvements for altitude and substratospheric flying. *Aero Digest*, Feb. 1937, p. 82.



100 Years Ago, February 1912

Feb. 22 Jules Vedrines pilots the first airplane to go over 100 mph, a Deperdussin monoplane. C. Gibbs-Smith, *Aviation*, p. 247.

Faculty Openings
Aeronautics & Astronautics
PURDUE UNIVERSITY

PURDUE UNIVERSITY

The School of Aeronautics & Astronautics (AAE) at Purdue University invites outstanding individuals at all levels to apply for a tenured/tenure-track faculty position. The successful candidate will contribute to and enhance existing research and educational programs in gas turbine combustion, liquid and solid rockets, supersonic combustion, and advanced propulsion. Applicants who conduct computational research in propulsion and energy are especially sought. The preferred areas of expertise are turbulent reacting flow modeling and high-fidelity simulations of reacting multiphase flows in propulsion and energy systems. Exceptional candidates in other areas will also be considered.

AAE faculty members conduct research and teaching in the broad disciplines of Aerodynamics, Aerospace Systems, Astrodynamics and Space Applications, Dynamics and Control, Propulsion, and Structures and Materials. Details about the School, its current faculty, and research may be found at the Purdue website: https://engineering.purdue.edu/AAE

Applicants should have an excellent academic record, exceptional potential for world-class research, and a commitment to both undergraduate and graduate education. This tenure-track position is available at the assistant, associate, and full professor ranks. For consideration, please submit a curriculum vitae, statement of teaching and research interests, and the names and addresses of at least three references to the College of Engineering Faculty Hiring website, https://engineering.purdue.edu/Engr/AboutUs/Employment/, indicating interest in AAE. Review of applicants begins on 1/30/12 and continues until the positions are filled. A background check will be required for employment in this position.

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

VirginiaTech
Invent the Future

Faculty Position in Aircraft Design

Aerospace and Ocean Engineering – http://www.aoe.vt.edu

The Department of Aerospace and Ocean Engineering seeks applications for a faculty position in the area of aircraft design at the assistant, associate, or full professor level. The successful candidate is expected to have experience, preferably with industry relevance, in aircraft design, and to have an established research program in one or more associated areas such as aerodynamics, aircraft stability and control, avionics, multidisciplinary design optimization (MDO), and air traffic control systems.

Applicants must hold an earned doctorate in aerospace engineering or a closely related field. Responsibilities will include teaching at both the undergraduate and graduate levels, directing graduate students, and establishing an externally funded research program. AOE faculty members are active in a number of interdisciplinary research centers and groups, including the AFRL-VT-WS Collaborative Center on Multidisciplinary Sciences **(http://www.dept.aoe.vt.edu/research/groups/afrl/)** and the Virginia Center for Autonomous Systems **(http://www.unmanned.vt.edu)**. Faculty have access to Virginia Tech's extensive computational resources, including System X, and world-class experimental facilities to support aeroacoustic and high-speed flow measurements, advanced materials characterization, and other activities related to aircraft design.

Virginia Tech, the land-grant university of the Commonwealth of Virginia, is located in Blacksburg, adjacent to the scenic Blue Ridge Mountains. The university has a total student enrollment of 28,687, with more than 6000 students in the College of Engineering. Additional information about the department can be found at **http://www.aoe.vt.edu**. Additional information about Blacksburg, Virginia can be found at **http://www.bev.net**.

Review of applications will begin on February 1, 2012 and will continue until the position is filled. Interested persons should apply on the web at **http://jobs.vt.edu** (posting number **0110944**) along with a current curriculum vita, a cover letter, teaching and research vision statements and the names and addresses of three references. All enquiries can be sent to: Prof. Rakesh K. Kapania (**rkapania@vt.edu**), Mitchell Professor, Virginia Tech, Aerospace and Ocean Engineering, 215 Randolph Hall 0203, Blacksburg, VA 24061.

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

Virginia Tech is an equal opportunity/affirmative action institution

UCLA Engineering

University of California, Los Angeles
Mechanical and Aerospace Engineering Department

We are currently accepting applications to fill full-time faculty positions at the Assistant, Associate, or Full Professor level in Mechanical and Aerospace Engineering (Tracking # 0205-1112-01). Areas of particular interest include, but are not limited to: 1) *robotics*, such as design and realization of robotic systems making scientific and technological breakthrough and societal impacts, 2) *thermal science and engineering.*

Applicants must hold a doctoral degree in engineering or a closely related discipline. Successful candidates will be responsible for teaching undergraduate and graduate courses and for developing a strong, externally sponsored research program. The Mechanical and Aerospace Engineering Department is interested in candidates who are committed to the highest standards of scholarship and professional activities, and to the development of a campus climate that supports equality and diversity. The University of California is an affirmative action/equal opportunity employer.

Please apply by submitting your materials via our online application form, http://apps.mae.ucla.edu/cgi-bin/recruitment/index.php. Applications will be accepted until March 15, 2012. Do not send hard copies, as they will not be processed or returned.

FACULTY POSITION ANNOUNCEMENT
MECHANICAL AND AEROSPACE ENGINEERING
OKLAHOMA STATE UNIVERSITY (Aerospace Engineering - Unmanned Aerial Systems)

A tenure track faculty position at the level of Assistant Professor, Associate Professor or Professor is available with starting date negotiable, but beginning no earlier than August 2012. For those with sufficiently meritorious records, an endowed professorship or chair is available above the level of Assistant Professor. Applicants should have teaching and research interests and experience in one or more areas that relate to Unmanned Aerial Systems (UAS). It is expected that the successful candidate will have the ability to teach undergraduate courses in aerospace engineering, and graduate courses that support the candidate's research as well as our new UAS Options for the MS and PhD degrees. Good oral and written communication skills, as judged by both students and faculty, are also necessary. An earned Ph.D. in aerospace engineering, mechanical engineering, or engineering mechanics is required, together with an earned B.S. degree in aerospace engineering from an ABET accredited or equivalent program. The successful candidate must have demonstrated potential for excellent teaching at the undergraduate and graduate levels, and for developing a strong externally funded research program. The research areas of the successful applicant must be in an area that directly supports Unmanned Aerial Systems in order to support the rapidly growing UAS programs at OSU. Post doctoral or industry experience is desired. Excellent opportunities exist for the successful applicant to collaborate in the UAS area with the University Multispectral Laboratories (www.okstate-uml.org), which owns and operates a fully equipped, full scale UAS airfield, together with other relevant facilities. A second UAS airfield operated by the School of MAE for lighter UAVs became fully operational in 2011. Applications will be accepted until the position is filled. Send (electronically) letter of application, statement on teaching interests and philosophy, statement on specific plans for securing extramural funding for at least two research projects, including contacts already made with funding agencies, curriculum vitae, and list of five references to: Dr. A. S. Arena, aarena@okstate.edu, Chair, Aerospace/UAS Engineering Search Committee, School of Mechanical and Aerospace Engineering, 218 Engineering North, Oklahoma State University, Stillwater, OK 74078-054 (www.mae.okstate.edu). OSU is an affirmative action/equal opportunity/E-verify employer committed to diversity.

