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September 2011

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WINGS OF GOLD

One hundred years of U.S. Navy air power

Launch vehicles: A worldwide roundup

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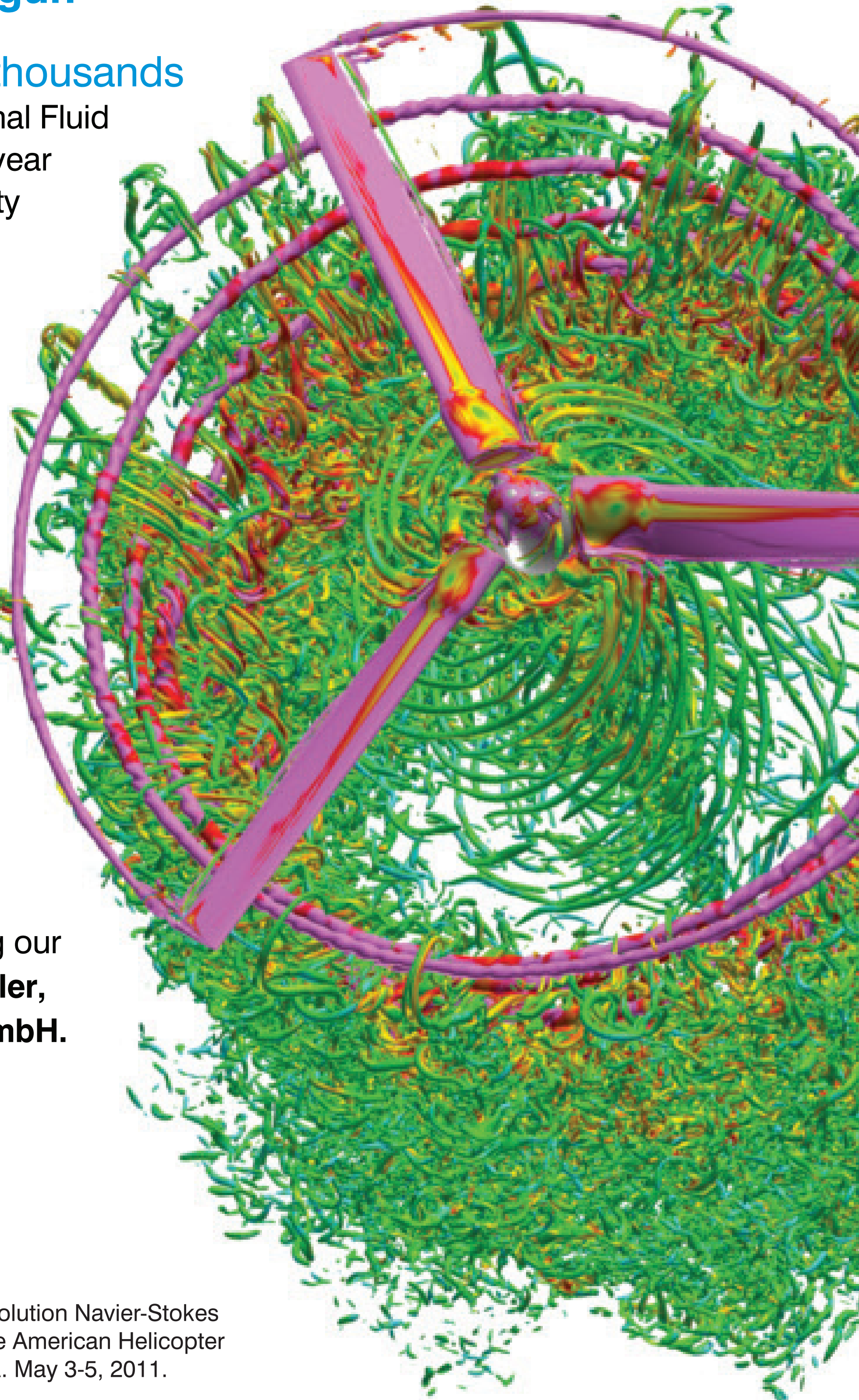

AEROSPACE AMERICA

September 2011

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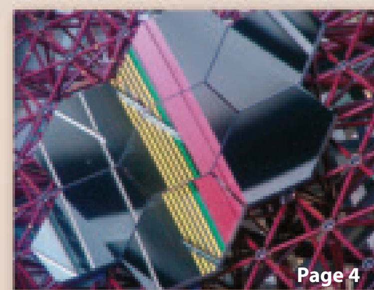
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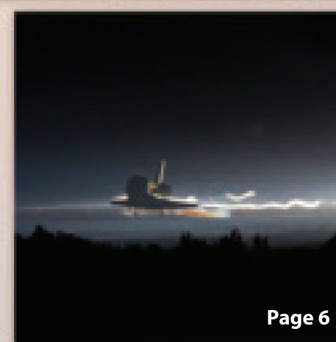
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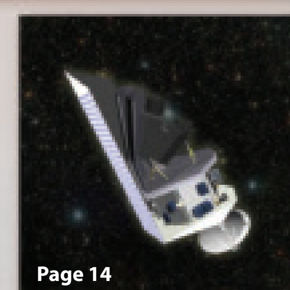
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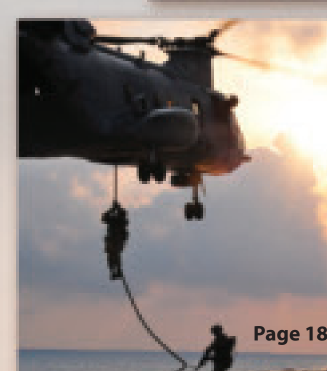
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Editorial

Playing with fire

This summer in our nation's capital, loud and often ugly political warfare broke out that passed for discussions about raising the nation's debt ceiling. The rancorous back-and-forth between the two houses of Congress seemed to be more about anointing winners and losers than dealing with America's growing economic woes, shedding more heat than light on the actual issues at hand. But as lawmakers rushed to meet one deadline, they allowed another to go unmet.

At the final hour, after reaching an agreement that seemed to please no one, the lawmakers went off for their August break. But the partisan bickering had resulted in a failure to extend the operating authority of the Federal Aviation Administration. As a consequence, nearly 4,000 men and women were put out of work and thousands of people in the construction industry who were set to work on airport projects around the country lost wages as they were told to stand down.

Since the FAA could no longer impose taxes, airlines could not collect them, and the federal government lost an estimated $388 million in revenues. (Some airlines fared better, however; they raised their ticket prices to match what they would have collected in taxes, pocketing the difference; and passengers who paid the taxes were told they would not receive refunds.) This sum is particularly ironic, because one of the sticking points in the failure to agree to an extension was a disagreement over a $16-million cut in subsidies to rural communities.

Air traffic controllers and airplane inspectors are paid from separate accounts, and they continued to work. So did dozens of airport inspectors, who worked without pay and were asked to cover their own travel expenses. That back pay may never be restored. Said Randy Babbitt, the FAA administrator, "We can neither pay them nor can we compensate them for expenses. We are depending and living on their professionalism at this point."

Two weeks later, an agreement of sorts was reached on the Hill, with both parties taking credit for working for the greater good. But the agreement will only last until the middle of this month, and then the whole ugly cycle may begin again.

While most transportation bills are traditionally part of long-term spending packages, the FAA's last long-term funding expired in 2007; since then there have been more than 20 short-term extensions as Congress has bickered over details.

Air travel is the lifeblood of U.S. and international commerce. Safe and reliable air transportation is crucial in a global community. So we ask ourselves this: Should the department responsible for maintaining the outstanding safety records posted in the past be asked to function with funding that might disappear in weeks, or months? Should the highly skilled, dedicated workforce that makes sure you and I arrive safely every time we travel be asked to do so without compensation from time to time, because politics has trumped reason?

We really need to do better, or the consequences may catch up with all of us one day.

Elaine Camhi
Editor-in-Chief

South Africa opens new routes to space

THIS MAY, THE $250-MILLION INTELSAT New Dawn communications satellite was launched on board an Ariane 5 from Kourou, French Guiana, marking another important step for Africa's growing space industry capabilities. The satellite's 28 C-band and 24 Ku-band 36-MHz transponder units have been designed to supply critical communications infrastructure for African customers, although a problem with the west antenna reflector has impaired the delivery of C-band services to the region.

Based on Orbital's STAR-1 platform, New Dawn operates from a geostationary orbital slot at 32.8° East. The satellite is designed to generate approximately 4.8 kW of electrical power to support the hybrid C- and Ku-band payload.

The program is important not just because of the increased Ku-band services it will bring to Africa, but also because it is largely a private venture: African institutions are providing around 90% of the total financing for the joint project, with Intelsat contributing the balance. A private telecommunications investment company,

The New Dawn communications satellite was launched in May.

Convergence Partners, is leading the South African investor group, which includes the Industrial Development Corporation of South Africa and the African Development Bank.

According to Andile Ngcaba, chairman of Convergence Partners, "The satellite will not only deliver crucial services specifically tailored for Africa, it will also herald the dawn of a new era where Africans enjoy far greater involvement in the space communications industry."

KAT-7 is a seven-dish prototype interferometer array in the Karoo semidesert region of South Africa.

Industry grows as needs increase

Although Africa's involvement in the space industry is relatively small compared with other regions of the world, and concentrated in just a few countries, it covers a wide range of applications and is growing rapidly. The need for space-based assets for Earth observation, disaster management, and communications to support sustainable development, including the fight against poverty, is arguably greater in Africa than in any other region of the world.

South Africa is the most active of all African nations in the space market, and its space programs are concerned with pure science as well as more commercial efforts and infrastructure projects.

According to South African Minister for Technology Naledi Pandor, speaking in April at the opening of the Global Office of Astronomy for Development (OAD) within the South African Astronomical Observatory (SAAO): "We have some 60 astronomers working here in South Africa (25 here at the SAAO), and they are half of Africa's 120 astronomers. But more than numbers, we also have the political will.… We have invested in astronomy. We have invested in complex measuring instruments. We have SALT [Southern African Large Telescope], Meer-KAT [Karoo Array Telescope], and the bid to host the SKA [Square Kilometre Array]. We chose to invest heavily in science and astronomy because of its role in development, not only within South Africa, but all across Africa. Big astronomy projects such as SALT, MeerKAT, and SKA entail major capacity development programs in order to train the next generation of engineers and astronomers from all over Africa."

The OAD is a partnership between the International Astronomical Union, the global association of astronomers, and the South African National Research Foundation. In 2009 the IAU launched its Astronomy for the Developing World program, which uses astronomy to foster education and capacity-building throughout the world. The new South African facility has been built to "stimulate development at all levels including primary, secondary, and tertiary education, science research, and the public understanding of science, building on the success of the International Year of Astronomy 2009," according to the SAAO.

SALT is the largest single optical telescope in the southern hemisphere.

Astronomy research on the rise

South Africa has growing capabilities in astronomy research. SALT is the largest single optical telescope in the southern hemisphere. It has a hexagonal primary mirror array 11 m across, comprising 91 individual 1.2-m hexagonal mirrors, and is similar to the Hobby-Eberly Telescope in Texas. Designed to operate from the near ultraviolet to the near infrared, SALT is funded by a consortium of international partners from South Africa, the U.S., Poland, India, the U.K., Germany, and New Zealand.

The telescope has had some teething problems. Originally built in 2005, it was taken out of commission in 2009 for upgrades aimed at improving the quality of outer-field images. The fix was completed in 2010, and since then the telescope and instruments have been undergoing recommissioning, due to be concluded by the end of this year.

"SALT is currently operational and undertaking commissioning observations," according to SALT astronomer Nicola Loaring. "These are engineering tests coupled with scientific observations designed to test the functionality of SALT and to accurately characterize its instruments. Some data from these observations are scientifically useful and have been/will be published. We currently have a call for science proposals due to be launched on 30th June 2011 for 2011 Semester II observations; Semester II will commence on 1st September 2011. We expect that the majority of commissioning observations will be completed by this time and SALT will move more into regular scientific operations."

The big prize, however, would be for South Africa to host the Square Kilometre Array, a $1.5-billion program for which the country is in competition with Australia. The SKA Science and Engineering Committee, based at Manchester University in the U.K., will announce the selected site for the telescope in 2012. The SKA will be between 50 and 100 times more sensitive than any other radio telescope on Earth, and South Africa is in a consortium with eight other African partner countries to host the project.

Under construction in the Northern Cape is MeerKAT, South Africa's precursor telescope to the proposed SKA. MeerKAT will comprise 64 Gregorian offset dishes, each 13.5 m in diameter, and will be delivered in three phases: commissioning in 2014/2015, with science operations starting in 2016 via a processing bandwidth of 750 MHz, followed by second and third phases with the addition of two receivers. The processing bandwidth will be increased to at least 2 GHz, with a goal of 4 GHz.

According to SKA South Africa, the organization behind the country's bid for the SKA project: "MeerKAT supports a wide range of observing modes, including deep continuum, polarization and spectral line imaging, pulsar timing, and transient searches." Among other operations, MeerKAT will be used to investigate gravitational radiation, observing the distant universe and nearby galactic objects.

MeerKAT will also be part of the global very long baseline interferometry network of telescopes working together simultaneously to seek extraterrestrial intelligence and download information from space probes.

A new space agency

Meanwhile, the South African National Space Agency (SANSA) was launched in December 2010, along with a national space strategy. SANSA's remit covers a wide range of activities, from Earth observation to space engineering, operations, and science. SANSA Space Operations, headquartered at Hartebeeshoek, conducts tracking, telemetry, and communications activities, launch support, in-orbit testing, mission control, and space navigation.

South Africa launched its second LEO satellite, the SumbandilaSat, on a Russian Soyuz in September 2009. Since then it has been transmitting images to support various applications including disaster management, food security (crop yield estimation), land use, and safety and security.

The first South African Earth observation satellite was Sunsat, a 64-kg spacecraft housing a multispectral imager with a 15-m resolution operating

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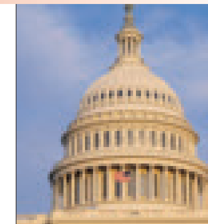


As an era ends, uncertainties loom

After 30 years of scientific triumph and two tragedies, the nation's space shuttle program ended July 21 when the Atlantis orbiter touched down in Florida. Many in Washington see Atlantis's curtain call as the end of a half-century of U.S. dominance in space exploration, leaving Russia as the sole country possessing a vehicle that can carry astronauts to the ISS. On both sides of the aisle, some Washington legislators question whether it is good policy to leave the U.S. with no way to put people into space.

"I am gravely concerned with the gap we're facing," Sen. John Boozman (R-Ark.) says. "There will be an extended period of time between the shuttle and the next U.S.-developed capability to launch humans into space."

In a statement issued late last year, Apollo astronauts Neil Armstrong, Eugene Cernan, and James Lovell appeared not merely concerned but alarmed. "Without the skill and expertise that actual spacecraft operation provides, the USA is far too likely to be on a long downhill slide to mediocrity," they wrote. "America must decide if it wishes to remain a leader in space. If it does, we should institute a program that will give us the very best chance of achieving that goal."

NASA Administrator Charles Bolden

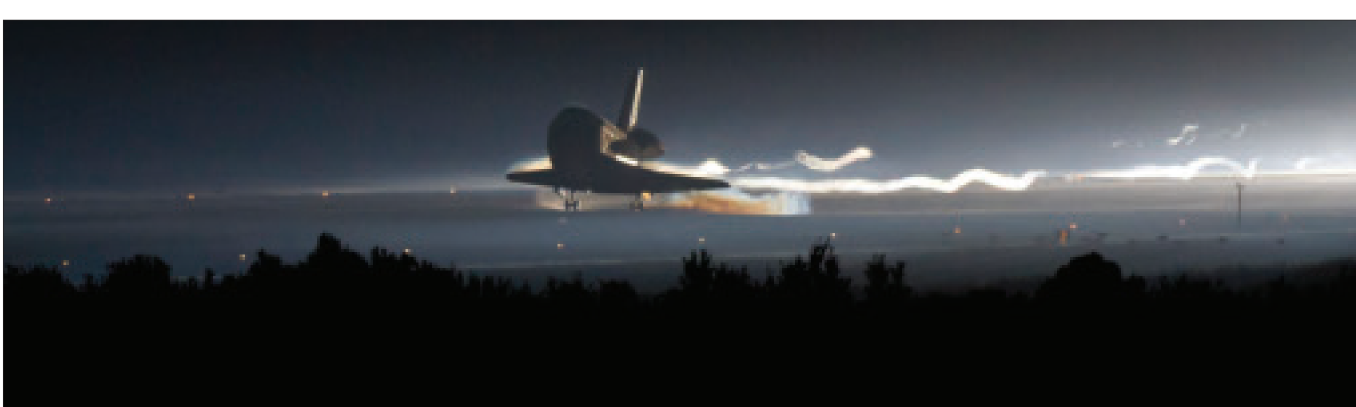
NASA, with flat budgets expected to average at most about $18 billion in the years immediately ahead, is developing a heavy-lift rocket through the Space Launch System and, for the long term, a multipurpose crew vehicle largely drawn from Orion. But under administration policy, the agency is looking solely to the private sector for the means to lift astronauts into LEO.

Even the staunchest supporters of the administration say U.S. space policy today is ambiguous and lacks a focused goal that can inspire Americans. One critic suggests that "unless there's a super-secret replacement spaceship ready to be rolled out to the launch pad," it is not possible to make much sense out of a recent upbeat but enigmatic statement by NASA Administrator Charles Bolden:

"The future is bright for human spaceflight and for NASA," according to Bolden. "American ingenuity is alive and well. And it will fire up our economy and help us win the future, but only if we dream big and imagine endless possibilities. That future begins today."

One space program worker at Cape Canaveral said he was eager to dream big but was looking at a pink slip. The end of the shuttle program triggered 2,000 immediate job layoffs, with many more to come. With the White House and Capitol Hill fixated on debt and deficits, another worker said, simply, "I can't explain our policy to you because they haven't explained it to me."

Earlier this year, NASA handed out $270 million in seed money to each of four companies—Boeing, Blue Origin, SpaceX, and Sierra Nevada—to boost their efforts to develop spacecraft that will carry human crews. Orbital Sciences plans to test its Taurus II launch rocket this fall and will later complete the Cygnus capsule that can be mated to the rocket to supply the ISS. United Launch Alliance is offering its Atlas V launch rocket, now used to boost un-



Space shuttle Atlantis touches down at the Kennedy Space Center Shuttle Landing Facility, completing the final flight of the space shuttle program, early Thursday morning, July 21, 2011. Photo credit: NASA/Bill Ingalls.

manned satellites, for human missions. This is a proposal about which Bolden says he is "truly excited."

But the most likely version of an FY12 NASA appropriations bill, which passed the House of Representatives July 14, cuts agency spending by $1.6 billion, to $16.8 billion, and retains only $312 million (the same amount that was permitted this year) to develop commercial space taxis.

Civil aviation gridlock

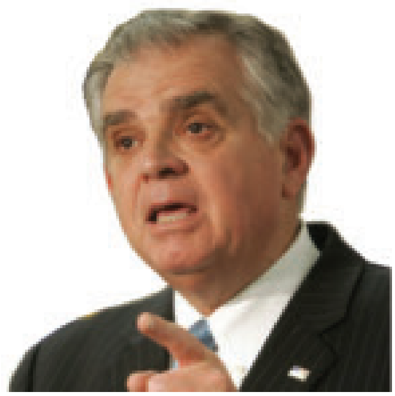
If NASA sometimes appears to need a compass, the FAA is "downright dysfunctional," according to Nathan Serenko, a retired airline pilot and former lobbyist for a pilots' union. "The FAA has dedicated people, and air travel in America has a superb safety record," explained Serenko in a telephone interview. "The problem is, both Congress and the executive branch seem determined to undermine the FAA at every turn."

While Washington and the nation were debating the federal debt ceiling, few outside the capital seemed to notice that the FAA's operating authority, as well as its authority to collect taxes, expired on July 22.

Congress adjourned without resolving a dispute over a cut in subsidies to 13 rural airports and an even larger disagreement over a provision in long-term funding legislation that would make it difficult for airline workers to unionize. Lawmakers also differed on the number of flights that should be allowed at Ronald Reagan Washington National Airport.

"The fact that Congress can't work this out is exactly why people are fed up with Washington," DOT Secretary Ray LaHood told reporters. The FAA comes under LaHood's department. "This is no way to run the best aviation system in the world." he said.

A few days after adjournment, Senate Majority Leader Harry Reid (D-Nev.) announced that an agreement had been reached that would provide continued funding for the agency until Congress reconvened this month. Only a few members of the Senate had to return to offer unanimous consent to a bill that had already passed in the House. The deal does not settle any of the disputes that led to the partial FAA shutdown.



Secretary of Transportation Ray LaHood

Until the agreement was reached, collection of airline ticket taxes came to a halt (with some carriers still collecting the same amount for a ticket), resulting in a loss for the Treasury of some $300 million. The certification process for aircraft, including Boeing's 787-8 freighter, was suspended. Airport construction work came to a halt in some areas. About 4,000 FAA employees (out of 47,000) were furloughed, and experts cited between 70,000 and 90,000 as the number of private-sector jobs that were idled.

To many in Washington these problems are emblematic of larger, long-term FAA concerns. The agency has not had a formal authorization bill since 2007. Since then Congress has enacted no fewer than 20 temporary enabling bills to keep the agency in business.

Founded in 1958, the same year as NASA, the FAA is expected to regulate air and space commercial transportation, handle pilot licensing, and develop and operate an air traffic control (ATC) system. In recent years, the agency has been faulted for the slow pace of development of its satellite-guided, Next Generation (NextGen) ATC system.

Several successive FAA administrators, warning of an exponential increase in air travel gridlock, have promised to implement NextGen as soon as funding will permit. Experts in Washington blame the delay on the on-again, off-again status of FAA funding, on technological challenges, and on reluctance by air carriers to make a large investment in untested equipment and procedures. NextGen's future is inextricably linked to a convoluted 'mix' of user fees and taxes that pay for the nation's aerial highways. That arrangement has been in need of revision for years, but in today's environment no one was expecting the system to be upgraded soon.

New faces at DOD

New people but not new policies: That is the story in the nation's defense establishment, where few of the names on a new roster of Pentagon leaders—Panetta, Dempsey, Winnefeld, Odierno, Greenert—are household words. While they may not be familiar to the average citizen, all were chosen because they fit in with admin-

Gen. Martin Dempsey

istration policies in Iraq, Afghanistan, and elsewhere in the military's area of responsibility.

"The Obama administration had well-established policies for using the military overseas before it nominated these people," said naval analyst Norman Polmar in a telephone interview. "With policy constant and spending cuts certain, the armed forces will be doing things that look familiar, but with greater difficulty."

The administration's defense policy includes:

- Narrower focus on military strikes on al-Qaeda and the Taliban rather than a more general 'war on terror' or a broader nation-building effort.
- Pursuing the war in Afghanistan, but with a withdrawal of about 10,000 troops over the next year—a pullout larger than military advisors wanted but smaller than critics of the White House would like to see.
- Continuing support for NATO-led military operations in Libya, even as Obama critics say the president is exceeding his authority under the 1973 War Powers Resolution. Others say the effort in Libya lacks a clear direction and even a clear goal.
- Reducing military expenditures over the next 12 years by $400 billion, a figure that uniformed officers say will be difficult to achieve and critics argue is not large enough to significantly reduce the nation's deficit and debt woes.

In an unusual 100-0 vote with no abstentions and no absences, the Senate confirmed Leon Panetta, 73, to become secretary of defense. The oldest person ever to be named to the post, Panetta is an inside-Washington operator with deft budget skills. He was an Army officer (1964-66), a congressman from California (1977-1993), head of the Office of Management and Budget and later White House chief of staff for President Bill Clinton (1994-1997), and director of the CIA (2009-2011).

At the latter agency, Panetta surprised many by taking personal charge of the 'drone war' in Pakistan—the targeting of al-Qaeda and Taliban figures by remotely piloted aircraft. He also took personal charge of the CIA-military operation that killed Osama bin Laden in Pakistan on May 1.

With Panetta replacing Robert Gates as the top defense official (and second-in-command of the armed forces, behind the president) observers in Washington will be watching for further blurring of the lines between intelligence and military agencies. More important, they will be watching Panetta's approach to budget issues. "If you thought Gates was a budget attack dog, just watch and see how hard-headed Panetta can be," says retired Air Force Col. James Newman, a Washington defense analyst.

Uniformed leadership changes

Gen. Martin Dempsey, who will replace Adm. Michael Mullen as chairman of the Joint Chiefs of Staff (JCS) on October 1, is an armor officer and an uncontroversial pragmatist. Agence France-Presse describes him as "an extrovert known for an irreverent sense of humor and a penchant for singing in public." (His rendition of "New York, New York" is said to be a match for Frank Sinatra's.)

Obama named Adm. James A. 'Sandy' Winnefeld Jr, who heads the U.S. Northern Command and the North American Aerospace Defense Command, to become vice chairman of the JCS. A naval aviator, Winnefeld was an F-14 Tomcat pilot and used the callsign 'Jaws.'

The selection of Dempsey is unusual because he had only taken over as Army service chief on April 11. Gen. Ray Odierno, veteran commander of U.S. forces in Afghanistan, now replaces him as Army chief of staff.

Said Odierno in a statement, "The future battlefield will be populated with hybrid threats—combinations of regular, irregular, terrorist, and criminal groups. We must," he said, "understand and prevail against these threats." The Army's biggest problem is that it has senior officers who have never heard a shot fired in anger, and junior captains and majors who have known nothing but constant combat. Odierno will institute a program to bypass tradition and put battle experience ahead of seniority.


Gen. Ray Odierno


Adm. Jonathan W. Greenert

Adm. Jonathan W. Greenert will become chief of naval operations, or CNO, the term for the Navy's service chief. Greenert, 58, is a submarine officer. Among many assignments, he commanded the nuclear attack submarine USS Honolulu. He has a broad-based record as an operational commander and will be skilled at making the Navy's case on Capitol Hill. "He knows how to ask the right questions," retired Vice Adm. Lou Crenshaw, a budget expert, told the *Navy Times*. Greenert has often pointed to the strain being placed on the defense budget by personnel costs and has cautioned that military pay and benefits may take hits in the future.

Some perceived the selection of Greenert as a snub to Adm. James Stavridis, U.S. combatant commander in Europe, who had been seen as a possible JCS chairman or CNO. Others saw it differently: "After having two combatant commander jobs, it might have been a step down for Stavridis to become CNO," said naval analyst Polmar in a telephone interview. "Also, Stavridis has the disadvantage of being too closely associated with [former defense secretary] Donald Rumsfeld, for whom he served as a staff assistant."

Robert F. Dorr
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(Continued from page 5)

from an altitude of 600 km. Built by postgraduate engineering students at the University of Stellenbosch, it was launched by NASA in February 1999.

According to CEO Sandile Malinga, "SANSA focuses on four key themes, namely, Earth observation, space science, space operations, and space engineering. Data obtained through Earth observation is provided to government to facilitate resource management and planning. Space science monitoring provides valuable information on the impact of space weather as well as basic research in the space environment. In terms of space operations, SANSA has an ideally located ground station that services a vast array of international clients. Lastly, on engineering, South Africa intends to build on the experience gained in locally developing SumbandilaSat to further improve local satellite manufacturing capability in the microsatellite segment. All our programs are underpinned by a strong capacity-building drive and emphasis on science advancement and outreach."

SANSA: Developing operational capabilities

Since its formation in 2010, the South African National Space Agency (SANSA) has been gradually evolving to undertake a wide range of operations. April marked the start of its second, or foundational, operating phase, with the integration of different operations and the refinement of structures, policies, and plans. Next will come the 'full operating phase,' starting 2012/2013, which will entail the start of the National Space Program: Earth observation, space operations, space science, and space engineering.

"SANSA was established by the government in a bid to steer the country from a largely resource-based economy to a knowledge-based economy through delivery of the 10-year National Innovation Plan, which addresses five priorities including space science and technology," according to Sandile Malinga, SANSA's CEO. "Emanating from this is a national space strategy that focuses on environment and resource management; health, safety, and security; and innovation and economic growth. Primarily, SANSA is to ensure that the national space strategy is implemented by bringing together key strategic institutions, promoting better coordination of national space activities under SANSA, and creating a visible point of contact for national space activities. The long-term goals for SANSA are to coordinate all space science and technology-related activities from a central entity and support government's goals through the 10-year national innovation plan."

A primary operational focus will be further improvement of the Earth observation data center. Space operations include data acquisition, tracking, telemetry, and control activities, together with in-orbit testing, launch support, and satellite mission control. The agency plans to host increased amounts of ground-station infrastructure. SANSA space science will take a multidisciplinary and multiinstitutional collaborative approach to academic research, and space engineering will involve institutions such as Stellenbosch University, Cape Peninsula University of Technology, the University of KwaZulu-Natal, and Tshwane University of Technology, as well as industry partners, to develop South Africa's indigenous space capability.

According to Malinga, "The wisdom of embarking on a satellite program has always been challenged by those who argue for perpetual procurement of data from external satellite programs. Apart from the technological capacity development inherent in pursuing an indigenous space program, the overall benefit associated with the independence of controlling one's own satellite and imaging routines is immeasurable."

SANSA therefore aims to strike a balance between acquiring data for the nation's immediate and pressing requirements and deliberately pursuing a satellite program for future needs.

Collaborative efforts

The route to space for most African nations is via collaboration, and South Africa participates in a number of pan-African communications and EO programs. For example, the GEONETCast initiative is a global collaboration 'system of systems' network that allows for coordinating and integrating satellite data and information such as video broadcasting and imagery for Earth observation. It is part of the intergovernmental Group on Earth Observations network through which South African research and government departments are leading work groups in several areas. These include developing a global network of airborne, space-based, and ground-based sensors, creating a climate education series of teaching aids, and providing politicians around the world with a common, science-based model of environmental risks and vulnerability.

With EADS, SANSA is also developing a dedicated satellite sensing source to be owned and operated by African authorities. Called GEO-Africa, it will be "a permanent African space observatory based on an innovative mid-high-resolution geostationary satellite to be operated by Africans. It will be developed and implemented in partnership with the European Union. The GEO-Africa will ultimately provide for the much-needed real-time mapping for Africa, together with the associated communication of the spatial information for various societal and economic applications," according to SANSA. The satellite would monitor water levels, vegetation destruction, disasters, and agricultural production throughout Africa.

"SANSA is identifying partnership opportunities with other African space agencies to maximize the impact of our resources for the benefit of Africans," Malinga explains. "Currently we offer exchange programs for students from African universities to work with our scientists and engineers to share knowledge and build the necessary skills. SANSA will also have the space engineering directorate operational, and this will offer added value through production of space satellites and other technologies. There is also a plan to take part in a multinational satellite program called the African Resource Management Constellation, in partnership with Algeria, Kenya, and Nigeria."

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What marks South Africa's new impetus into the space market is not a simple concentration on Earth observation and telecommunications satellites, the focus of most nations that wish to acquire a foothold in the space market. Rather it is a much broader ambition to play a full role in space science and astronomy domains as well.

Philip Butterworth-Hayes
European correspondent
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Jim Maser

As a space industry executive, what is your view of U.S. space policy and planning?

From the industrial base standpoint, our nation badly needs a common, integrated, stable road map for space, for what we want to do in space, for how we want to access space. Space activities are being handled at the agency level. Different government agencies have their own space agendas, and those may or may not overlap or be intertwined. What we're seeing is various agencies in charge of relatively independent systems—satellites and space transportation systems.