AIAA Bulletin

The AIAA Career and Workforce Development Workshop at the 50th AIAA Aerospace Sciences Meeting, Including the New Horizons Forum and Aerospace Exposition, 10 January 2012. (Source: John Gattasse)

FEBRUARY 2012

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

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

Meeting Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
2012				
29 Jan–2 Feb†	**22nd AAS/AIAA Space Flight Mechanics Meeting**	Charleston, SC Contact: Keith Jenkins, 480.390.6179; keith@jenkinspatentlaw.com; www.space-flight.org	*Apr 11*	**3 Oct 11**
15–16 Feb	**15th Annual FAA Commercial Space Transportation Conference**	Washington, DC		
3–10 Mar†	**2012 IEEE Aerospace Conference**,	Big Sky, Montana Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org		
21–23 Mar†	**Nuclear and Emerging Technologies for Space 2012 (NETS-2012) held in conjunction with the 2012 Lunar & Planetary Sciences Conference**	The Woodlands, TX Contact: Shannon Bragg-Sitton, 208.526.2367, shannon.bragg-sitton@inl.gov, http://anstd.ans.org/NETS2012.html		
26–28 Mar†	**3AF 47th International Symposium of Applied Aerodynamics**	Paris, France (Contact: Anne Venables, 33 1 56 64 12 30, secr.exec@aaaf.asso.fr, www.aaaf.asso.fr)		
23–26 Apr	**53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** (Jan) **20th AIAA/ASME/AHS Adaptive Structures Conference** **14th AIAA Non-Deterministic Approaches Conference** **13th AIAA Gossamer Systems Forum** **8th AIAA Multidisciplinary Design Optimization Specialist Conference**	Honolulu, HI	*Apr 11*	**10 Aug 11**
14–18 May†	**12th Spacecraft Charging Technology Conference**	Kitakyushu, Japan Contact: Mengu Cho, +81 93 884 3228, cho@ele.kyutech.ac.jp, http://laseine.ele.kyutech.ac.jp/12thsctc.html		
22–24 May	**Global Space Exploration Conference (GLEX)**	Washington, DC	*Oct 11*	**1 Dec 11**
22–25 May†	**5th International Conference on Research in Air Transportation (ICRAT 2012)**	Berkeley, CA Contact: Andres Zellweger, 301.330.5514, dres.z@comcast.net, www.icrat.org		
4–6 Jun	**18th AIAA/CEAS Aeroacoustics Conference (33rd AIAA Aeroacoustics Conference)**	Colorado Springs, CO	*Jun 11*	**9 Nov 11**
4–6 Jun†	**19th St Petersburg International Conference on Integrated Navigation Systems**	St. Petersburg, Russia Contact: Prof. V. Peshekhonov, +7 812 238 8210, elprib@online.ru, www.elektropribor.spb.ru		
18–20 Jun†	**3rd International Air Transport and Operations Symposium (ATOS) and 6th International Meeting for Aviation Product Support Process (IMAPP)**	Delft, the Netherlands Contact: Adel Ghobbar, 31 15 27 85346, a.a.ghobbar@tudelft.nl, www.lr.tudelft.nl/atos		
19–21 Jun	**AIAA Infotech@Aerospace Conference**	Garden Grove, CA	*Jun 11*	**6 Dec 11**
25–28 Jun	**28th Aerodynamics Measurement Technology, Ground Testing, and Flight Testing Conferences including the Aerospace T&E Days Forum** **30th AIAA Applied Aerodynamics Conference** **4th AIAA Atmospheric Space Environments Conference** **6th AIAA Flow Control Conference** **42nd AIAA Fluid Dynamics Conference and Exhibit** **43rd AIAA Plasmadynamics and Lasers Conference** **44th AIAA Thermophysics Conference**	New Orleans, LA	*Jun 11*	**17 Nov 11**
27–29 Jun†	**American Control Conference**	Montreal, Quebec, Canada Contact: Tariq Samad, 763.954.6349, tariq.samad@honeywell.com, http://a2c2.ort/conferences/acc2012		
11–14 Jul†	**ICNPAA 2012 – Mathematical Problems in Engineering, Aerospace and Sciences**	Vienna, Austria Contact: Prof. Seenith Sivasundaram, 386/761-9829, seenithi@aol.com, www.icnpaa.com		
14–22 Jul	**39th Scientific Assembly of the Committee on Space Research and Associated Events (COSPAR 2012)**	Mysore, India Contact: http://www.cospar-assembly.org		
15–19 Jul	**42nd International Conference on Environmental Systems (ICES)**	San Diego, CA	*Jul/Aug 11*	**15 Nov 11**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
30 Jul–1 Aug	**48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit Future Propulsion: Innovative, Affordable, Sustainable**	Atlanta, GA	*Jul/Aug 11*	**21 Nov 11**
30 Jul–1 Aug	**10th International Energy Conversion Engineering Conference (IECEC)**	Atlanta, GA	*Jul/Aug 11*	**21 Nov 11**
13–16 Aug	**AIAA Guidance, Navigation, and Control Conference AIAA Atmospheric Flight Mechanics Conference AIAA Modeling and Simulation Technologies Conference AIAA/AAS Astrodynamics Specialist Conference**	Minneapolis, MN	*Jul/Aug 11*	**19 Jan 12**
11–13 Sep	**AIAA SPACE 2012 Conference & Exposition**	Pasadena, CA	*Sep 11*	**26 Jan 12**
11–13 Sep	**AIAA Complex Aerospace Systems Exchange Event**	Pasadena, CA		
17–19 Sep	**12th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference 14th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference**	Indianapolis, IN	*Oct 11*	**7 Feb 12**
23–28 Sep†	**28th Congress of the International Council of the Aeronautical Sciences**	Brisbane, Australia Contact: http://www.icas2012.com		**15 Jul 11**
24–27 Sep†	**30th AIAA International Communications Satellite Systems Conference (ICSSC) and 18th Ka and Broadband Communications, Navigation and Earth Observation Conference**	Ottawa, Ontario, Canada Contact: Frank Gargione, frankgargione3@msn.com; www.kaconf.org	*Nov 11*	**31 Mar 12**
24–28 Sep	**7th AIAA Biennial National Forum on Weapon System Effectiveness**	Ft. Walton Beach, FL	*Nov 11*	**15 Mar 12**
1–5 Oct	**63rd International Astronautical Congress**	Naples, Italy (Contact: www. iafastro.org)		
5–8 Nov†	**27th Space Simulation Conference**	Annapolis, MD Contact: Harold Fox, 847.981.0100, info@spacesimcon.org, www.spacesimcon.org		
2013				
7–10 Jan	**51st AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition**	Dallas/Ft. Worth, TX	*Jan 12*	**5 Jun 13**
14–18 Jul	**43rd International Conference on Environmental Systems (ICES)**	Vail, CO		
19–22 Aug	**AIAA Guidance, Navigation, and Control Conference AIAA Atmospheric Flight Mechanics Conference AIAA Modeling and Simulation Technologies Conference AIAA Infotech@Aerospace Conference**	Boston, MA		
10–12 Sep	**AIAA SPACE 2013 Conference & Exposition**	San Diego, CA		

To receive information on meetings listed above, write or call AIAA Customer Service, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344; 800.639.AIAA or 703.264.7500 (outside U.S.). Also accessible via Internet at www.aiaa.org/calendar.

†Meetings cosponsored by AIAA. Cosponsorship forms can be found at http://www.aiaa.org/content.cfm?pageid=292.

AIAA **Courses** and **Training Program**

DATE	COURSE	VENUE	LOCATION
2012			
21–22 Apr	**Fundamentals of Composite Structure Design**	SDM Conferences	Honolulu, HI
21–22 Apr	**Introduction to Bio-Inspired Engineering**	SDM Conferences	Honolulu, HI
21–22 Apr	**Aeroelasticity: State-of-the-Art Practices**	SDM Conferences	Honolulu, HI
21–22 Apr	**Introduction to Non-Deterministic Approaches**	SDM Conferences	Honolulu, HI

**Courses subject to change*

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From the Corner Office

GLOBAL INTEGRATION AND COLLABORATION—KEY THEMES FOR OUR FUTURE

Klaus Dannenberg, Deputy Executive Director and Chief Strategy Officer

Well into the second century of flight, our industry continues to inspire the human imagination and to contribute to critical missions within both national and global economies (e.g., national security, transportation of goods and people, global communications, and acquisition of environmental data). The professional associations affiliated with our industry worldwide are also entering their second century. Believe it or not, within this global community, AIAA is still one of the youngsters. AIAA just passed its 80th anniversary. But the Royal Aeronautical Society (RAeS) is 146 years old and is clearly the granddaddy of professional aerospace associations. This year, the German national aerospace society, the Deutsche Gesellschaft für Luft- und Raumfahrt (or DGLR) will be 100. The AIAA salutes the DGLR and will support their upcoming celebrations in Berlin during 2012. Since other national aerospace societies are also approaching their centennial anniversaries, this seems to be an appropriate time to reflect on our mutual global contributions and our challenges as we collectively address our future. This theme is in keeping with the past two months' editorials by Mike Griffin and Bob Dickman, but adds another dimension.

Of necessity, through the 1960s and beyond, many of the societies were nationalistic in nature, competing with one another in many ways. That was a natural consequence of the world situation, with hot and cold world wars and competition for international sales in the high tech aviation arena. Then over the past 20 years, three significant trends arose that influence our way forward: 1) the morphing of global, nationalistic hostilities into significant, but asymmetric and localized ones, 2) the increased prioritization of civil missions worldwide, and 3) the emergence and maturation of the global industrial base and supply chain. With these trends, the need for nations (and their associated aerospace societies) is changing to emphasize greater cooperation and collaboration across national boundaries, often stimulated by AIAA and our international equivalents. So the question is "What do we do differently?" The somewhat simplistic answer is "Become more user focused."

Since our Institute is dominated by engineers and scientists, it is easy for us to become enamored with the wonders of technology—trying to unlock its secrets and to determine new applications for each mini-breakthrough. But with that focus, we retreat into our technology cocoon when we should be breaking out of that cocoon to be active participants and leaders in the broader world. We need to change that. That's what Mike and Bob have been discussing in the December and January editorials. So, for example, rather than remaining focused on technologies or even platforms, we need to expand our horizons and address how those platforms are used—whether for environmental monitoring for business applications, for communications relays, or for whatever other uses we may invent. We don't want to do away with our technology focus. But we need a place for the users to understand how our technologies impact them and a mechanism for them to interact with our members. That's still a technical forum, but it means a stronger focus on integration as well as a greater emphasis on collaboration with using communities.

Our integration efforts need to address both integration of technologies and subsystems, i.e., "design integration" as well as the "mission integration" of our platforms and sensors with the phenomenology as well as the users. So if the application is weather, we must integrate the satellite and airborne platforms with their sensors, with the observed weather phenomenology, and with the weather models used by the forecasters to make their predictions. In this case, the aviation and space platform designers, the platform operators, the weathermen, data linkers, and the atmospheric modeling communities all need to be interacting with one another. That means collaboration of at least 5–6 various groups, each of which have their own professional associations. But it doesn't stop there. Weather is not restricted by national boundaries and other nations are also interested in the results and are willing to share information to develop more comprehensive global results. Therefore, other national societies also need to participate in these interactions.

As you can easily see, this can get pretty complicated pretty quickly. And to further complicate things, every society has its own business models and interests. But this is exactly the direction in which our industry and our professional associations are headed. The themes of integration and global collaboration are ones that will increasingly be encountered in our future. We must address them or run the risk of losing our relevance, not only nationally, but worse—globally! So our support of the DGLR and other societies will continue to grow and hopefully become more integrated with the entire community of developers, operators, and users of our products as we accompany and lead our professional community into the future. We welcome your interests and your participation. If you have any feedback on these topics, please share them with us at **klausd@aiaa.org**.

AIAA 2012 SUSTAINED SERVICE AWARD RECIPIENTS ANNOUNCED!

AIAA is pleased to announce that Sustained Service Awards will be presented to the following members during 2012; we sincerely thank them for their dedication and service. The Sustained Service Award recognizes significant service and contributions to AIAA by members of the Institute.

Region 3

Ian Halliwell, Dayton/Cincinnati Section, "For sustained service to AIAA at section, regional and national levels."

Region 5

Michael Mackowski, Phoenix Section, "For over ten years of leadership and contributions to the AIAA Phoenix Section and for dedication in promoting STEM education programs."

Region 6

Jeffrey Puschell, Los Angeles Section, "For excellence and sustained service to AIAA across a wide range of activities related to technical committees and conferences."

Eileen Wyckoff, Vandenberg Section, "For nearly three decades of dedicated service and contributions to AIAA and the AIAA Vandenberg Section."

International

Frank Coton, "For sustained service to AIAA publications and technical services as an associate editor, as an author, as technical committee member and chair, and as a conference session and general chair."

Nominations for the AIAA Sustained Service Award may be submitted to AIAA no later than **1 October** of each year. Contact Carol Stewart at 703.264.7623 or carols@aiaa.org for more information.

AIAA ANNOUNCES 2012 FELLOWS AND HONORARY FELLOWS

AIAA is pleased to announce the 2012 AIAA Fellows and Honorary Fellows. Presentation of the new Fellows and Honorary Fellows will take place at the AIAA Aerospace Spotlight Awards Gala, Wednesday, 9 May 2012, at the Ronald Reagan Building and International Trade Center, in Washington, DC.