The big question right now is whether each agency will have enough resources to support the high fixed costs of its particular approach to space. We need to determine if some of those elements can be combined across the agencies, as opposed to continuing to pursue independent approaches. An integrated road map would do that.

Who would draft it? NASA and other agencies are limited in scope. They basically do what they're told to do with the resources provided by the administration and Congress.

Exactly, so there has to be a single, integrating body, and I don't know what the answer is. I have been told that, in the past, the vice president usually has taken the lead in coordinating space activities and has championed space initiatives and programs. I don't think that is currently the case. Aerospace Industries Association has been making some recent recommendations that address the issue and can be found on their Web site.

Is the space industry collegial enough to agree on and push for an integrated approach to space?

The companies are talking about where we see things going and what we think has to happen. But in the absence of a high-level national road map for space, we are all guessing. And what we have seen through the years is that we have guessed wrong many times.

In industry, we're doing as much as we can to make sure that we are sized and organized for what we perceive the future to be. But we can't be sure. Developing an integrated plan and a road map at a high level of government is something that this nation is simply going to have to address, or we will continue to find ourselves challenged with the costs of gaining access to space.

How does the lack of a space road map hurt industry now?

The absence of a road map makes it hard for us to decide exactly where to invest in space, or what technologies to invest in. We may think there is an area of technology that the nation wants to pursue, and we invest in it, and after a short period of time, the nation decides that that area is not what it wants to pursue. So we have basically wasted our money.

For example?

When I first took this position with Pratt & Whitney Rocketdyne, some people came up to me and said, Jim, we really need to invest in nu-

Jim Maser is president of Pratt & Whitney Rocketdyne, a division of Pratt & Whitney responsible for the design, manufacturing, and performance of power and propulsion systems. Previously, he served as president and general manager of Sea Launch, an international partnership that launches commercial communications satellites. Under his leadership, Sea Launch emerged as one of the world's premier heavy-lift launch services.

After serving at Sea Launch, Maser joined Space Exploration Technologies (SpaceX) as president and chief operating officer of the startup company, which was selected by NASA to demonstrate delivery and return of cargo to the ISS.

Maser has a strong background as an aerospace engineer, with extensive experience in program management and design, and in engineering leadership. He was a research fellow at NASA Lewis (now NASA Glenn) prior to joining McDonnell Douglas (now Boeing) in the 1980s. Beginning with the Boeing Delta and Evolved Expendable Launch Vehicle programs in structural design, he became the leader of advanced studies in systems integration, and was one of the key architects of the evolution of Delta II to Delta IV. In 1998, after serving as chief engineer of Delta III, Maser became chief engineer of Sea Launch.

Maser graduated magna cum laude from the University of Akron with a bachelor's degree in engineering, followed by a master's in engineering. He later received a master's degree in business administration from the University of California at Los Angeles. In 2000, AIAA honored Maser with its George M. Low Space Transportation Award.

Interview by James W. Canan

clear thermal propulsion, and I said I didn't see any real future in that because I didn't see anything coming out of any of the government agencies that suggested they would spend money on that—and even if they did, I didn't see that there would be much demand or volume for that kind of propulsion. And then, over a year ago, when Constellation was canceled, everyone started talking about nuclear thermal propulsion to explore the various planets and do scientific missions. All of a sudden, it looked like my position on nuclear thermal propulsion was wrong. But now, it looks like technology has been zeroed out of the NASA budget, so it looks like I was right about nuclear thermal propulsion.

"We are at a crossroads. The situation is urgent, and time is running out."

We have that kind of back-and-forth in many areas, and that's why, in the absence of a longer-term integrated national vision for space, it is very challenging for industry to figure out where and how to invest.

Is the uncertainty dangerous for our country?

Yes it is. We are at a crossroads. The situation is urgent, and time is running out. Constellation was canceled on February 1, 2010, and here we are, a year and a half later, and we still don't know what we're going to do in space. In the past, when we had starts and stops with various initiatives, we always had the shuttle program to fall back on. Now the shuttle is ending and we don't know what we're going to do next. It's no longer just a gap in getting to space, it's a gap in planning what we're going to be working on to get there. If we don't get together on a common plan, years will go by and the gap will only get bigger.

Wasn't there a gap between the Apollo and shuttle programs back in the late '70s?

There was a gap of six years, basically, from the last Apollo launch in 1975 and the shuttle's first launch in 1981. But the shuttle program was started in 1972, so there was a three-year overlap in work for the industry. And even though the NASA budget for going forward with the shuttle was much less than its budget for Apollo in the '60s, everybody knew what that budget was going to be and could adjust to it, and to the future. Even though the adjustment was hard, everybody knew it could be done, and did it.

The situation we're in now is that the shuttle is ending and we still don't know what the future holds. We don't know what we're going to be working on, and we don't know when, so we don't know how to adjust. We do know that it would be foolish to downsize significantly during this gap.

What do you mean?

Losing critical skills and intellectual capital that the space industry—civil and military—developed through the past 50 years; we face significant loss of capability in our industry that we may not be able to regain. Rebuilding the capability could take a long time and come at great expense. So we are at a very, very critical point in time. We are in a high-risk position in terms of losing some of our critical capabilities. We need to decide right now how we want to get into space and what we want to do there. It is a matter of months, not years, before we have to do something.

What about your company amid all this? What happens if nothing much stirs in space policy and planning?

To us, and to many in the industry, it seemed unwise to outright cancel Constellation without knowing what we will be doing next, and without knowing if some of the work being done on Constellation could be extended to the next architecture. If we stop that work, starting it back up will create significant delays and cost much more money. Even if some aspects of that architecture, and that of the shuttle, are not used in the next architecture, we will still be maintaining our critical skills and keeping them sharp toward something that might be the next architecture.

If shuttle ends and our Constellation contracts are canceled with no decision or plans for follow-on activity, we and many others would be facing a loss of 80-90% of our NASA business over a short period of time, which would be very challenging for the nation's leadership in space.

Some would say that the nation does indeed have a plan and a strategy for how to proceed beyond Constellation, that NASA's portfolio nicely combines commercial and government space programs in a proportion that benefits everyone.

I like that model. I've been a great supporter of commercial flights to low Earth orbit, especially of commercial cargo flights to the space station. Industry should be able to take on that

"We are in a high-risk position in terms of losing some of our critical capabilities. We need to decide right now how we want to get into space and what we want to do there."

challenge with existing technology. I think it's a very cost-effective way to take cargo to space, and then ultimately to adapt it to crew transportation too. It also frees up resources and allows NASA to focus its best and brightest on the innovative kinds of things—space exploration and science missions—that NASA was really created to do. So that model is very sound, in my opinion.

But the fundamental issue here is not the model itself, it is the manner in which, and the time frame in which, that model is being executed. We are seeing a very strong focus and priority on commercial transportation to low Earth orbit and an absence of decision or direction for space exploration.

Elaborate on what you said about NASA focusing on science and exploration. Tell us more.

A big part of NASA's charter is to do inspirational things. Those things have gone beyond space itself, including a huge contribution to information technology, for example, in terms of software capability and computing power, and to advances in guidance, navigation, and control. By doing the very hard stuff required for all that, NASA has sparked a big portion of the innovative solutions for the incredible advancement of IT overall, and that ties directly in to national security.

Even if people don't go into space, NASA creates their first spark of inspiration in science, technology, and engineering. There are a lot of people in technology today who are not involved in space but were inspired by space in the first place. So NASA needs to continue to do the really hard, inspirational things.

What next?

We have to address many questions about our role in space, about the need for human space exploration. For example, is there a human future in space, or should there be? Ultimately that question will be answered by those who show up in space. If we are not there, we will not be part of the process. Do we want to show up, or do we want to abdicate and leave space exploration to other countries, including China?

Should NASA play more of a leading role, on its own, in making national decisions on space?

I think ultimately NASA has no choice but to do that. Otherwise, decisions will be legislated, and they may or may not be what NASA wants. So NASA has to take the lead and make the decisions. It ultimately comes down to where NASA wants to go, by when, and how that fits into the budget that's available. Maybe some things in that budget will have to go. We need to decide on a time frame and then pursue it with consistency and stability so that it can survive multiple administrations and the fluctuating relationships between the White House and Congress.

Should NASA be free to deal with Congress more directly and creatively on its own, with less White House involvement?

I think it should happen, and if we don't figure out very soon how to make it happen, then we are at grave risk. In general, everyone agrees that we need a compelling vision for space that's enduring, that we need stability. There's a lot of debate on how we achieve that. Ultimately, NASA has to decide. That's what I'm encouraging. We are running out of time. Let's make a decision, and industry will do what it has to do to adapt to that. There is a big sense of urgency in industry.

"Our industry is made up of really smart people, and we don't need to wait until we have all the answers."

Not everyone feels that way, it seems.

Some say, let's hold off for a few years while we develop the technology, so that we don't build the wrong rocket. I say that would be like Lindbergh saying, I'm going to wait until somebody develops the jet engine. What we have to do is go where we have to go with the best technology we have at the time, develop advanced technology in parallel, make sure our system is designed to adapt to new technology as it comes online, and insert that advanced technology as we go. Technology maturation is a process that takes time. Some technology may never mature.

So we can't let technology development dictate strategic decisions and timing.

That's right. We need to keep going whether technology matures or not, and be able to insert the technology as it is successfully developed—not the other way around. Our industry is made up of really smart people, and we don't need to wait until we have all the answers. We will figure out some of these things as we go along.

When it comes to mission success, we want to be sure that we have been very thorough. But when it comes to overall decisions on where and how we want to go, we can start with an 80% solution and work through the details as we're going. Time is money, and if we waste time, we waste money. So the sooner we get going, and the faster we go, the more efficient we will be. And industry will partner with NASA and with Congress to make it happen.

In this vein, how does our approach to space policy and operations compare to our approach in the '60s, back in the day of Apollo?

We have become more risk averse, and that's another challenge, another problem. We have to address that problem head-on right now.

Tell us more about your company's role in all this.

We are obviously very engaged with NASA relative to our core liquid propulsion business. NASA has been the key to this nation's capability in propulsion, and I think they will continue to be the key in the future. But we have positioned our company not to be as reliant on NASA, knowing that the shuttle would come to an end at some point.

When I came to the company, about 80% of our business was with NASA. We have moved aggressively to develop a more diversified portfolio. Over the past four years, we have evolved our business to the point where it is about 60% NASA and the rest in other areas. The Air Force is our second biggest customer—the launches we do for them. We are working in the missile defense area, which is growing, and we're working in, and investing heavily in, hypersonics, which I think is a potential game-changer in terms of propulsion technology. We're also investing in small thrusters.

How about the energy arena?

We have been investing in the energy world to some degree, because a lot of what we do translates into energy opportunities—efficient means of combustion, of cooling, of handling high thermal gradients and pressures. The energy world is different from the space world. The technologies are the same, but the businesses are a lot different.

What is the relationship between PW Rocketdyne's work on advanced propulsion technology and the strategic decisions that you say the nation needs to make on space? How do they fit?

That's all part of what I've been saying, that we as a nation need to decide where we are going in space. Our company's investment strategy is aligned around where we think the market will be in the future, and the government marketplace is not clear and has been very inconsistent.

For a couple of years, the government will say, this is where we want to go and this is the technology that we will need to get there. And then, after a few years, they say, never mind, we didn't know what we were talking about, so now we're going to go here, and these are the technologies we will need, and so we invest in them. We have done that. Industry has invested in initiative after initiative that were just dropped.

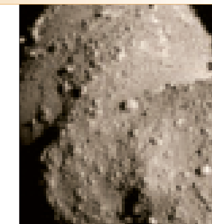
Look at the X-33, at how much money industry invested in it before it was canceled. Look at NASP [National Aerospace Plane], at other space launch initiatives that were canceled. This pattern is extremely disruptive. The stability of the shuttle program and, to some degree, DOD launch programs allowed industry to absorb that disruption. Now the shuttle is ending, and things are up in the air.

The military space scene also has had problems with costs and sense of direction. How does PW fit into that arena?

We have been working with our customer, United Launch Alliance, and their customer, the Air Force, in terms of where they want to go and what kind of business volume is out there in the future. On the DOD side, our goal is to find ways to be more profitable and to work with the Air Force on what is the most efficient way for them to procure the goods and services they want. We have some ideas on that, including a more cost-effective way for the Air Force and us to test our RS-68A engine that flies on Delta IV.

Is the Air Force receptive to that?

Yes, definitely. This is a great time for ideas to be heard. There is high motivation to work together for more cost-effective methods. And we as a company are highly motivated to do that. So we are putting together a list of ideas that, overall, could save the U.S. government money and still provide high-quality products and services, and create new ways of sharing risks. We are optimistic on the military side of space.



Finding NEOs: Stepping stones for human exploration

NASA's astronauts hope to visit a nearby asteroid in the 2020s, but this November 8, near-Earth asteroid 2005 YU55 will come to us. In an unusually close flyby of Earth, the 400-m-wide, apparently carbonaceous body will pass within 0.85 lunar distances (330,000 km), enabling ground-based radars and telescopes to obtain high-quality topographical and compositional measurements.

This close encounter is serendipitous but hardly rare. On average, one 10-m object cruises past us within the Moon's orbit every day. But finding near-Earth objects (NEOs)—especially the ones that come closest to Earth—is a tough problem. Because they are typically both small and, in most parts of their orbits, distant from Earth, NEOs are often challenging for telescopes to see. Present ground-based observatories are just too limited in capability to find, on a practical time scale, the asteroids that we might target for robotic and human exploration .

Although more than 8,000 NEOs have been discovered by ground- and space-based searches, and more than a million sizable bodies make up the NEO population, we have barely begun to search for those asteroids that make the best human mission candidates. Last February's 'Target NEO' international asteroid workshop reported that today we know of just *one* object with the right size, orbit, and proximity to make a worthy exploration target.

To meet President Obama's 2025 asteroid mission goal, managers must identify enough 'accessible' asteroids to enable planners to develop NEO mission concepts well in advance. But finding enough sizable NEOs in accessible orbits is a daunting task. Using current ground-based techniques, we will not find enough mission-worthy candidates in time, said the Target NEO participants. The workshop experts recommended that NASA launch a space-based search telescope as its highest priority in pursuing the 2025 goal (see www.TargetNEO.org).

Why NEOs?

The president's 2010 decision to make an asteroid NASA's next human spaceflight goal came after his cancellation of the Moon-focused Constellation program. With the Moon out of the picture, nearby asteroids are the only celestial bodies within reach of NASA capabilities for the next couple of decades. Mars and its moons are just too far away for now, requiring round trips lasting at least 18-30 months. But some NEOs approach Earth so closely that missions lasting six months or less should be feasible.

Achieving NASA's 2025 asteroid exploration goal depends on a robust set of target objects, discovered early enough to design hardware and develop operations plans. (Dan Durda, SWRI)

Aside from attractive celestial mechanics, near-Earth asteroids hold out the promise of insights into planetary origins, water and other space resources, operations experience applicable to Mars, the civil engineering knowledge needed to divert a future Earth impactor, and the excitement of probing distant, alien worlds firsthand. With China openly hinting it will send taikonauts moonward by 2020, asteroid exploration can protect U.S. technological leadership and furnish the experience and resources necessary for the economic development of near-Earth space.

No matter how political sands shift in 2012, or what course our 'flexible path' in space takes, NEOs are likely experiential stepping stones to commercial opportunities in Earth-Moon space (water production, iron and nickel mining, strategic metals), and eventual human exploration of Mars.

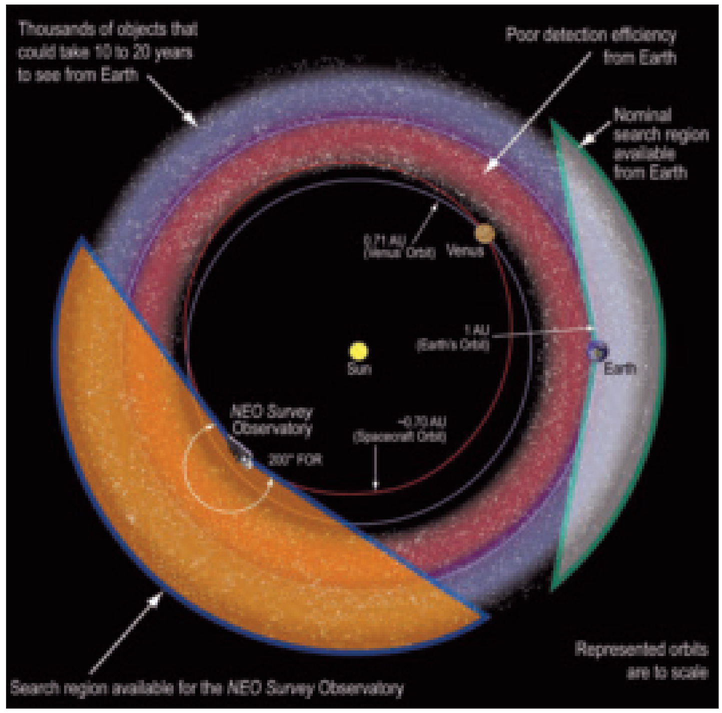
What is a 'good' target?

A reasonable target for astronaut exploration should have certain attractive characteristics. First, it should be large and complex enough to occupy the skills of astronaut explorers for at least a couple of weeks during the course of a multimonth journey. Thus a target NEO should be larger than, say, 30 m in diameter; a 100-m object would be a truly imposing presence, weighing in at about 1 million metric tons.

Second, the asteroid should offer a low-delta-V mission opportunity from Earth during the 2020s—'low-delta-V' means the round-trip mission should be less than the 9 km/sec of velocity change required for a lunar surface round trip.

Third, for crew health reasons (particularly radiation exposure), the mission should take no more than six months round trip.

Fourth, the target asteroid should enable in-situ demonstrations of various water- and metal-extraction processes. C-type asteroids are rich in carbon, organics, nitrogen, phosphorus, sulfur, and in some cases water; they would get my vote for a first astronaut visit. C-types can be selected via spectroscopic characterization, using Earth- or space-based telescopes. Eventually, astronaut expeditions should explore a representative spectrum of asteroid compositional types (perhaps about a half dozen) to give us a good sense of the range of asteroid mineralogical and physical properties.



A space-based NEO search takes advantage of orbital geometry. Earth-based telescopes are limited to Earth's night sky, but a sensor in an interior, Venus-like orbit will detect NEOs that will take decades to find from Earth. Complementary Earth- and space-based sensors will rapidly find both hazardous NEOs and the best targets for human exploration. (Ball Aerospace, NASA)

Finally, initial missions should avoid asteroids with chaotic or rapid rotation rates (less than a couple of hours), those circled by a natural satellite, or those surrounded by orbiting debris. Mission risk will be high enough without adding those hazards.

An impoverished catalog

Do any known near-Earth asteroids meet those criteria? NASA has been searching for NEOs larger than 1 km across for 15 years, and has found about 87% of the statistically predicted population. An impact from one of these could cause global disaster due to dust-induced cooling and subsequent agricultural failure.

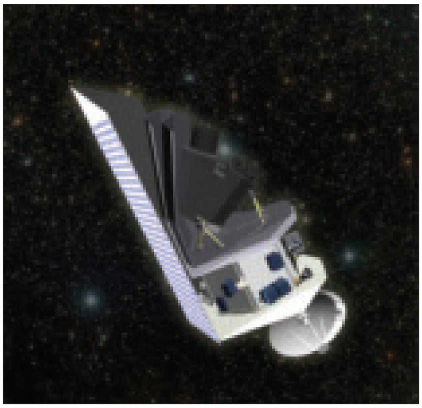
A byproduct of this Spaceguard Survey has been the discovery of many smaller NEOs, down to the size of pickup trucks (such as 2008 TC3, which struck Earth 19 hr after its October 2008 discovery). The current near-Earth asteroid tally is above 8,000, with discoveries accelerating as more sensitive search telescopes come online (see www.neo.jpl.gov).

Asteroids are best detected from the ground at opposition, when they are close to a line between Sun and Earth, with their full diameter illuminated by sunlight. Of course, an asteroid must be visible from Earth's night side to be seen by a ground-based telescope; nearby asteroids in the daytime sky are completely invisible to us. To find those objects from the ground, their orbits must carry them beyond Earth so they can be detected at opposition. Those asteroids—like the Atens, which spend most of their time in orbits interior to Earth's—are nearly impossible to detect from the ground, even with sensitive facilities like PanSTARRS and the planned Large Synoptic Survey Telescope. A good discussion is in the National Research Council's report, *Defending Planet Earth* [http://www.nap.edu/catalog.php?record_id=12842 #toc].

Another serious problem in finding asteroids with low-delta-V trajectories is orbital phasing. The most accessible NEOs have orbits much like Earth's, with semimajor axis close to 1 AU, and low eccentricity and inclination. Such an object exhibits long intervals between successive close Earth encounters, when it is 'in tandem' with Earth. That encounter is when a small asteroid is most likely to be discovered, and when a piloted mission is most feasible, but its Earth-like orbit means it will be a long time—a decade or more—before the asteroid is again close by. For example, one favorable candidate, 2000 SG344, was found in 2000, but its next favorable observation and piloted mission phasing will not recur until around 2028 or 2029.

The long intervals between Earth encounters,

NASA's newly selected OSIRIS-REx mission will sample C-type NEO 1999 RQ36, and return tens of grams of the organic and possibly water-rich asteroid to Earth in 2023.



The Near-Earth Object Survey spacecraft proposed by Ball Aerospace would prowl for hazardous NEOs and astronaut targets from a Venus-like orbit.

along with factors such as cloudy weather and confinement to searching only Earth's night sky, mean that for ground-based telescopes, many of the best asteroid targets may be discovered far too late for missions in the 2020s. In fact, we would have to discover them before 2015, a decade before their next Earth encounters in the mid-2020s. The stark conclusion from the Target NEO workshop was that ground-based surveys simply will not provide those discoveries in time.

Taking the search to space

Up to now, we've found most NEOs by waiting for them to come to us, in the clear night sky, relatively close to Earth. Target NEO presenters stated that at the present rate of discovery, only a few *tens* of accessible NEOs larger than 30 m in diameter will be found by 2025. That's too few to provide managers with an attractive set of targets and timely launch options. The only solution is to remove the geometrical blinders limiting our searches. We must find a 'mountaintop' for our observatory somewhere off the planet.

The ideal location is one that will enable us to get at those NEOs that orbit mainly in Earth's daytime sky, and to get more frequent opportunities to observe those objects in attractive, Earth-like orbits. An orbit closer to the Sun, like that of Venus, for example, gives us two advantages: First, a telescope there can look outward and see all those asteroids lost in the glare of our daytime sky; and second, it will circle the Sun in seven months, significantly faster than asteroids in Earth-like orbits. Like a race car on an inside track, the telescope will overtake those NEOs and shorten the interval between detection opportunities. The Venus-like orbit telescope will find more asteroids, and do it much faster, than observatories on the ground.

An infrared detector is best for finding NEOs. Relatively close to the Sun, they have equilibrium temperatures of 170-300 K, and glow brighter in emitted thermal wavelengths than in reflected visible light. The survey spacecraft design would feature passive cooling and perhaps an active 'chiller' to keep the IR detector at optimum performance.

A Ball Aerospace analysis showed that an infrared space telescope with an aperture of 0.5 m would find 90% of 140-m and larger asteroids in just over eight years, along with many smaller ones. The same spacecraft, derived from the successful Spitzer and Kepler designs, would find 80% of the astronaut-accessible NEOs larger than 60 m within two years of launch.

In May, NASA chose a similar IR telescope concept, called NEOCam, for technology development funding. As proposed by a JPL team led by Amy Mainzer, NEOCam would operate at Sun-Earth L1, a million miles sunward of Earth. Although this 0.5-m telescope would not have the inside track advantage of a Venus-like orbit, it would still find many asteroids in interior orbits by searching as close as 40 deg to the Sun, catching NEOs as they overtake Earth. Mainzer predicts that in 10 years of operation, NEOCam would find 90% of all objects larger than 140 m in diameter, fulfilling the goal of the George E. Brown planetary defense survey ordered by the Congress in 2005.

Timing is everything

Regardless of the particular spacecraft and sensor chosen, it is important to begin the search as soon as possible. The Target NEO report recommended we orbit a NEO survey telescope at least a decade before any human NEO expedition. If it starts the survey by 2015, then by the early 2020s NASA could tap a very large catalog of NEOs: There are an estimated 1 million objects 30 m and larger in the near-Earth population. Finding a significant number of these (even a 30-m NEO packs the kinetic energy of a Tunguska-sized, 3-5-megaton TNT explosion) will help us identify and track thousands of hazardous asteroids and give NASA's managers hundreds of suitable mission candidates.

The survey would cost about $500 million, roughly the cost of one NASA Discovery-class planetary mission. The results would not only enable astronaut mission planning, but would also furnish vital data for planetary defense, and for a scientific understanding of the raw ingredients of terrestrial planetary formation. The bottom line is that a timely NEO survey telescope is as important for human spaceflight goals and objectives as a heavy-lift booster, or NASA's projected multipurpose crew vehicle. We need it to find a robust target set for NEO exploration, and to reduce budgetary, operational, and mission-related risks.

Next steps for NEOs

With a space-based NEO telescope spitting out a flood of new asteroid discoveries, NASA could hit a series of milestones, culminating a decade later in its first astronaut expeditions. Follow-up ground observations or repeat glimpses from the space observatory would refine the orbits of attractive NEOs. Those with the most favorable orbits could be characterized in terms

Asteroid 2005 YU55 (seen in a 2010 radar image) will pass within the Moon's orbit on November 8. Goldstone and Arecibo radar observations should image surface details as small as 7.5 m, and create a shape model with 4-m accuracy.

of diameter, albedo, spectral class, estimated mineral composition, rotation rate, and the presence of companions (about 16% of known NEOs are binary objects). Several precursor missions could then explore the best candidates, making detailed measurements of topography, composition, physical properties, and operations hazards.

Attempts to meet such asteroid exploration milestones by 2025 must build steadily on progress from previous efforts. The entire process starts with approval and execution of the space-based NEO search. The Target NEO report recommended to NASA that it immediately begin a Phase A survey mission study to identify feasible instrument concepts, then compete the mission for early development and launch.

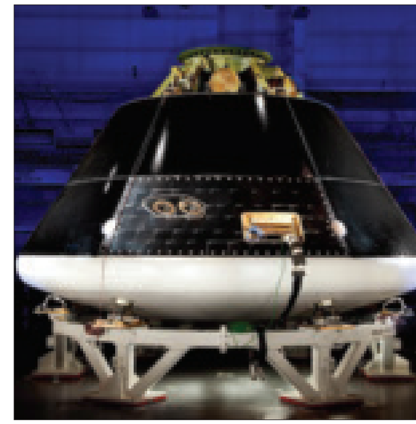
Agency leadership in this area would almost certainly see an international collaborative response from JAXA, the Canadian Space Agency, ESA, and others via proposed scientific and planetary defense asteroid missions such as Hayabusa II, NEOSSat (near-Earth object surveillance satellite), and Don Quixote.

Search synergy

NASA's own experts, including the NASA Advisory Council's 2010 ad hoc Task Force on Planetary Defense [http://www.nasa.gov/pdf/490945main_10-10_TFPD.pdf], cited the space-based survey as a top priority. The Target NEO report calls it the key to serious asteroid exploration. Rarely does one NASA project promise such enabling, cross-cutting results, delivering synergistic benefits to NASA's efforts in human exploration, planetary defense, science, and space resources, all for the price of a single planetary probe.

Limited funding and NASA's own organizational barriers have hurt the search. Traditionally, asteroid research has been sponsored by the Science Mission Directorate (SMD); however, its planetary exploration budget is already fully committed.

In late May the SMD selected the OSIRIS-REx (origins-spectral interpretation-resource identification-security-regolith explorer) NEO sample return as its next New Frontiers-class (around $800 million) mission; SMD on its own is unlikely to follow with another NEO-centered mission.



Astronauts on future asteroid expeditions may use the NASA multipurpose crew vehicle, which is currently in ground testing at Lockheed Martin's Denver facility, to return them to Earth from a multimonth NEO mission. A NEO-capable spacecraft will require habitation and propulsion modules as well as a reentry vehicle. (Lockheed Martin.)

The Exploration Systems Mission Directorate (ESMD) has had no success in funding a line of robotic precursor missions. Planetary defense from rogue asteroids has yet to win NASA priority; the agency spends only about $6 million annually on ground-based NEO surveys and research. Yet early NEO detection via space-based search is the necessary precursor to developing any future asteroid deflection capability.

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As NASA looks for ways to build momentum toward its declared 2025 human spaceflight goal, the agency would do well to start with an affordable NEO survey mission that pays dividends in such a wide-ranging array of space activities. Getting that survey off the ground will be the surest sign that NASA, the White House, and Congress are committed to deep space exploration. The target for the first astronaut expedition to a NEO won't be discovered until we get serious about looking for it.

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Military rotorcraft: Strongest aero market

Military rotorcraft have enjoyed strong growth over the past few years, outperforming every other aero market during the 2008-2010 economic downturn. Between 2008 and 2010 deliveries rose 13.5% by value.

For strategic and programmatic reasons, this growth looks sustainable for the next few years, with a high plateau following for most of the rest of the decade. However, there are long-term market and technological challenges that could impact the industry before 2020.

Robust U.S. growth

Three major factors are propelling U.S. market growth. The first is strategic relevance. In a time of shrinking force structures and dwindling budgets, force mobility is more important than ever. This is true for land forces, which need transports to move personnel and equipment and to provide firepower, and for naval forces, which more than ever must rely on shipborne helicopters to patrol larger areas with fewer ships.

Also noteworthy is that rotorcraft are among the very few types of military equipment that have strong relevance in all three areas of military force application. A military can be used for traditional warfighting, counterinsurgency, or peacekeeping/nation-building roles. Rotorcraft are essential for all three, unlike, for example, aircraft carriers or main battle tanks.


CH-46


V-22

The second factor is an aging fleet. As a result of strategic requirements, and of the much greater than expected level of current fleet utilization in Iraq, Afghanistan, and elsewhere, hopes that older machines could be gradually replaced have disappeared. The best example of this is that the Marine Corps, arguably the most frequently deployed fighting force in the world today, relies on aging Boeing CH-46 transports for the bulk of its lift requirements. The last of these were built 40 years ago, in 1971.

The third factor is the complete absence of technological substitutes for a major part of the military rotorcraft market. In most other defense market segments, there is the competitive threat posed by alternative means of achieving the same effect. For example, the requirement for traditional tactical combat aircraft can be delayed or reduced with increased use of UAVs. Similarly, the requirement for the manned strategic bomber has been reduced and delayed by the arrival of ICBMs.

By contrast, the key driver behind the military rotorcraft market is the need for transport, for which there is no substitute or replacement in sight. Indeed, military transport (including the V-22 tilt-rotor) makes up over half the total rotorcraft market by value, and about two-thirds of the military market.

U.S. military procurement remains the big driver behind rotorcraft market growth, and behind the surge in transport requirements in particular. The best example of this is the Army's UH-60M squad transport. The current UH-60A/L fleet is extremely worn out, and the Army plans to buy 1,235 M models as replacements. Sikorsky delivered the 300th UH-60M in July, and has delivered more than 3,000 UH-60s of all variants.

Other key U.S. transport programs include Bell/Boeing's V-22 tilt-rotor (360 planned and 180 delivered to the Marine Corps by mid-2011, with another 50 for Special Operations Command), and Boeing's CH-47F/G (525 new and rebuilt aircraft planned with over 150 delivered by mid-2011).