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 2012 AIAA Honorary Fellows are:

Arnold D. Aldrich, Aldrich & Associates
Paul Nielsen, Software Engineering Institute
Robert J, Stevens, Lockheed Martin Corporation

The distinction of *Fellow* is conferred by AIAA upon outstanding members of the Institute who have made notable and valuable contributions to the arts, sciences, or technology of aeronautics or astronautics. The 2012 AIAA Fellows are:

Nadine Aubry, Carnegie Mellon University
Carlos E. Cesnik, University of Michigan
John W. Daily, University of Colorado Boulder
David B. Doman, Air Force Research Laboratory
J. Philip Drummond, NASA Langley Research Center
Jeffrey M. Forbes, University of Colorado Boulder
Subramanyam R. Gollahalli, The University of Oklahoma
Ralph Heath, Lockheed Martin Corporation
David K. Holger, Iowa State University
James A. Horkovich, Raytheon Missile Systems
James E. Hubbard, Jr., National Institute of Aerospace
Mordechay Karpel, Technion-Israel Institute of Technology
Hitoshi Kuninaka, Japan Aerospace Exploration Agency (JAXA)
John S. Langford, Aurora Flight Sciences
Azad M. Madni, Intelligent Systems Technology, Inc.
Moshe Matalon, University of Illinois at Urbana-Champaign
Arun K. Misra, McGill University
Roger Ohayon, Conservatoire National des Arts et Métiers
Ellen M. Pawlikowski, U.S. Air Force Space and Missile Systems Center
J.V.R. Prasad, Georgia Institute of Technology
Mark E. Russell, Raytheon Company
Robert S. Ryan, Consultant
John D. Schmisseur, Air Force Office of Scientific Research
Mary L. Snitch, Lockheed Martin Corporation
John Sullivan, Purdue University
Miguel R. Visbal, Air Force Research Laboratory
Norman M. Wereley, University of Maryland
David A. Whelan, Boeing Defense, Space & Security

AIAA President Brian Dailey 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 great contributions to our field and technical community. 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, visit **www.aiaa.org**.

AIAA CONGRATULATES LOUIS CHENEVERT ON BEING NAMED *AVIATION WEEK* PERSON OF THE YEAR

AIAA congratulates **AIAA Fellow Louis R. Chênevert**, chairman and chief executive officer of United Technologies Corp., an AIAA Corporate Member, on being named *Aviation Week*'s 2011 Person of the Year.

AIAA President Dr. Brian D. Dailey stated: "The American Institute of Aeronautics and Astronautics congratulates Louis Chênevert on being named *Aviation Week*'s 2011 Person of the Year. Under his direction, United Technologies Corp. has overseen the efforts of Pratt & Whitney, Sikorsky, and Hamilton Sundstrand to become one of the world's premier aerospace manufacturers. From repositioning Pratt & Whitney to become a major player in the commercial jet engine market, to developing engines for the next generation of narrowbody jets, to the Collier Trophy-winning Sikorsky X-2 helicopter, Chênevert's efforts truly embody *Aviation Week*'s standard for the award—which is to recognize the person who has had the most impact on the broader aviation and defense community."

Under Chênevert's direction, United Technologies Corp. reached an agreement to purchase Goodrich, vastly expanding UTC's presence in the aircraft supply market. He was also instrumental in restoring P&W as a major player in the narrowbody commercial jet engine market, with Pratt & Whitney's Geared Turbofan jet engine being selected by Airbus for use in its A32NEO jet. Pratt & Whitney, which Chênevert led from 1999 to 2006, also will collaborate with Rolls-Royce to develop engines for the next generation of narrowbody jets, and is now the sole engine supplier to the Joint Strike Fighter program.

Prior recipients of the annual *Aviation Week* Person of the Year award have included: Jeff Smisek, CEO, United Continental Holdings, Inc., in 2010; "The Space Entrepreneur" in 2009; Robert Gates, former U.S. Secretary of Defense, in 2008; and Tsien Hsue-shen, the "father" of China's space program, in 2007. For more information about the *Aviation Week* Person of the Year award, please visit www.aviationweek.com.

The Albuquerque Section hosted Dr. Harrison Schmitt, former Apollo 17 astronaut and former U.S. Senator from New Mexico. Dr. Schmitt, a native of New Mexico, was one of the first scientists chosen to serve in the astronaut corps, and was the last person to step on the moon, just over 39 years ago. His presentation to a packed house of Albuquerque Section members focused on the geologic aspects of the Apollo 17 mission to the moon and his thoughts on the future of manned spaceflight.

Dr. Schmitt is in the center of the picture, joined on the left by Albuquerque Section Chair Don Nash (left) and AIAA Vice President for Technical Activities Basil Hassan (right).

DR. PRABHAT HAJELA NAMED ACTING PROVOST

Dr. Prabhat Hajela, currently Vice Provost and Dean of Undergraduate Education, has been named Acting Provost at Rensselaer Polytechnic Institute. Dr. Hajela is a Professor of Aerospace Engineering in the Department of Mechanical, Aerospace, and Nuclear Engineering. In his role as Vice Provost, he has been instrumental in helping Rensselaer maintain its leadership position in Undergraduate Education. Dr. Hajela's administrative mandate has included the oversight of undergraduate programs, including engaging the five academic schools in program development and implementation.

Dr. Hajela is a past Vice President of the International Society of Structural and Multidisciplinary Optimization. He was also a past Chair of ASME's Aerospace Division. In 2003, he served as a Congressional Fellow responsible for Science and Technology Policy in the Office of U.S. Senator Conrad Burns (R-MT).

He maintains a collaborative role in research, working with graduate students and research colleagues in areas related to complex system analysis and design in the presence of uncertainties. He has published over 270 papers and articles in the areas of structural and multidisciplinary optimization, and is an author/editor of four books in these areas. In 2004, he was the recipient of AIAA's Biennial Multidisciplinary Design Optimization Award. Dr. Hajela is a Lifetime Fellow of AIAA, a Fellow of the Aeronautical Society of India (AeSI), and a Fellow of the American Society of Mechanical Engineers (ASME).

Dr. Hajela received his undergraduate degree (with distinction) in 1977 from the Indian Institute of Technology, Kanpur. He received master's degrees in Aerospace Engineering from Iowa State University (1979) and in Mechanical Engineering from Stanford University (1981). He was awarded his Ph.D. in Aeronautics and Astronautics from Stanford University in 1982 and did postdoctoral training at UCLA before joining the University of Florida as a faculty member in 1983, where he was promoted to the rank of Associate Professor in 1987. He was recruited to Rensselaer in the Department of Mechanical and Aerospace Engineering in 1990 and was promoted to full professor in 1992. He was appointed to his current position as Vice-Provost in 2005.

RECENT HISTORIC SITE CEREMONIES IN GERMANY, GEORGIA, AND CALIFORNIA

Emily Springer

Over the fall, there were several historic site ceremonies held around the world. In October, Region VII Director Juergen Quest spoke at a ceremony designating **Bremen Airport**, in Germany, as an AIAA Historic Aerospace Site. The airport, which celebrated its 100th anniversary in 2009, is probably best known for the establishment there of the Focke-Wolf Company. The company was founded in 1923 by Henrich Focke and Georg Wulf for the development and construction of civil and trainer airplanes.

Today, Germany's second largest Airbus site is located at the airport with about 3,000 employees. On 26 June 26, Henrich Focke's Fw 61, the world's first practical helicopter, made its successful maiden flights at Bremen Airport site with test pilot Ewald Rohlfs at the controls. One year later, the Fw 61 held all existing world records for helicopters for Germany.

Many other accomplishments were also made by Focke-Wulf in Bremen, including the development and manufacture of the FW 200 Condor and the Fw 190 fighter aircraft; and the Fa 223, the enlarged version of the FW 61, was developed in 1938 in the Focke-Achgelis company in Hoykenkamp near Bremen. After World War II, the VAK 191 VSTOL aircraft was constructed at the VFW-Focker Company, the successor to the Focke-Wulf Company, at Bremen.

On 9 November, Region II Director Alan Lowrey and the AIAA Atlanta section hosted a ceremony honoring the original 1940s **Delta Airlines buildings** in Atlanta. Two aircraft hangars and several office buildings at Delta's World Headquarters, constructed between 1941 and 1947, indicate the historic partnership between Delta Air Lines, the City of Atlanta, and Hartsfield- Jackson Atlanta International Airport. On 1 March 1941, Delta officially moved its corporate headquarters to Atlanta on leased airport property, constructing office space and Hangar 1, the largest aircraft hangar in the Southeast. In 1947, the complex doubled in size. From this site, Delta's growth from regional airline to global carrier paralleled, and helped fuel, the rise of Atlanta to world prominence as a major business and transportation center. The original 1940s buildings at Delta's headquarters still exist and are home to the Delta Air Transport Heritage Museum and Delta executive and administrative offices.

In December, Vice President–Standards Wilson Felder designated **Space Park**, in Redondo Beach, CA, as an AIAA Historic Site. Space Park began in the early 20th century with the Thompson Company, a valve manufacturer, who combined with two visionary engineers—Simon Ramo and Dean Wooldridge, to form what eventually became the Thompson-Ramo-Wooldridge Corporation (TRW). Now owned by Northrop Grumman, over 100 military and spacecraft have been developed at Space Park. These craft include Pioneer 10; the Lunar Excursion Module Descent Engine; the Chandra X-Ray Observatory, and many others. In addition, employees at Space Park were instrumental in assisting NASA with returning the crew of Apollo 13 home safely.

Tony Springer, AIAA Historic Sites Committee Chair; Juergen Bula, Director, Bremen Airport; Juergen Quest, AIAA Director, Region VII; and Wolfgang Geissler, American Helicopter Society. They are standing in front of the Junkers W33 that made the first east-to-west crossing of the Atlantic in 1928.

Alan Lowrey, AIAA Director, Region II; Harold Bevis, Delta Air Transport Heritage Museum Board; Tiffany Meng, Delta Air Transport Heritage Museum; and Brian Dater, AIAA Atlanta Section chair.

AIAA SEEKS MEMBERS FOR THE STANDARDS EXECUTIVE COUNCIL

The Standards Executive Council, which represents a diverse group in the aeronautics and astronautics field and oversees the development of Standards at AIAA, is seeking to increase its membership.

Members are responsible for providing policy, direction, and guidance to approved consensus bodies, AIAA staff, and the AIAA Board of Directors on all issues related to the Standards Program, from formation of Committees on Standards to approval of standards for publication. Candidates are recommended by the Chairperson (VP, Standards) and appointed by the AIAA President for 3-year term with re-appointments on the recommendation of the Chairperson.

For more information or to request an application, please contact Ms. Laura McGill, VP-Elect, Standards, at ljmcgill@raytheon.com or AIAA Program Manager, Standards at amyb@aiaa.org.

OBITUARIES

Last Living B-52 Designer Died in December

Holden W. (Bob) Withington died on 9 December at the age of 94. He was the last of the B-52 designers to die.

Over a weekend in 1948, six aeronautical designers from the Boeing Company, including Withington, holed up in a hotel suite in Dayton, OH. With balsa wood, glue, carving tools, and silver paint, the group created an impressive 14-inch scale model of an airplane on a stand, along with a neatly bound 33-page proposal. Col. Pete Warden, the Air Force chief of bomber development, studied the result and pronounced, "This is the B-52."

The B-52, laden with nuclear warheads, was a forbidding-looking mainstay of American air defense during the Cold War and a strategic deterrent to a nuclear attack. It saw substantial duty in Vietnam and the Iraq wars and is still in use. And its fundamental design—novel wings with engine "pods" positioned underneath—became the standard for almost all commercial jet carriers.

A year after the B-52 breakthrough, Mr. Withington and other Boeing engineers turned their attention to designing a civilian jet transport plane. They used many features of the bomber, particularly the wing design and engine placement, to create the Boeing 707, the airliner that ushered in the Jet Age.

In 1941, Boeing recruited Mr. Withington from MIT, where he had earned a master's degree and done research using the university's wind tunnel. His first assignment was to design and build a state-of-the-art wind tunnel for Boeing. Theodore von Karman, the eminent mathematician and aeronautical expert, passed on a piece of advice: "Make it as fast as you can." Mr. Withington built the wind tunnel to produce speeds of 625 miles an hour, close to the sound barrier.

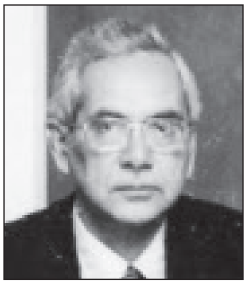
In 1945, George Schairer, a renowned Boeing aerodynamicist, was part of an expert group following American troops through Germany to snap up intelligence on German weapons. He discovered that the Germans had performed extensive studies on swept-back wings. He sent a letter to Mr. Withington, who immediately began testing the concept in his wind tunnel. In less than a month, Mr. Withington proved that swept-back wings worked. When they were combined with jet engines, the way forward seemed clear. He tested the new wing formulation for use in Boeing's B-47 bomber, the B-52's predecessor. He did his tests at night when power was cheaper, sleeping on a cot next to the tunnel. The resulting six-engine jet bomber perplexed even Mr. Withington. "That's a mighty strange-looking airplane," he recalled thinking in a 2002 interview. "I wonder if it will really fly."