UH-60

Key export triumphs

U.S. manufacturers have been further bolstered by a series of very impressive export market victories. The biggest deal, for Saudi Arabia, was first announced in mid-2010. Under current plans, the Saudis will buy about 72 UH-60s, 70 Boeing AH-64D Longbow Apaches, and 36 Boeing/MD Helicopter AH-6 Little Birds. A firm contract signature is expected this year, and in June Saudi Arabia announced that it was actually planning to expand its U.S. weapons acquisition plans.

Second, in April Sikorsky's S-70

(UH-60) won the Turkish Utility Helicopter Program (TUHP), a $3.5-billion deal for up to 121 helicopters. AgustaWestland's AW149 was the loser.

The third notable export market win was for the Australian naval helicopter requirement. In June, the Royal Australian Navy signed for 24 MH-60Rs in a $1.5-billion deal. The losing competitor was the NFH 90. The same month, Taiwan signed the launch order for the Block III iteration of the AH-64D. Covering 30 helicopters, the contract was the largest AH-64 export order in over a decade.

Given the security of U.S. rotorcraft programs, and the strong upgrade road maps that come with them, U.S. export standing looks set to remain high in this market. Another factor that keeps the export market strong is relatively high barriers to entry. Even though many countries have large rotorcraft requirements, only one export market—South Korea—is trying to create a new home-grown industry to meet domestic needs. India, a very large market, has been trying to do this for several decades, but with very limited results.

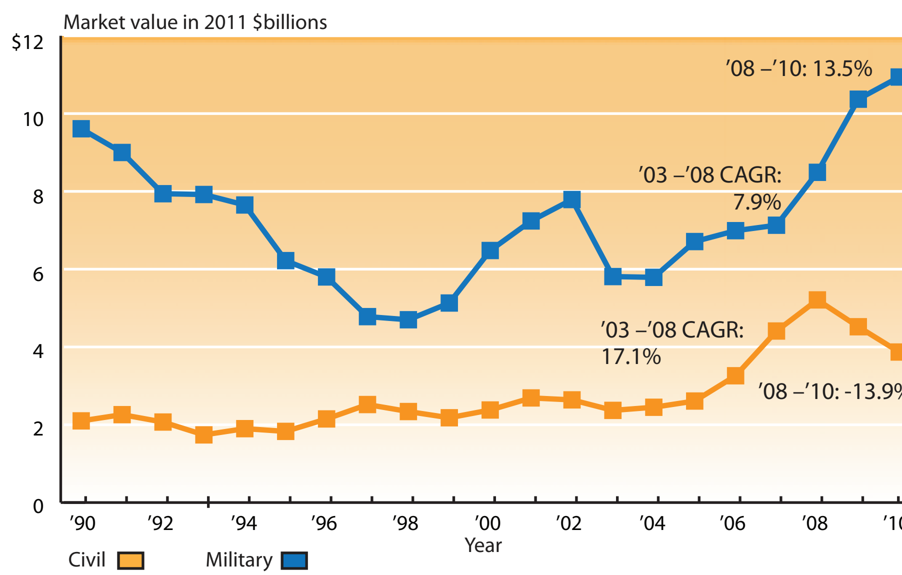
Long-term threats

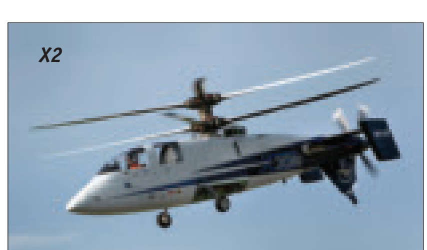
The problem with a massive reequipment cycle, in the U.S. and internationally, is that any boom cycle will probably be followed by a bust. What goes up is likely to come down. The military rotorcraft market is no exception.

While times are quite good right now, many of the current programs of record are scheduled to wind down around the end of the decade. Even today, the supplemental spending packages that have boosted U.S. defense budget rotorcraft procurement are tapering off, along with U.S. involvement in Iraq (and probably Afghanistan within a few years). This implies a market bust as militaries complete their reequipment cycles and, possibly, use those fleets at a reduced pace.

Compounding the potential market problem is a lack of R&D funding for new technologies and platforms. Other than Sikorsky's CH-53K transport, due to enter service in 2018, there are basically no new rotorcraft programs nearing fruition, or even in the advanced design phase. All that is on the horizon are requirements concepts, such as the U.S. Joint Multi-Role rotorcraft. JMR may produce a funded research program, but it is not scheduled to reach the engineering and manufacturing development phase until 2030.

CIVIL AND MILITARY ROTORCRAFT DELIVERIES





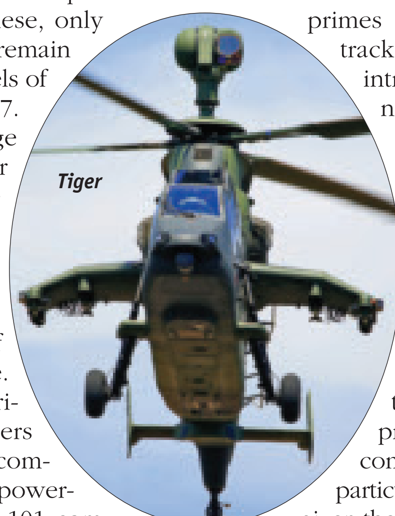
To a certain extent, this paucity of new helicopters might not be concerning from a military capabilities standpoint. Much of the innovation in rotorcraft today is happening at the subsystem level, with advances in engines, weapons guidance systems, datalinks, and munitions. Boeing's AH-64 Apache, soon entering its fourth decade in service and being rebuilt in a third incarnation as the AH-64D Block III, shows that a relatively old airframe can retain world-class combat effectiveness through technology insertion. All that is necessary is a prime contractor whose focus is less on new design and more on systems integration.

To retain a new design capability, manufacturers are coping with this R&D downturn by spending their own money on innovative concepts such as Sikorsky's X2 technology demonstrator or Eurocopter's X3 fast hybrid design. However, both of these, like past concept aircraft such as the Bell/AgustaWestland 609 civil tilt-rotor, emphasize speed as their primary design attribute. It is far from clear that military or civil market customers will pay much of a premium for speed.

European challenges and opportunities

European manufacturers will also need to cope with programs that wind down. There are three primary military rotorcraft programs, the Eurocopter/AgustaWestland NH 90/NFH 90 transport and naval helicopter, the Eurocopter Tiger attack helicopter, and the AgustaWestland EH 101 transport and naval helicopter. Of these, only the NH 90 looks set to remain in more than token levels of production beyond 2017.

One key challenge for European helicopter makers is to resume military export market growth. All three of these programs enjoyed notable export success at the start of their production phase. Yet all three are experiencing an export orders drought. The Tiger competes against the very powerful AH-64, and the EH 101 competes in a relatively small market niche. But the NH 90 series should be doing better. As Eurocopter ramps up production, deals with quality issues, and works to reduce costs, it should resume its drive against Sikorsky's H-60 series for transport and naval orders. However, over the past few years Sikorsky has reestablished a very strong export market presence.

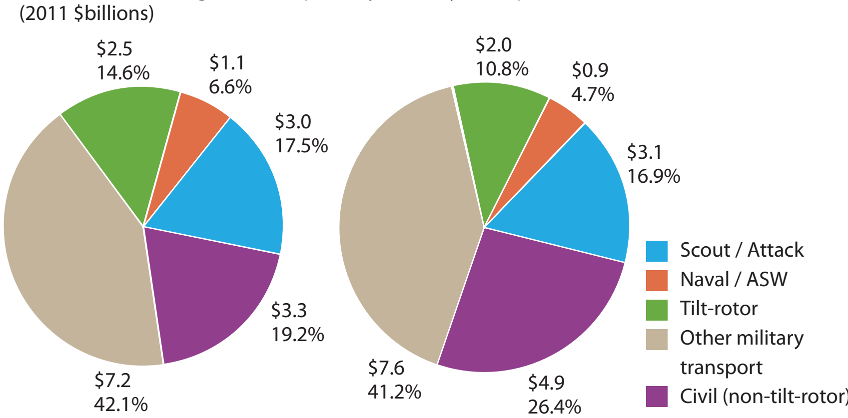

Tiger

Another challenge for European primes is to protect and expand their impressive civil market position. Eurocopter and AgustaWestland now respectively hold the number one and two market positions in the civil segment, displacing Bell. Until as recently as 1997, Bell held the top spot. With limited military market prospects, it is essential that the two European primes continue their strong track record of frequently introducing competitive new civil products.

In addition, European primes need to leverage their civil product offerings to create military platforms. A key part of any helicopter company's strategy is migrating technology between civil and military product lines. European companies have become particularly adept at this, but given the chronic and worsening shortage of R&D funding for military rotorcraft in Europe, they need to increase their efforts.

For an interesting example of aggressive (and perhaps premature) technology migration, consider AgustaWestland's plans for the AW139 family. The 139 has been tremendously successful, largely on the civil market, with well over 500 orders. In 2006 the

KEY ROTORCRAFT MARKETS
Growth in most segments, especially military transport
(2011 $billions)




AW139

company firmed up plans for its AW149, a heavier military derivative of the 139. A multirole battlefield helicopter, the AW149 will carry 12-16 troops and a wide variety of weapons.

However, as noted above the 149 lost the key Turkish TUHP competition to Sikorsky in April, and there are no signs of another 149 sales prospect. Yet this has not stopped AgustaWestland from launching the AW189, a civil derivative of the 149. The 189, announced at the June 2011 Paris Air Show, is therefore a civil derivative of the unlaunched military derivative of the 139.

Access to the U.S. market is a key part of that civil-to-military technology migration challenge. Eurocopter here has scored one big hit in the past few years, winning the Army's Light Utility Helicopter (LUH) competition with its EC 145 civil design. The resulting military version, designated the UH-72, is the best example of the growing popularity of commercial-off-the-shelf (COTS) platforms. However, so far both Eurocopter and AgustaWestland have been stymied in their efforts to compete for further COTS programs, such as the Army's armed reconnaissance helicopter, or the Air Force's CSAR-X or CVLSP.

✈✈✈

Despite these challenges, European primes, and their U.S. counterparts, have the luxury of time. The next seven years, at least, look like a high plateau after several years of very strong growth. But in the second half of the decade, the industry will need to deal with the strong likelihood of shrinkage after the current military programs of record start to wind down.

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WINGS OF GOLD

One hundred years of U.S. Navy air power

Less than a decade after powered flight was achieved, U.S. Navy aviation came into being, opening new possibilities for extending the nation's air power. In its first 100 years it has made advances unimaginable to those who pioneered it.

Eugene Ely

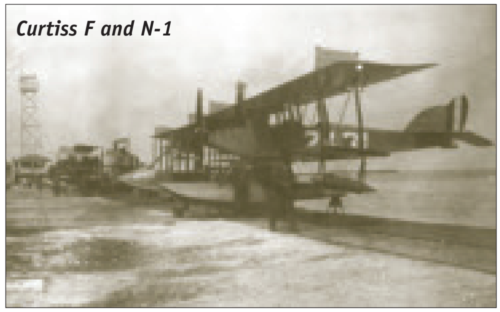
by Edward Goldstein
Contributing writer

Like the turn of the millennium, the actual celebration date for the centennial of U.S. Navy aviation is in the eye of the beholder. The Navy officially dates the beginning of its air arm to May 8, 1911, when Capt. Washington Irving Chambers, head of the Aeronautics Desk at the Bureau of Navigation, requisitioned two of Glenn Curtiss'A-1 Triad seaplanes. Others point to November 14, 1910, when civilian pilot Eugene Ely took off in a Curtiss pusher biplane from the light cruiser USS Birmingham at Hampton Roads, Virginia. Still others cite January 18, 1911, when Ely landed the Curtiss pusher on a modified deck of the armored cruiser USS Pennsylvania, anchored in San Francisco Bay, thus proving that aviation could be useful for naval applications.

From these modest beginnings, the Navy would gradually incorporate aviation, whose importance to growing U.S. military requirements it was just beginning to recognize—due in part to Alfred Thayer Mahan's battleship-oriented 'sea power' concepts. Aviation served at first in a support role to fleet and near-shore operations, then as a decisive offensive weapon in WW II, and finally as an all-purpose tool that today allows the U.S. to project power and conduct expeditionary operations anywhere on the globe at a moment's notice.

USS George H.W. Bush. Photo by Mass Communication Specialist 3rd Class Billy Ho.

About the cover
A T-45C Goshawk is directed to a catapult aboard the USS John C. Stennis. Photo by Mass Communication Specialist 2nd Class Kyle Steckler.



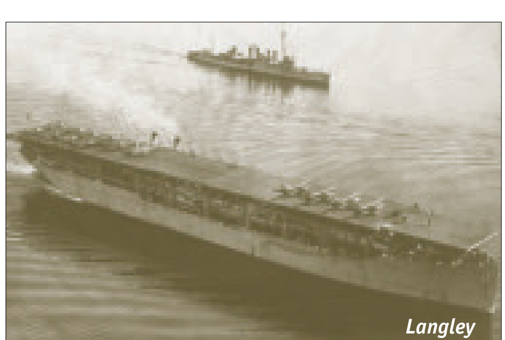
Curtiss F and N-1

The story of U.S. Navy and Marine Corps aviation is one of inspiring innovation in taking a new technology and incorporating it into strategy and operations. The idea of flying a land-based aircraft in combat is daunting enough. To conceive of launching—and figuring out how to direct toward their air-, land-, and sea-based targets—scores of propeller-driven and later jet aircraft off a ship bobbing in the water, and then recovering them safely from different locations in a vast ocean, is astounding. With jets, moreover, this is done in all sorts of weather conditions, day and night.

The vision of these planners—and the creativity of their aircraft, helicopter, radar, avionics, weapons systems, and carrier designers, as well as the courage and discipline of the aviators and 'airdale' support crews—has contributed immensely to the nation's defense and strategic interests

The decisive element

The history of naval aviation cannot, however, be seen as a constantly ascending arc. Efforts in this area did not receive the major ramp-up in investment they needed until the reality of WW I loomed. Moreover, it took a rivalry with the Army to prompt Navy brass to fight for an independent naval air arm, and the prospect of a sea war with Japan—taken seriously by Navy war planners as early as the 1920s—to convince the Navy that carrier-based airplanes, not battleships, might be the decisive element in ocean-wide war. Once the Allies proved victorious in WW II, the Navy was challenged again to justify its aviation activities, and to constantly upgrade its capabilities to meet the requirements of the Cold War's hot wars and of current-day conflicts.



Langley

In 1917, when the U.S. entered the Great War, the Navy had only 54 aircraft on hand, one air station, one airship (to patrol against submarines), and three spotting balloons. Toward the war's end, the Navy had 570 aircraft in theater (the Curtiss N-9 floatplane was the mainstay), along with 15 airships and 215 balloons. Naval and Marine air assets contributed to scouting and fleet protection, to antisubmarine warfare, and, after initial opposition from the Army, to the bombing of German targets.

After the war, the chief of naval operations proposed production of fighters, torpedo carriers, and bombers for the fleet; single-engine, twin-engine, and long-distance patrol and bomber planes for naval air stations; and a combination of land and sea planes for the Marine Corps. In addition, Congress in 1920 funded the conversion of the Collier Jupiter into the first U.S. aircraft carrier, the Langley, which was followed into service by the Lexington and the Saratoga.

The following year Army Air Service officer Billy Mitchell conducted his public battleship bombing 'demonstration,' trying to convince Army and Navy leaders of the strategic attack value of air power. Prior to his 1925 court-martial for insubordination, Mitchell also lobbied for a unified air service under his command.

"What Mitchell really wanted was the British model, with all military aviation unified under an air marshal," says Robert van der Linden, Smithsonian National Air and Space Museum Aeronautics Division chair. "The Navy argued, 'You can't do that. What we do is unique.' In fact, the British did unify military aviation in the 1920s and the 1930s, and it didn't work."