It did, and the B-47 bomber was used from 1951 to 1965. The Air Force wanted a heavier bomber with more range, and chose Boeing to build the B-52 prototype. A debate raged in the service and beyond over the merits of a jet engine versus those of a turbo prop, which would use less fuel but sacrifice speed. At a meeting at Wright Field in Dayton, Colonel Warden decreed that the turbo prop idea should be dropped in favor of jet engines, and then ordered the group back to their hotel room for their weekend of frenzied work. They used slide rules for calculations.

After the success of the B-52, Mr. Withington climbed Boeing's executive ladder. At one point, he was vice president and general manager of the company's effort to build a supersonic jetliner to challenge the Concorde of Britain and France and the Tu-144 of Russia. Congress killed the project in 1971 because of worries about sonic booms and environmental damage. He retired as vice president for engineering in 1983. He got his pilot's license after he retired, and at 80, he built a two-seater airplane in his backyard. Mr. Withington was an AIAA Fellow.

AIAA Fellow Metzger Died in December

Sidney Metzger, 94, an electrical engineer who was a pioneer in the theory, design, development, and realization of satellite communications systems, died on 22 December.



Mr. Metzger received his B.S. in Electrical Engineering from New York University with honors. He received his Masters in Electrical Engineering from the Polytechnic Institute of Brooklyn in 1948. He began his career at the U.S. Signal Corps at Fort Monmouth, NJ in 1939. During his time in the Corps, he wrote the specifications for radio-relay communication technology in the United States. Among the many projects he led, Mr. Metzger was the only civilian on the committee that oversaw the implementation and use of SIGSALY, the first secure telecommunications system in World War II that successfully resisted German deciphering. The top secret SIGSALY system effectively protected the security of telephone conversations between Churchill and Roosevelt, as well as top generals in the European and Pacific Theatres.

Mr. Metzger continued his pioneering work in communications technology after the war. From 1945 to 1954, he was Manager of the Radio Relay Department for IT&T Federal Labs, responsible for commercial and military microwave relay equipment, which resulted in the first over-water telecommunication between Prince Edward Island and mainland Canada. In 1946, he oversaw the global deployment of radio-relay communications.

In 1954, Mr. Metzger managed what later became the Communications Engineering Department of the Astro-Electronics Division at RCA Laboratories. Under contract with the Army, he directed and managed the quick design and assembly of communications equipment deployed on Project SCORE, the world's first communications satellite, launched in December 1958. SCORE was the U.S.'s initial technological response to the Soviet Union's launch of Sputnik in 1957. In 1960, the communications package Mr. Metzger developed was launched on TIROS, the world's first weather-communication satellite. He then was project manager for RELAY 1, a communications satellite launched in 1962. In 1963, Mr Metzger became Manager of the Engineering Division and one of the first employees hired at the Communications Satellite Corporation (COMSAT), newly created under the Communications Satellite Act of 1962. Under his technical leadership, in a range of positions culminating as Vice President and Chief Scientist at his retirement in 1982, the world-spanning system of synchronous communications satellites envisioned two decades earlier became both a reality and an integral part of the modern, global telecommunications network.

Mr. Metzger was a member of the National Academy of Engineering and its Air and Space Engineering Board, a Fellow of both the Institute of Electrical and Electronics Engineers (IEEE) and AIAA, and a recipient of numerous awards and recognition. These awards included the IEEE's awards for International Communications and Aerospace Electronics (1976), the AIAA Aerospace Communication Award (1984), and the NEC Foundation's inaugural C&C Award for integration of computers and communications technologies (1985). He holds eleven patents—two jointly—in the communications field.

AIAA Associate Fellow Fleisig Died in December

Ross Fleisig, an aerospace engineer for more than fifty-five years and scientist at three aircraft and spacecraft companies, died on 28 December 2011. He was 90 years old.

Mr. Fleisig received a Bachelor of Aeronautical Engineering in 1942 and a Master of Science in Applied Mechanics in 1955, both from Polytechnic University in Brooklyn, NY. After graduating in 1942, he was employed as a Senior Aerodynamacist by Chance Vought Aircraft, where he contributed to the design of U.S. Navy fighter and bomber aircraft and guided missiles employed during World War II. In 1950, he joined Sperry Gyroscope Company in Great Neck, NY, as a Project Engineer, and was promoted to Engineering Section Head. Mr. Fleisig supervised technical personnel in missile guidance and control systems, helicopter flight control and lunar spacecraft navigation development fields.

In 1960, he joined the Grumman Corporation as Dynamic Analysis Project Engineer on the NASA Orbiting Astronomical Observatory. In 1961, as head of the Apollo Lunar Module (LM) Dynamics and Performance Analysis, he managed more than 100 engineers, scientists, and supporting personnel in the definition of LM trajectories and propulsion requirements. He was promoted to Spacecraft Team Manager, and he directed over 100 engineers, technicians, and quality control specialists in the final assembly, integration, and ground test of the Apollo 11 LM-5 Eagle. The LM-5 was the first spacecraft to land on the moon and return the astronauts to the mother craft in lunar orbit.

Mr. Fleisig's last years at Grumman were spent as Advanced Systems Engineering Manager for U.S. Air Force space trajectory software and helicopter systems development. Mr. Fleisig ended his career as a private consultant, serving U.S. and German aerospace concerns.

Mr. Fleisig was a member of the National Society of Professional Engineers; an AIAA Associate Fellow; past President, Director, and Fellow of the American Astronautical Society; member of the International Astronautical Academy; Fellow of the American Association for the Advancement of Science and the British Interplanetary Society. Mr. Fleisig authored 33 technical papers and was a frequent lecturer to engineering and scientific societies, colleges, public schools, service organizations, and other civic groups.

Mr. Fleisig's honors included the NASA Apollo 11 Manned Flight Awareness Award "in recognition of personal contribution and dedication that made possible this historic achievement"; the NASA Medallion; Grumman Citation for Excellence in recognition of personal achievement and for outstanding contribution to the Lunar Module Program of Project Apollo; and the AIAA Thomas Sanial Award. Mr. Fleisig was selected as an AIAA 1995–1997 Distinguished Lecturer, and was one of three recipients of the 1997 Achievement Award by the Engineers Joint Council of Long Island. Mr. Fleisig was a very active participant in the Long Island Section. He was section vice chair (1996–1997) and section programs officer (1995–1997).

AIAA Fellow Nesline Passed Away in December

Dr. Frederick W. (Bill) Nesline Jr., a proud veteran of the U.S. Navy in World War II, died on 30 December 2011 at age 84.

Dr. Nesline was a strong proponent of continuing education, and he earned a B.S. degree from the University of Maryland, and a Masters of Engineering and Ph.D. degree from Yale University, as well as an MBA from Northeastern University. He was also an Assistant Professor at MIT.

While at Raytheon Company, he chaired the company's advanced degree program. Dr. Nesline had a long and distinguished career at the Raytheon Company. He was Director of Engineering for Raytheon's work on the Apollo Program in the 1960s. He published 72 technical papers on guidance, control, and missile design. He taught courses in missile design in many countries. During his professional career, he also founded and was President of Applied Analysis Inc.

In 1986, Dr. Nesline became an AIAA Fellow and received the AIAA Mechanics & Control of Flight Award in 1991. He received the Thomas L. Phillips Award for Excellence in Technology from Raytheon Company (1992). In 1994, he received the University of Maryland College of Engineering Centennial Medal.

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. Any AIAA member in good standing may be a nominator and are highly urged to carefully read award guidelines to view nominee eligibility, page limits, letters of endorsement, etc.

AIAA members may submit nominations online after logging into **www.aiaa.org** with their user name and password. You will be guided step-by-step through the nomination entry. If preferred, a nominator may submit a nomination by completing the AIAA nomination form, which can be downloaded from **www.aiaa.org**.

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 honors 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 honors contributions by individuals that advance the health of the aerospace community by enabling cooperation, competition, and growth through the standardization process. (Presented odd years)

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

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

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

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

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

Missile Systems 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*** recognizes a significant accomplishment in the management of missile systems programs.

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

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

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

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.

Publications

New and Forthcoming Titles

Designing Unmanned Aircraft Systems: A Comprehensive Approach
Jay Gundlach

AIAA Education Series
2011, 800 pages, Hardback
ISBN: 978-1-60086-843-6
Member Price: $84.95
List Price: $109.95

Tactical and Strategic Missile Guidance, Sixth Edition
Paul Zarchan

Progress in Astronautics and Aeronautics
2012, 900 pages, Hardback
ISBN: 978-1-60086-894-0
Member Price: $104.95
List Price: $134.95

Boundary Layer Analysis, Second Edition
Joseph A. Schetz and Rodney D. Bowersox

AIAA Education Series
2011, 760 pages, Hardback
ISBN: 978-1-60086-823-8
AIAA Member Price: $84.95
List Price: $114.95

Introduction to Flight Testing and Applied Aerodynamics
Barnes W. McCormick

AIAA Education Series
2011, 150 pages, Hardback
ISBN: 978-1-60086-827-6
AIAA Member Price: $49.95
List Price: $64.95

Space Operations: Exploration, Scientific Utilization, and Technology Development
Craig A. Cruzen, Johanna M. Gunn, & Patrice J. Amadieu

Progress in Astronautics and Aeronautics Series, 236
2011, 672 pages, Hardback
ISBN: 978-1-60086-817-7
AIAA Member Price: $89.95
List Price: $119.95

Spacecraft Charging
Shu T. Lai

Progress in Astronautics and Aeronautics Series, 237
2011, 208 pages, Hardback
ISBN: 978-1-60086-836-8
AIAA Member Price: $64.95
List Price: $84.95

Order 24 hours a day at www.aiaa.org/new

Exergy Analysis and Design Optimization for Aerospace Vehicles and Systems
Jose Camberos and David Moorhouse

Progress in Astronautics and Aeronautics Series, 238
2011, 600 pages, Hardback
ISBN: 978-1-60086-839-9
AIAA Member Price: $89.95
List Price: $119.95

Engineering Computations and Modeling in MATLAB/Simulink
Oleg Yakimenko

AIAA Education Series
2011, 800 pages, Hardback
ISBN: 978-1-60086-781-1
AIAA Member Price: $79.95
List Price: $104.95

Introduction to Theoretical Aerodynamics and Hydrodynamics
William Sears

AIAA Education Series
2011, 150 pages, Hardback
ISBN: 978-1-60086-773-6
AIAA Member Price: $54.95
List Price: $69.95

Eleven Seconds into the Unknown: A History of the Hyper-X Program
Curtis Peebles

Library of Flight
2011, 330 pages, Paperback
ISBN: 978-1-60086-776-7
AIAA Member Price: $29.95
List Price: $39.95

Basic Helicopter Aerodynamics, Third Edition
John M. Seddon and Simon Newman

AIAA Education Series
Published by John Wiley & Sons, 2011, 3rd Edition, 264 pages, Hardback
ISBN: 9-781-60086-861-0
AIAA Member Price: $49.95
List Price: $74.95

Gas Turbine Propulsion Systems
Bernie MacIsaac and Roy Langton

AIAA Education Series
Published by John Wiley & Sons, 2011, 368 pages, Hardback
ISBN: 9-781-60086-846-7
AIAA Member Price: $84.95
List Price: $119.95

Upcoming AIAA Professional Development Courses

21–22 April 2012

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

SDM Course and Conference Registration Fees

To register, go to **www.aiaa.org/events/sdm.**

	Early Bird by 26 Mar 2012	*Standard (27 Mar–20 Apr)*	*Onsite (21–22 Apr)*
AIAA Member	$1260	$1360	$1460
Nonmember	$1338	$1438	$1538

Fundamentals of Composite Structure Design **(Instructor: Rikard Heslehurst, Senior Lecturer, School of Aerospace, Civil and Mechanical Engineering of the University College, UNSW at the Australian Defense Force Academy)**

This seminar has been developed specifically for engineers who require some fundamental understanding of the structural design requirements for composites. The application of composite materials is discussed initially in terms of the constituent component material properties and manufacturing processes based on the design requirements analysis. The tailoring of structural properties through lamination and fiber orientation placement are discussed in relationship to strength of materials issues and load/deformation response. The design development of the laminate is based on design outcomes and how fiber/resin systems and ply orientation is determined to achieve these design outcomes. This seminar briefly will cover the design requirements of stress analysis for the design detail such as joints, structural stiffening against instability, and other structural discontinuities. Other aspects of the seminar to be covered include environmental and longevity aspects, certification and in-service support issues.

Introduction to Bio-Inspired Engineering **(Instructor: Chris Jenkins, Head of Mechanical & Industrial Engineering, MSU, Bozeman, MT)**

The primary purpose of this course is to inform engineers and other technical professional in the use of bio-inspired engineering (BiE) to expand the design space of possible solutions to technical problems. We do that by first understanding how nature solves problems. Then, and at least as important, is learning how to translate biological knowledge into engineering practice. Even though the domain of biology is vast and new discoveries occur daily, much is known about biological solutions. Turning this knowledge into technical solutions is the challenge we face—it is also the focus of considerable attention in modern BiE, and hence this course as well.

Aeroelasticity: State-of-the-Art Practices **(Instructors: Dr. Thomas W. Strganac, Texas A&M University, College Station, TX; Dr. Carlos E. S. Cesnik, University of Michigan; Dr. Walter A. Silva, NASA Langley Research Center; Dr. Jennifer Hegg, NASA Langley Research Center; Dr. Rick Lind, University of Florida; Dr. Paul G. A. Cizmas, Texas A&M University; Dr. Gautam SenGupta, The Boeing Company; John Lassiter, NASA Marshall Space Flight Center)**

In recent years, there has been a renewed interest in aeroelasticity arising from high performance aerospace systems, multiple control surface configurations, and pathologies associated with nonlinear behavior. This course provides a brief overview of aeroelasticity and examines many new "fronts" currently being pursued in aeroelasticity that include reduced-order models, integrated fluid-structural dynamic models, ground vibration testing, wind tunnel tests, robust flutter identification approaches for wind tunnel and flight test programs, aeroservoelasticity, and aeroelasticity of very flexible aircraft. The course will emphasize current practices in both analytical and experimental approaches within industry and government labs, as well as advances as pursued by these organizations with the support of university research.