As van der Linden notes, the RAF spent little time developing airplanes for their fleet arm, "leaving them with beyond obsolete airplanes. Can you imagine fighting Midway with biplanes? That's what the British were asked to do." Historian Sterling Michael Pavelic concludes, "What Mitchell did achieve, unwittingly, was a determination in the U.S. Navy to pursue naval aviation as part of the Navy, for specifically naval roles."

Hand-in-hand with this commitment was Joseph Mason 'Bull' Reeves' work to make the promise of carrier aviation a reality. As commander, Aircraft Squadron, Battle Fleet, aboard the Langley in 1925, Reeves "had that sort of forward-looking ability that allowed him to ask the right questions, to get people to provide useful and workable answers, and test them through the annual fleet exercises known as Fleet Problems," notes Douglas Smith, U.S. Naval War College professor of strategy and policy and a former Navy commander.


Fleet Problem

Reeves' first challenge was to get the Langley to launch more than six aircraft at a time. He initiated improvements in launching and landing techniques, and in arresting wire and barrier placement, which allowed more planes to stay above deck. He also organized deck operations, using color-coding that assigned crews, including the landing signal officer, to specific duties.

With Reeves' support, fighter squadron commander Frank Wagner figured out how to overcome the problem of antiaircraft fire by adopting steep-angle dive-bombing techniques. These were later proved in combat by the Marines in the 1927-1933 Nicaraguan campaign against the Sandinista guerilla army of Augusto Sandino, and also were used to great effect in subsequent wars.

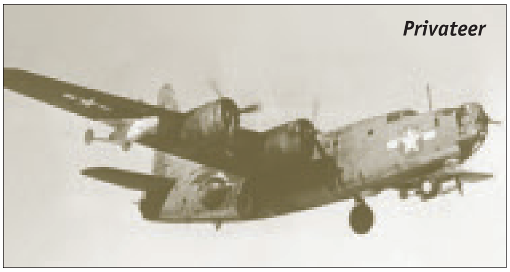
A forgotten Sunday at Pearl Harbor

During the interwar period, the Navy conducted 21 Fleet Problems and occasional joint exercises with the Army, preparing the tactics needed to fight a two-ocean war. In the 1932 Army-Navy Grand Joint Exercise No. 4, the Blue (U.S.) force tried to recapture Hawaii from a hypothetical invading Black (Japan) force. On Sunday morning, February 7, from a spot northeast of Oahu, Blue force commander Adm. Harry Yarnell launched 152 biplanes through cloud cover to a raid on Pearl Harbor. While the raid caught Pearl's defenders totally off guard, the exercise umpires concluded that under real wartime circumstances the attack could not have succeeded. Historian Thomas Fleming called the event "a date that would live in amnesia."

The Japanese, however, did pay attention to Yarnell's feat, and basically used his movements as a playbook for their December 7, 1941, attack on Pearl Harbor.

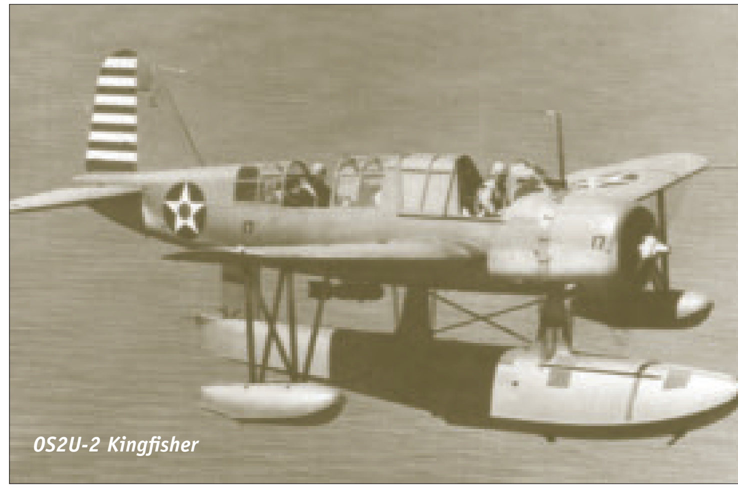
Says van der Linden, "Pearl Harbor was an incredible validation of naval aviation. Unfortunately it was proved against us." He adds, "[Japan's] navy did us a favor in the


Douglas Devastators on the USS Enterprise



Privateer

PBMS-3



OS2U-2 Kingfisher

long run by crippling our battleship fleet. All we essentially had left were carriers. We had to use them."

Winning a two-ocean war

There were 20 major sea battles in WW II's Pacific Theater; the first two were critical. Retired Navy Capt. Robert 'Barney' Rubel, dean of the Center for Naval Warfare Studies at the U.S. Naval War College, describes the battles of the Coral Sea and Midway as "two men with knives in a dark room dueling. They had to find each other, and the one to get in the first blow was lethal."

Indeed, Coral Sea (May 4-8, 1942) was history's first major sea battle in which neither side's ships saw or shot at each other, with all of the fighting initiated by aircraft. Although both sides suffered major losses, the Japanese advance toward Australia was halted, aided by intercepts of Japanese radio signals, the use of radar, and the agility of Douglas SBD Dauntless dive bombers, which kept the Japanese carriers Shokaku and Zuikaku out of the Battle of Midway.

At Midway (June 4-7, 1942) a decisive victory resulted not only from radio intercepts but also from having Dauntless squadrons spot and destroy, within six minutes, the carriers Hiryu, Soryu, and Akagi while they were rearming their planes.

"Japan lost four carriers and hundreds of the most highly trained pilots in the world at Midway. It was a true turning point in the war," says van der Linden. Following Midway, the U.S. Navy was able to go on the offensive, support amphibious landings at Saipan, Iwo Jima, and Okinawa, and carry the war to the Japanese homeland.

Douglas Dauntless

In the Battle of the Atlantic, the U.S. Navy was not opposed by German or Italian carriers but did have to contend with German U-boat Wolf Packs, which heavily damaged allied shipping throughout the war. The response was an effective antisubmarine warfare screen, which included the use of Vought-Sikorsky OS2U Kingfisher scout planes, Consolidated PB4Y Privateer and PBY Catalina patrol bombers, Martin PBM Mariner bombers, and Navy/Coast Guard Grumman Widgeon patrol aircraft to protect supply and troop transport convoys and to hunt down the U-boats.

"By 1943-1944 the last place you wanted to be as a German was in a U-boat," because of the Allies' effective patrol effort, says van der Linden. "You had a 60% chance of getting killed. It was not a happy place to be."

Naval aviation in the jet age

Soon after WW II, the Navy began operating jet aircraft, first straight-wing and then supersonic swept-wing versions. This was not an easy transition. The service had to contend with unreliable jet engines, fueling issues, complex cockpit displays, and tricky handling characteristics that made it difficult to fly these aircraft over rough terrain and land them safely on carrier decks.

"They say it's a controlled crash, and that's what it is," says van der Linden. "When you're coming down on an aircraft carrier you are not gently coming down like an airliner, you are slamming down onto it. They have to take the shock and do it over and over and over again." Rubel observes that it essentially took 40 years, until the reliable McDonnell Douglas (now Boeing) F/A-18 Hornet multirole fighter jet entered operations, to bring down a horrific accident rate: "Between 1947, when we got our first jets, and 1988, the Navy lost about 13,000 aircraft to accidents and killed about 9,000 aviators. That's the price we paid."

In addition to getting better aircraft, the Navy worked to improve pilot training, accident investigations, and carrier arresting systems. Also of help was the Navy's adoption of three British innovations: the angled deck, which allowed jets to land without having to avoid parked aircraft; the optical mirror landing system (later replaced with Fresnel lenses) to provide pilots with a visual indication of glide slope; and the steam-powered catapult, essential for heavier jets requiring greater launch speeds.

Among new aircraft that helped the Navy deal with the realities of the Cold War were the Lockheed P-3 Orion, the carrier-based Grumman S-2 Tracker and Lockheed S-3 Viking patrol planes, which used sophisticated electronics and antisubmarine weapons to search the seas for Soviet submarines and enemy warships, the supersonic Vought F-8 Crusader, which obtained essential low-level photographs during the Cuban missile crisis, and the classic all-weather McDonnell F-4 Phantom II series of multipurpose fighters that dominated air combat in the 1960s and 1970s.

SH-60B Seahawk


1/11 3464

The postwar Navy was also eager to get into the nuclear warfare business, as it saw the newly formed Air Force's insistence that the B-36 nuclear bomber would make carriers obsolete as an existential threat. Accordingly, the Navy proposed a large fleet of 'supercarriers,' beginning with the USS United States, a ship large enough to support nuclear-armed aircraft. In April 1949, Secretary of Defense Louis Johnson, an Air Force ally, abruptly canceled the proposed ship. Secretary of the Navy John Sullivan and a number of admirals resigned in protest. In response to a congressional uproar,

A6-E Intruder

the Navy commissioned its first supercarrier in 1955, the USS Forrestal. Six years later the Navy launched its first nuclear-powered carrier, the USS Enterprise.

This argument about carrier aviation's relevance quickly subsided when the Korean War broke out. Following North Korea's June 25, 1950, surprise attack across the 38th parallel into the Republic of Korea, the U.S. intervened to protect its South Korean ally with the Navy's Seventh Fleet, which was first on the scene. Throughout the war, USAF planes based in Japan had limited range once they reached the Korean peninsula. Thus, says Smith, U.S. and South Korean ground forces relied on the fact that "carrier aviation could sustain tactical air support in proximity with bombs, with fuel, with personnel, with supplies, with maintenance facilities right there. This was hugely important." In all, Navy and Marine Corps carrier aircraft flew more than 30% of all Korean War combat sorties.

As the war progressed, the Marines learned to use helicopters such as the Sikorsky HRS-1 for observation and evacuation, laying communications wire and telephone cables, search and rescue, covert operations, gunfire spotting, and transporting troops and supplies from ship to shore through the new doctrine of amphibious vertical envelopment developed by Lt. Gen. Roy Geiger.

Today vertical envelopment still shapes the basic structure of Marine amphibious operations. "Only about 15% of the world's shorelines are accessible by World War II-era amphibious vehicles," observes Smith. "Once the Marine Corps got the idea of vertical envelopment, of moving men and equipment by helicopters to the shore, amphibious operations quadrupled the amount of shoreline we could access." The Marines also deserve credit for having the vision in recent decades to adopt vertical/short takeoff and landing Harrier aircraft for multirole tasks and, along with the Navy and other services, the revolutionary V-22 tiltrotor aircraft.

Although the Vietnam War remains a sore spot in the nation's collective memory, there is no doubt that Navy and Marine Corps aviation contributed admirably to the warfighting effort. The Marines used helicopters effectively for behind-the-lines missions throughout the Mekong River Delta. And throughout the war, U.S. carriers operating about 150 mi. offshore from the demilitarized zone and South Vietnam's Cam Ranh Bay conducted quick-response missions that Smith says allowed U.S. planes "to be on station in a matter of minutes if they were needed to support ground troops." Navy jets also contributed to the Christmas 1972 bombing of military targets in the Hanoi-Haiphong area. That operation resulted in an uneasy negotiated peace that brought U.S. prisoners of war home.

After the Cold War

Since the fall of the Soviet Union, there has been a willingness by the services to work more in concert with each other and with allied nations, and to conduct joint operations. The maturation of advanced command and control, target identification, precision guidance, electronic warfare, and the use of advanced composite materials and stealth technology have been vital to enabling such cooperation. They allow Navy aviation to work alongside the other military services in initiating devastating first strikes in combat and in conducting more effective search and rescue, antisubmarine and antisurface warfare missions, and special operations.

In the run-up to the first Persian Gulf War, Navy carrier assets were used to dissuade Saddam Hussein from attacking Saudi Arabia while Desert Shield, the coalition of the U.S. and its allies, built up troop strength on Saudi soil. These carriers then helped launch Operation Desert Storm. In that operation, the world witnessed a new approach to overwhelming an enemy in warfighting, with the Navy using Grumman A-6 Intruder Strike aircraft, armed with precision-guided weapons that helped quickly destroy the Iraqi air force and Iraq's command and communications facilities; E-2 Hawkeye airborne early warning propeller aircraft, which provided essential communications links between the coalition's ground forces, air force, and the Navy; and P-3 Orions, which identified and targeted Iraqi surface ships and provided electronic and targeting information for the protection of U.S. and Saudi equipment.

Navy and Marine aircraft also proved vital to the 1999 NATO air campaign in Kosovo, in which no U.S. casualties were suffered, and to Operation Enduring Freedom, where carrier-based F-14 Tomcat and F/A-18 Hornet fighters conducted vital first strikes with no nearby land bases available for coalition warfighters.


Scan Eagle

Similarly, when Operation Iraqi Freedom began, Turkey's unwillingness to host allied forces underscored the importance of having sea-based air assets available in times of crisis abroad.

Looking ahead

"The Future of Naval Aviation," a 2006 study by Owen R. Cote Jr., associate director of MIT's security studies program, notes that ongoing geopolitical revolutions "will dramatically increase the future demand for a secure sea base capable of projecting


F-18F

dominant power ashore in wartime against the full spectrum of possible opponents. It is adapting to these demands by exploiting technologies and operational practices developed in the last decade that will greatly increase naval aviation's ability to surge and concentrate forces rapidly; protect the sea base from new air, surface, and undersea threats; and find, identify, locate, track, and strike mobile as well as fixed targets ashore, under all weather conditions, and in timely enough fashion to produce the desired effects."

Among the technologies Cote cites in the Navy's recent decade-long recapitalization strategy are advanced airborne early warning aircraft; increased persistence and range for strike fighters; modernized air-

borne electronic attack platforms; advanced surface, undersea, and mine warfare helicopters; and long-range, persistent, land-based maritime patrol reconnaissance.

Not mentioned in this litany are UAVs, used to great effect by the Navy in ongoing conflicts. Smith does not think the Navy will move in the direction of relying primarily on them, because of the continual need to "have manned aircraft and an onboard intelligence that's close to the action, and can see what's going on from a broader perspective. America, I think, is the predominant nation on Earth right now in terms of power, resources, and moral intent. And there are some things great nations just do. I think having capable aircraft carriers is among those sorts of things."

Launch vehicles

Soyuz

A worldwide roundup

by J.R. Wilson
Contributing writer

There are just a few achievements that have become generally accepted indicators that a country has achieved 'First World' status. One such indicator is the possession of long-range missiles, from those with regional 'reach' to full-fledged ICBMs.

Having an ICBM also is the first step toward an even more exclusive club—spacefaring nations, whose capabilities fall into four categories: launching satellites into Earth orbit, launching unmanned missions to the Moon and beyond, launching their own astronauts into orbit using their own launch system, and launching their own astronauts to the Moon or beyond.

There currently are 10 members in the first group, four in the second, three in the third (U.S., Russia, China) and one (U.S.) in the fourth. There also is one private company in the third group: Scaled Composites won the 2004 Ansari X Prize by launching three astronauts into suborbit twice, using the same vehicle, in two weeks.

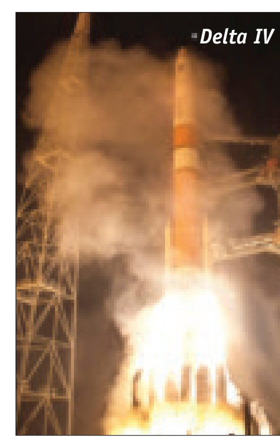
Far more nations have used foreign launch capabilities to place satellites into orbit, just as they have used the U.S. shuttle and Russian Soyuz to send their citizens into orbit, primarily to the ISS. Though this does not give them true 'spacefaring nation' status, it often stimulates national interest in developing some level of self-sufficiency.

Where we will be going in space in the next 50 years is difficult to forecast. But one thing is certain: The withdrawal of the U.S. government from indigenous human spaceflight capability, the increasing capability of China, and the rise of India and others to fill the resulting void will change the future and the nature of human space exploration.

United States

Americans were stunned in October 1957 when the first artificial satellite orbited Earth—the Soviet Sputnik. That achievement spurred the creation of what is now DARPA, tasked to ensure the U.S. would never again experience a technological surprise. It also led to creation of the Army Space & Missiles Command, which was given the first

A few major 'space powers' continue to dominate the world's launch activities, but the number of nations eyeing membership in that exclusive club is on the rise.



orders to turn military rockets into space launchers, and NASA, which assumed responsibility for U.S. space programs.

Even as the U.S. struggled with its first attempts to launch satellites, President John F. Kennedy surprised the world by announcing the goal of sending astronauts to the Moon and returning them safely before the end of the 1960s. From Project Mercury's first suborbital crewed flight in 1961 to astronauts setting foot on the Moon in 1969, the U.S. caught up with and then surpassed the Soviet Union in space. Over 40 years later, no other nation has sent humans beyond Earth orbit—nor has the U.S. since December 1972.

Unmanned launches, however, continued to advance. In the 1980s, President Ronald Reagan 'privatized' the launcher business, turning full ownership of the highly successful Delta and Atlas systems over to their builders, McDonnell Douglas (now Boeing) and General Dynamics (now Lockheed Martin). Since 2006, the current versions of both—the Delta II medium, Delta IV heavy, and Atlas V medium/heavy—have been built by United Launch Alliance, a Boeing/Lockheed joint venture.

The space shuttle was to have replaced all ELVs, but the launch frequency envisioned for it never materialized. For now, the future of the Delta II remains murky as its contract with the Air Force ends, leaving NASA to maintain the vehicle's infrastructure. NASA, too, had intended to end its use of the Delta II this year, but recently announced it would keep the vehicle on its list of available launchers, although production has stopped.

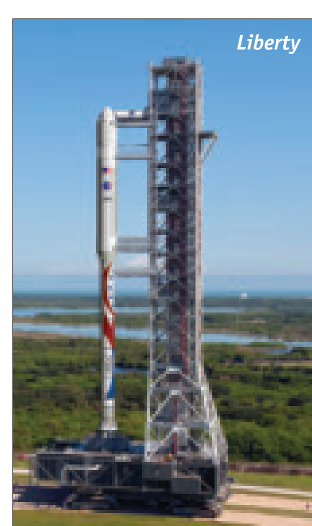
The change resulted from significant increases in Atlas V's cost and the lack of a proven vehicle below the Atlas V/Delta IV class. That also has led NASA to look more closely at new private launch systems, and at non-U.S. launchers.

Until one of the private launchers becomes successful, the only way to reach the ISS, at least through the end of this decade, will be by buying a seat on Russia's Soyuz..

In its July 2010 report to Congress on the future of NASA, the Congressional Research Service (CRS) noted, "While reliance on Soyuz on an interim basis is acceptable, longer term use would not be."

Teal Group analyst Marco Cáceres tells *Aerospace America,* "We're at a pause. We will not have a manned spaceflight capability we can call American—either government or private—for the near term. The hope is that private industry will come through within a few years, certainly with regard to carrying cargo to the space station, but eventually with human-rated vehicles. The hope now lies with companies like SpaceX and Orbital Sciences. But it will take at least three or four more years to develop human-rated vehicles and test them well enough that everyone feels comfortable.

"I would identify Virgin Galactic as…more of a joint venture. Sir Richard Branson owns the vehicle and is British, but the manufacturer is American. That traditionally has not been the way things have gone—human-rated space has always belonged to some government. But when you open up to private industry, they can buy from other countries and claim it as their own, so you have to word it differently—it's not a national capability as in the past.



LAUNCH VEHICLE ROUNDUP

Country	Prime Contractor/ Launch Sites	Vehicle Designation	Series	First Launch	Number of Successful/ Failed Launches	Number of Stages	Propellant	Payload Wt., kg
Argentina								
	Space Activities National Commission/ Bahia Blanca	Tronador		1	2007	1 of 2		
				2			Liquid	200 LEO
Brazil								
	CTA Aerospace Technical Center/ Alcântara Launch Center	VLS-1	V1-4	Dec 1997	0 of 2	3	Solid - liquid upper	38 LEO
		Alfa (VLS-2)					Solid	LEO/GEO
		VLM		2016		3 of 4	Solid	150
		Cyclone-4		2013 or 2014				5,300 LEO 1,800 GEO
Canada								
	Planet Space/ Cape Breton, Nova Scotia	Athena III*				3	Solid	794-1, 896 LEO
		Canadian Arrow*				2	Liquid first; solid second	
		Silver Dart*				2	Nova rocket first stage; lifting body second	
China								
		Long March (Chang Zheng)	1D		1 of 2		Liquid	1,500 LEO
			2C		32			2,400 LEO
			2D		14			3,500 LEO
								8,400 LEO
			2G					
			3A		17			8,500 LEO 2,300 GTO
			3B/E					12,000 LEO 5,500 GTO
			3B(A)					
			3C		4			3,700 GTO
			4B		11			4,200 LEO 1,500 GTO
			4C		4			4,200 LEO 1,500 GTO
			5	2014				25,000 LEO 14,000 GTO
			6	2013				500 SSO

We do that already with ILS and SeaLaunch, for example, where both are based in the U.S. but the rockets they use are built by the Russians and Ukrainians."

SpaceX, established in 2002, already has seven successful launches of its Falcon launch vehicle and Dragon reusable spacecraft, and a future 30-launch manifest through 2017 for 10 customers. In December 2008, NASA awarded SpaceX a $1.6-billion contract for at least 12 Falcon/Dragon missions to resupply the ISS through 2015, with a roughly equivalent options package, as part of its commercial orbital transportation services program. The first cargo flight is scheduled for late this year.

The Scaled Composites/Virgin Galactic effort, probably the first private manned transport to go into operation, is intended to provide tourists, at $200,000 a ticket, with a brief trip to the edge of space.

The system comprises a twin-fuselage mothership, WhiteKnight Two, which will carry the reusable suborbital SpaceShipTwo to 50,000 ft, then release it to continue upward using its own hybrid liquid/solid motor. It can carry six passengers and two crew about 6 mi. beyond the Karman Line (at 60 mi. altitude, the break point between Earth's atmosphere and space).

Another industry possibility is the Liberty launcher, a joint venture of Alliant Techsystems (ATK), the Utah-based builder of the shuttle's solid rocket boosters, and Astrium, a subsidiary of EADS and a primary contractor on the Ariane commercial rocket. It would build on ATK's efforts on NASA's Ares rocket, part of the Constellation program planned to replace the shuttle and canceled by President Obama shortly after he took office.

Proton

Offered in response to NASA's Commercial Crew Development-2 procurement initiative, the two-stage Liberty would be able to carry 44,500 lb of cargo—or any crew vehicle currently in development—to the ISS. ATK Aerospace Systems Group President Blake Larson says because it is a combination of two proven human-rated launch systems, the Liberty rocket could make its initial test flight by the end of 2013 and reach operational capability in 2015. Liberty will launch it from Kennedy Space Center, using existing facilities.

For the U.S., the future of space launch is split between military and government use of commercial rockets and commercial launch for civilian customers. It is further divided between manned and unmanned.

Russia

With the end of the shuttle, Russia has regained the lead in space for the fifth time since it began the space race. Although China also now has both manned and unmanned capability, for at least the next few years Russia alone will have the combined capability to launch manned flights to the space station, unmanned payloads to Earth orbit, and interplanetary probes.

Unlike the U.S., which opted for a major technological leap with the shuttle, the Russians have stayed with essentially the same rockets and spacecraft developed by the Soviet Union in the 1960s and 1970s. Although that has given them a record of reliability without significant new investments, it is uncertain whether they will be able to stay ahead of the aggressive Chinese space program, which includes unmanned interplanetary probes and the goal of landing taikonauts on the Moon by 2020.


Soyuz

"Russia is in good shape. They have a good fleet of vehicles—nothing spectacular, basically 1960s technology, but it works," Cáceres says. "The Soyuz is the only vehicle that is human-rated and tried and tested to get people to the space station and back. The vehicle also is very successful in satellite launches. Russia has a very diverse customer base—military, government, and commercial—and has a captive market."

The country is looking to increase domestic launch capabilities with the planned Vostochny Space Center. Billed as a "new stage in the development of Russian cosmonautics," with two launch pads and a training center, it is scheduled to begin satellite and cargo launches in 2015 and manned missions in 2018.

LAUNCH VEHICLE ROUNDUP

Country	Prime Contractor/ Launch Sites	Vehicle Designation	Series	First Launch	Number of Successful/ Failed Launches	Number of Stages	Propellant	Payload Wt., kg
China, continued		Kaituozhe	1					50 LEO
Denmark								
	Copenhagen Suborbitals/ Baltic Sea	HEAT	1X*	2010	1 of 2		Hybrid solid	300 suborb. 50 LEO
			TM65	2012			Bi-liquid	
Europe								
	European Space Agency (Arianespace)/ Guiana Space Center	Ariane 5	ECA	2002	31	2	2 SRB side boosters; cryogenic main stage; liquid	21,000 LEO 10,050 GTO
			ES	2008	2	2		>20 tons
			ME	2016				11.2 tons GTO
		Soyuz-2	ST*	2011				3 tons GEO
		Vega		2011		4	Solid-liquid	2 tonnes HEO 1.5 tonnes HPO
India								
	Indian Space Research Organization (ISRO)	PSLV			9 of 10			1,050 GTO 3,200 LEO
			CA		6			2,100 LEO 1,600 GTO
			XL		1			3,800 LEO 1,140 GTO
			HP					3,800 LEO 1,130 GTO
		GSLV	Mk II		0 of 1			5,100 LEO 2,500 GTO
			III					5,000 GTO
Indonesia								
	Spacetecx/ LAPAN Space Center mobile pad	RPS-01	RX-420	2012 to 2014		4	Solid	25 LEO
		RX-750		2014		5	Liquid	50 LEO
Iran								
	Semnan	Kavoshgar	1	2008	1 of 2	2		
			2	2009		2		
			3*			2		
			4			2		
			5*			2		
		Safir	1	2008		2	Liquid	
			2	2009		2	Solid-liquid	50 LEO

The space program also has involved increasing cooperation with nations such as the U.S. and China, but also with others seeking to develop their own space programs. These would be aimed primarily at launching Earth-orbiting satellites or building launch facilities for use by other nations' rockets.

Russia reportedly has at least seven new launch vehicles at varying stages, from 'concept evaluation' (the MMB nuclear-electric tug, with first launch planned for 2018) to preliminary development (Rus-M for 2015) to development (Angara, 2012). Rus-M and Angara are seen as replacements for the existing Soyuz and Proton rockets. The aging Soyuz manned capsule's replacement—currently called the New Generation Piloted Transport Spacecraft—was displayed in mockup form at the Paris Air Show in July, but when it may be ready for flight is unknown.

Ukraine

When the USSR broke apart, Ukraine—which had produced about 60% of Soviet launch vehicles and more than 400 satellites—became an independent player in space. An estimated 20% of all satellite launches in the world today use Ukrainian rockets, primarily the Zenit, Tsyklon (Cyclone), and Dnepr. Although Ukraine still does not have a domestic launch facility, it officially became the 10th global 'space power'—a nation able to launch its own satellite using its own vehicle—with the August 1995 liftoff of the Sich-1 Earth observation satellite aboard a Cyclone rocket from Russia's Plesetsk launch facility.

In 2009, Ukraine hit a new high mark as the number of its rockets launched that year ranked fourth in the world—tied with China behind Russia, U.S., and Europe/ESA.

Ukraine has provided post-Soviet Russia with military satellites and launch vehicles since 1991 and has been aggressive in making bilateral agreements with other nations and private industry. These entail making satellites, providing launchers, and building and operating new spaceports. Ukraine is working with Brazil to build a new launch facility for the Cyclone-4 rocket and has been invited by Russia to participate in construction of Vostochny.


Zenit

In recent years, Ukraine has formed cooperative efforts with China, Japan, Saudi Arabia, Turkey, Nigeria, India, Azerbaijan, Belarus, Canada, Germany, and ESA, in addition to its ongoing work with Russia, the U.S., Kazakhstan, and Brazil, among others.

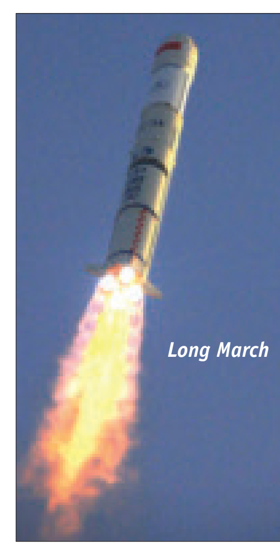
One major international effort is Sea Launch, a joint venture by Ukraine's Yuzhmash machine plant and Yuzhnoye State Design Office, Boeing Commercial Space (U.S.), Energiya Rocket and Space (Russia), and Akar ASA (Norway). In its first decade (1999-2009), Sea Launch recorded 28 successful missions out of 30 launches, using a Ukrainian two-stage Zenit rocket and Russian third-stage launching from a modified Norwegian ocean oil rig. The company halted operations while working through bankruptcy, but the National Space Agency of Ukraine expects operations to resume late this year with the Intelsat 18 communications satellite, although the launch will be from Kazakhstan's Baikonur Cosmodrome, a land launch option that Sea Launch began offering around 2003.

China

The Chinese space program is evolving far faster than many had anticipated, but currently is about where Russia's was in the 1960s. It has some satellites in orbit—with the annual number of launches beginning to close in on current U.S. and Russian numbers—and some manned orbital flights. It also has set a goal of putting its own space station in orbit by 2020 and landing Chinese taikonauts on the Moon by 2020-2025 and on Mars in the 2030s.

Some have called it a new space race, while others ask with whom China is racing. The U.S. essentially has abandoned manned spaceflight as a government effort. Russia remains active, but has advanced little beyond what was achieved by the mid-1970s. India, which also has an active satellite launch program and has said it wants to put its citizens on the Moon in the 2020s, has yet to achieve a manned launch and lags behind China on the unmanned side as well. And while other nations are expanding or pursuing unmanned launch capabilities, none is even close to China.

"The Chinese have a huge fleet of vehicles, much more modern than the Russians', but this is a purely government program and they haven't shown they can compete commercially. So as long as they do not, the Russians don't need to worry," Cáceres says. "The Chinese would like to


Long March

LAUNCH VEHICLE ROUNDUP

Country	Prime Contractor/ Launch Sites	Vehicle Designation	Series	First Launch	Number of Successful/ Failed Launches	Number of Stages	Propellant	Payload Wt., kg
Iran, continued		Shahab		2007	3 suborbital, 1 orbital of 5			
			5					
			6				Liquid-solid	
		Simorgh		2010				130 lb LEO
Israel								
	IAE	Shavit			6	3		160 LEO
Japan								
	JAXA (IHI Aerospace)	Epsilon	Standard	2013		3	Solid	1,200 LEO
			Optional			3	Solid-compact liquid	700 LEO 450 SSO
	Mitsubishi Heavy Industries	H-II	A		17 of 18			15,000 LEO 6,000 GTO
			B		2			19,000 LEO 8,000 GTO
New Zealand								
	Rocket Lab/ Mercury Island	Atea-1		2009		2		2 suborbital
North Korea								
	KCST/ Tonghae Satellite Launching Ground	Unha	2	2006		3	Liquid-solid	100 LEO
Romania								
	ARCA/ Black Sea	Haas				3		400 LEO
		Helen	2B	2010				
		Stabilo		2006	2	2		
Russia								
	Khrunichev State Research and Production Center/ Plesetsk Cosmodrome (possible future from Baikonur Cosmodrome)	Angara**	1.1	2012			Liquid	1.6 tonnes
			1.2	2013			Liquid	3.5 tonnes LEO 1.8 tonnes GEO
			AS-I					8.8 tonnes GEO
			A4B					
			V			3	Liquid	27 tonnes LEO 11.2 tonnes GEO
			100					100 tonnes LEO
			5-P*					6,350 LEO
			A3*					14,600 LEO 3,600 GTO
			A5					24,500 LEO

get commercial, but they have a lot of government and military launches—14 last year, all with Chinese payloads—so they really don't need to [go commercial].