Introduction to Non-Deterministic Approaches **(Instructor: Dr. Ben H. Thacker, Director, Materials Engineering Department, San Antonio, TX; Dr. Michael P. Enright, Principal Engineer, Materials Engineering Department, San Antonio, TX; Dr. Sankaran Mahadevan, Professor, Civil, Environmental and Mechanical Engineering, Vanderbilt University, Nashville, TN; Dr. Ramana V. Grandhi, Professor, Department of Mechanical and Materials Engineering, Wright State University, Dayton, OH)**

This course is offered as an introduction to methods and techniques used for modeling uncertainty. Fundamentals of probability and statistics are covered briefly to lay the groundwork, followed by overviews of each of the major branches of uncertainty assessment used to support component and system level life cycle activities, including design, analysis, optimization, fabrication, testing, maintenance, qualification, and certification. Branches of Non-Deterministic Approaches (NDA) to be covered include Fast Probability Methods (e.g., FORM, SORM, Advanced Mean Value, etc.), simulation methods such as Monte Carlo and Importance Sampling, surrogate methods such as Response Surface, as well as more advanced topics such as system reliability, time-dependent reliability, probabilistic finite element analysis, and reliability-based design. An overview of emerging non-probabilistic methods for performing uncertainty analysis will also be presented.

Standard Information for all AIAA Conferences

This is general conference information, except as noted in the individual conference preliminary program information to address exceptions.

Photo ID Needed at Registration

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

Conference Proceedings

This year's conference proceedings will be available in an online format only. The cost is included in the registration fee where indicated. If you register in advance for the online papers, you will be provided with instructions on how to access the conference technical papers. For those registering on-site, you will be provided with instructions at registration.

Young Professional Guide for Gaining Management Support

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

Journal Publication

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

Speakers' Briefing

Authors who are presenting papers, session chairs, and co-chairs will meet for a short briefing at 0700 hrs on the mornings of the conference. Continental breakfast will be provided. Please plan to attend only on the day of your session(s). Location will be in final program.

Speakers' Practice

A speaker practice room will be available for speakers wishing to practice their presentations. A sign-up sheet will be posted on the door for half-hour increments.

Timing of Presentations

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

Committee Meetings

Meeting room locations for AIAA committees will be posted on the message board and will be available upon request in the registration area.

Audiovisual

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

Employment Opportunities

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

Messages and Information

Messages will be recorded and posted on a bulletin board in the registration area. It is not possible to page conferees. A telephone number will be provided in the final program.

Membership

Professionals registering at the nonmember rate will receive a one-year AIAA membership. Students who are not members may apply their registration fee toward their first year's student member dues.

Nondiscriminatory Practices

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

Smoking Policy

Smoking is not permitted in the technical sessions.

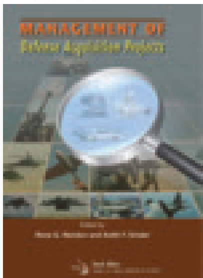
Restrictions

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

International Traffic in Arms Regulations (ITAR)

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

New and Best-Selling Books from AIAA



"An excellent way to get a solid grounding in the complex and challenging acquisition process."
—**Jacques S. Gansler**, Ph.D., University of Maryland, and former Under Secretary of Defense for Acquisition, Technology and Logistics

Management of Defense Acquisition Projects

Rene G. Rendon and Keith F. Snider
Naval Postgraduate School
2008, 292 pages, Hardback, ISBN: 978-1-56347-950-2
List Price $64.95
AIAA Member Price: $49.95

A History of Two CIA Projects. *Based on interviews, memoirs, and oral histories of the scientists and engineers involved, as well as recently declassified CIA documents, and photographs, reports, and technical drawings from Lockheed and Convair, this is a technical history of the evolution of the Lockheed A-12 Blackbird.*

From RAINBOW to GUSTO: Stealth and the Design of the Lockheed Blackbird

Paul A. Suhler
2009, 300 pages, Paperback, 1SBN: 978-1-60086-712-5
List Price $39.95
AIAA Member Price $29.95

While the focus of this book is on ground combat system vulnerability, many of the principles, methodologies, and tools discussed are also applicable to the air and sea system communities.

Fundamentals of Ground Combat System Ballistic Vulnerability/Lethality

Paul H. Deitz, Harry L. Reed Jr., J. Terrence Klopcic, and James N. Walbert
Progress in Astronautics and Aeronautics, Vol. 230
2009, 384 pages, Hardback, ISBN: 978-1-60086-015-7
List Price $119.95
AIAA Member Price: $89.95

"I urge all who are serious about understanding the development of the national security space arena to read it."
—**Roger D. Launius**
Smithsonian Institution

Shades of Gray: National Security and the Evolution of Space Reconnaissance

L. Parker Temple III
2005, 554 pages, Hardback, ISBN: 978-1-56347-723-2
List Price $29.95
AIAA Member Price: $24.95

Also From AIAA

Weaponeering: Conventional Weapon System Effectiveness
Morris Driels, Naval Postgraduate School
2004, 466 pages, Hardback, ISBN: 978-1-56347-665-5
List Price: $99.95
AIAA Member Price: $74.95

The Fundamentals of Aircraft Combat Survivability Analysis and Design, Second Edition
Robert E. Ball, Naval Postgraduate School
2003, 889 pages, Hardback, ISBN: 978-1-56347-582-5
List Price: $104.95
AIAA Member Price: $79.95

Mathematical Methods in Defense Analyses, Third Edition
J. S. Przemieniecki, Air Force Institute of Technology
AIAA Education Series
2000, 421 pages, Hardback, ISBN: 978-1-56347-397-5
List Price: $104.95
AIAA Member Price: $79.95

The Missile Defense Equation: Factors for Decision Making
Peter J. Mantle, Mantle & Associates, LLC
2004, 525 pages, Hardback, ISBN: 978-1-56347-609-9
List Price: $99.95
AIAA Member Price: $74.95

Effective Risk Management: Some Keys to Success, Second Edition
Edmund H. Conrow, CMC, CPCM, PMP
2003, 554 pages, Hardback, ISBN: 978-1-56347-581-8
List Price: $84.95
AIAA Member Price: $64.95

Approximate Methods for Weapon Aerodynamics
Frank G. Moore, Naval Surface Warfare Center
Progress in Astronautics and Aeronautics, Vol. 186
2000, 464 pages, Hardback, ISBN: 978-1-56347-399-9
List Price: $119.95
AIAA Member Price: $89.95

Order online at www.aiaa.org/books

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