"Their focus is on building a national space program, and they're perfectly happy with their expendable launch fleet—small, medium, large, all segments of the market. They would like to have a manned capability in orbit, so if they don't join the ISS, which I don't know that they will, they'll probably develop their own space station. I also think they will move quickly to go to the Moon—probably before the end of the decade, and definitely before the Indians."

As with most high-tech programs in China, separating fact from internal hyperbole and external speculation is difficult. A further complication is the Chinese penchant for calling almost every launch vehicle Long March, followed by a series number. Of about 20 versions of Long March built since 1970, nine remain in use and four are still in development, operating from four satellite launch centers in as many provinces around the nation. So it is likely any Chinese mission to the Moon or Mars also will begin atop a Long March.

Adding to the complexity of analyzing China's launch capabilities is the apparent failure of the country's efforts to match its predictions of future success. China should be benefitting from the way the U.S. and Soviet/Russian space programs dealt with unknowns at comparable points in their histories, for example—including the loss of space crews. But most Chinese advances have come in the past decade, following 30 years of comparative lethargy.

China launched its first satellite in 1970, but in its first four decades in space, it launched only 132 rockets, 166 satellites, one unmanned lunar probe, and six taikonauts, who spent a total of nine days in space. By comparison, in its first decade alone, NASA performed about 600 launches involving 800 spacecraft—including multiple probes to Mars, Venus, and the outer planets—and placed 44 astronauts in space, including four who walked on the Moon.

Cáceres notes that China has benefitted from a steady, albeit small, stream of military launches, while the U.S. military launched most of its own satellites rather than using NASA. "China is really committed and is likely to pump more money into its space program than the U.S. ever did."

Andrew Erickson, a Naval War College expert on China's naval and space forces, tells *Aerospace America* that the Chinese approach may prove more successful, for their purposes, than a cursory comparison with the U.S. or Russia might indicate.

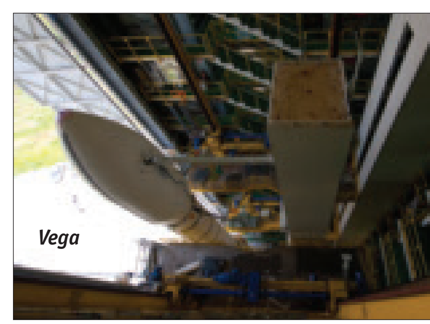
"China appears to have very advanced capabilities in both electrooptical and radar imaging, with very high resolution," says Erickson. "These seem to be exactly the type of capabilities for which to further develop space-based information, surveillance, and reconnaissance to support precision weapons.

"What is especially intriguing is that by employing diverse small satellite designs based on common buses or standardized platforms, China may not need to develop superior heavy spacecraft technologies, but could end up with military space capabilities greater than the sum of their parts."

That may suit their purposes very effectively, although quite differently from the U.S. military space program, which uses larger individual spacecraft. China's current strategy, if it continues, could result in increased future synergies, he believes, propelling China to a more prominent position.

Europe

In 1965, France became the third nation to launch its own satellite; the U.K. followed suit in 1971. But no individual European nation had the money or other resources to mount expansive space programs like those of the U.S. and the Soviet Union/Russia.


Vega

In 1975, France and the U.K. joined eight other western European nations to create the European Space Agency, merging two organizations set up in 1964—the European Launch Development Organization, a six-nation effort to develop a European launcher, and the European Space Research Organization, established by 10 nations to pursue scientific research in space, primarily through European satellites launched by the U.S.

Today ESA has 18 full members and one associate, Canada. Further expansion is likely if efforts to make ESA an official agency of the European Union by 2014 succeed. ESA continues to work with the U.S. and Russia—projects with the latter include developing a new medium-lift launch vehicle, the Soyuz-2—but relies primarily on its own rockets, the Ariane 5 ECA for heavy lift to GTO, Ariane 5 ES for launch to LEO, and the newly developed Vega for small pay-

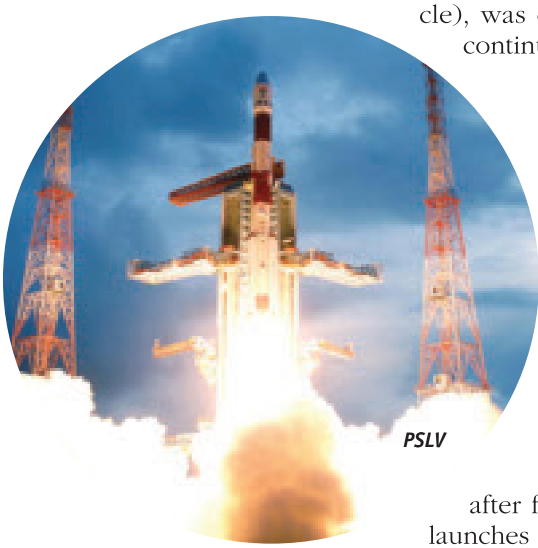
LAUNCH VEHICLE ROUNDUP

Country	Prime Contractor/ Launch Sites	Vehicle Designation	Series	First Launch	Number of Successful/ Failed Launches	Number of Stages	Propellant	Payload Wt., kg
Russia, continued		RN-45						45 tonnes LEO
		RN-75						75 tonnes LEO
		RN-150						150 tonnes LEO
		Proton			294 of 333			21,000 LEO 6,360 GTO
		Rokot			13 of 14			1,950 LEO
		Strella			1 of 3			1,700 LEO
	Makeyev	Shtil			2			430 LEO
		Volna			0 of 5			100 LEO
	MITT	Start-1			6			532 LEO 167 SSO
	NPO Polyot	Kosmos-3M			422 of 442			1,500 LEO
	TsSKB-Progress/ Plesetsk launch Baikonour launch	Soyuz	FG		31			7,130 LEO
			2.1a/b/v		7			2,800-7,800 LEO 1,700 GTO
			2 ST/ST K					7,800 LEO 3,000 GTO
			U		696 of 715			6,700 LEO 6,950 LEO
		Rus-M		2015				54,000 LEO 11,500 GTO
South Korea								
	KARI Khrunichev/ Naro Space Center	Naro-1			0 of 2	2	Solid-liquid	100 LEO
Ukraine								
	Yuzhmash	Dnepr	1		15 of 16			
		Tsyklon	4					5,500 LEO 1,700 GTO
	Yuzhmash/ RKK Energia	Zenit	3SL		27 of 30			6,100 LEO 5,250 GTO
			3SLB		4			3,750 GTO
	Yuzhnoye	Zenit	2M (SLB)		1			13,920 LEO
		Zenit	3SLBF		1			
United States								
	ATK/Lockheed Martin	Athena	Ic					
			IIc					1,712 LEO
		Space Launch System*						130,000 LEO
	Interorbital Systems/ Spaceport Tonga	Neptune	N30	2011		3	Liquid	30 PLEO
			N45			3	Liquid	45 PLEO
			N1000			4	Liquid	1,000 PLEO
			N4000			4	Liquid	4,000 LEO
		Minotaur	I		10			580 LEO

loads. Arianes have launched more than half the commercial satellites in use worldwide.

India

India became a space power in 1980 but has been limited to placing relatively small satellites into LEO—a total of 58 through 2010. Its first rocket, the ASLV (augmented satellite launch vehicle), was discontinued

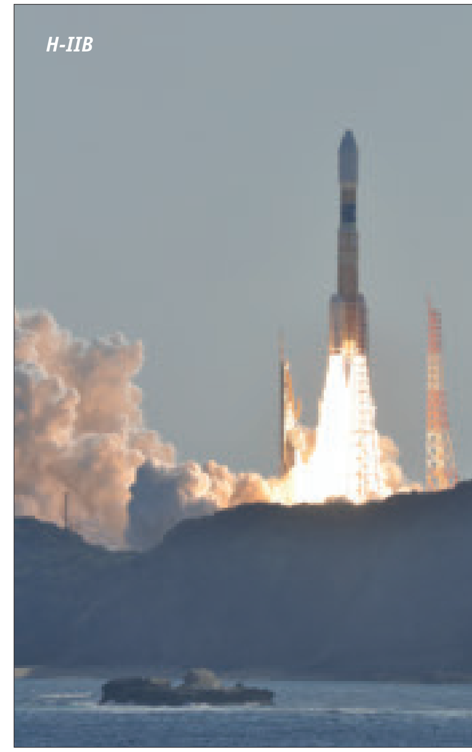


after four launches (including two failures and a partial success). The follow-on PSLV (polar) rocket has achieved most of the successful launches.

The GSLV (geosynchronous), larger and roughly comparable to Delta II or Ariane 4, has had a difficult history since its first developmental flight failed in 2001. The second developmental and first operational flights succeeded in 2003 and 2004, respectively; however, three of four subsequent attempts through December 2010 failed, the fourth being listed as a partial success. The next attempt, carrying GSAT-11, India's largest and post powerful communications satellite, is slated for late this year or early 2012.

Given its difficulties getting satellites beyond LEO, India's plan for sending astronauts to the Moon and establishing a permanent base there in the 2020s seems unlikely. The GSLV also will need to demonstrate a solid string of successful launches to GEO before India can begin to compete in the commercial launch arena with the U.S., Russia, Europe, or China.

"The most important things are cost, performance, and reliability. So far, the Indians have not proven they can come up with a reliable competitor to the Russians," Cáceres says, but adds that this does not preclude their joining the manned spaceflight club soon. "The most likely to try is probably India; the most likely to have the capability to succeed would be the Europeans, if they decided to human-rate the Ariane 5."



Japan

Japan is eager to become a full-fledged spacefaring nation, reasserting itself as an Asian power equal to China. The first all-Japanese rocket to launch a Japanese payload into orbit from a domestic site was the H-II in 1994. Because of cost issues, the vehicle was abandoned five years later; its follow-on, the H-IIA, made its first successful launch in 2001. The next year, Japan privatized H-IIA production, and Mitsubishi Heavy Industries became responsible for all development and marketing.

In addition to the H-IIA, Japan Aerospace Exploration Agency, or JAXA, has the H-IIB and H-II transfer vehicle in its operational fleet. It is also developing two others: the Epsilon launch vehicle and the LNG propulsion system, which could be used as the first stage of a reusable vehicle or alone to propel an interorbit transport or planetary probe.

Brazil

Brazil has long been a sleeper on the global scene. It is one of the world's largest nations by area, 'rich' in largely unexploited natural resources, and has the intellectual capital to join the ranks of space powers, but has been slow to capitalize through needed infrastructure construction, in large part because of intermittent economic and political instability.

It also is part of BRIC (Brazil, Russia, India, China) or, sometimes, BRICSA, which includes South Africa. This is a new political bloc

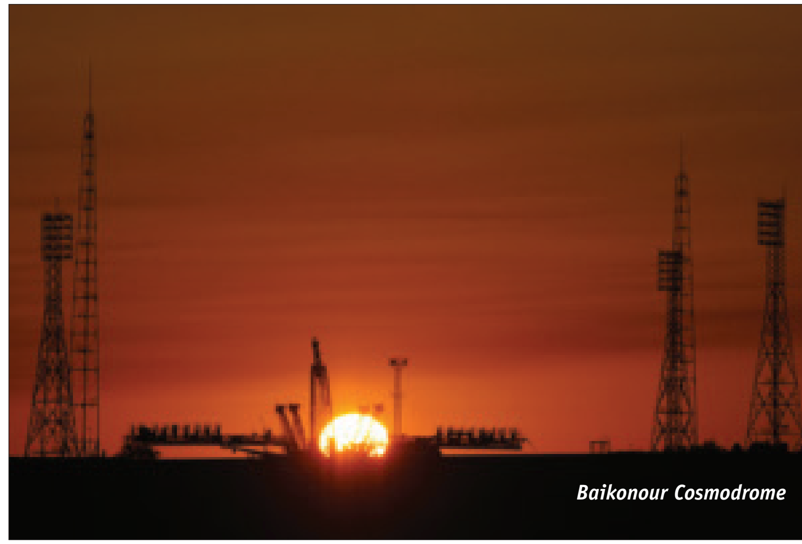
LAUNCH VEHICLE ROUNDUP

Country	Prime Contractor/ Launch Sites	Vehicle Designation	Series	First Launch	Number of Successful/ Failed Launches	Number of Stages	Propellant	Payload Wt., kg
United States, continued	Orbital Sciences/ Cape Canaveral, Vandenberg AFB, Wallops - Kodiak	Minotaur	IV		3			1,735 LEO
			V					
		Pegasus			35 of 40			443 LEO
		Taurus			6 of 9	4		1,350 LEO
			II	2011		2	Solid-liquid	5,750 LEO
	Scorpius Space Launch	SR-M Suborbital			2			
		Sprite						482 LEO
		Liberty						1,910 LEO
		Exodus						8,955 LEO
		Space Freighter						15,320 LEO
	SpaceX/Reagan Test Center Kwajalein Atoll Cape Canaveral or Kwajalein	Falcon	1	2006		2	Liquid	
			1e			2	Liquid	1,010 LEO
			9*	2010	2	2	Liquid	From Cape: 23,050 lb LEO 10,000 lb GTO From Kwaj: 18,870 lb LEO 10,320 lb GTO
			9 Heavy*	2012		2 with dual side boosters	Liquid	53,000 LEO 16,000 GTO
	United Launch Alliance (Boeing/ Lockheed Martin)/ Cape Canaveral and Vandenberg AFB	Delta	II	1989	156 of 158	2 LEO 3 GTO plus 3-9 strapons		6.1 tonnes LEO 2.2 tonnes GTO
			IV	2002	13	2 with 2 strapons	Liquid	48,264 lb LEO 28,620 lb GTO
			IV Heavy		3 of 4			22,950 LEO 12,980 GTO
		Atlas	V*	2002	25 of 26	2	Solid	64,860 LEO 28,660 GTO
			V Heavy*			2	Liquid	25 tons LEO

* *Human rating planned or possible.*
** *A number of designation and configuration changes to the Angara family of launch vehicles in the past decade makes it difficult to determine which specs go with which name.*

This chart shows only those launch systems currently in use or with the greatest likelihood of succeeding in the near term. Chinese, Iranian, and North Korean space launch companies, missions, and specs are among the most difficult to verify. The information in this chart is based on a compilation of multiple sources, looking for common names and details to avoid duplication or programs no longer active and to ensure the inclusion of new launch vehicles.

formed in 2009 with the stated purpose of challenging the U.S. as the only global superpower, giving "emerging and developing economies...a greater voice" and promoting "fundamental research and the development of advanced technologies." BRIC could significantly improve Brazil's future prospects as a spacefaring nation. It already is developing new satellites with China under the China Brazil Earth Resources Satellite program and is negotiating future launches from its two spaceports—Alcantara and MECB (Brazilian Complete Space Mission)—for U.S., Russian, Chinese, and Ukrainian rockets. Late last year Brazil also launched its own mid-sized rocket, VSB-30 V07, on a suborbital flight.


Baikonour Cosmodrome

Iran

Iran is the world's largest question mark, in terms of its ability to launch payloads into space. Russia and China both have been criticized in the past for selling missile technology to Iran. The fact that Iran has had little known success, even with launching small satellites to LEO, indicates that either what it bought was not a complete package or, as every nation attempting spaceflight learns, getting a satellite safely into orbit is not as easy as it may seem.

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In terms of space launch, Russia leads the world, followed by the U.S, with China a fast-growing third—passing Europe/ESA and Ukraine—and both India and Brazil serious contenders. Working together, which would be a first for such a group, they theoretically could leave both the U.S. and Europe far behind in future space launch and exploration capabilities. But thus far, little more than paperwork and rhetoric have emerged from BRIC.

Cáceres says there will be newcomers to the list of launch-capable nations, but he qualifies the prediction with an assessment of just what that will entail: "I'm sure Brazil eventually will do it, because it has the technology and the money. The same with North Korea and Iran—at least for tiny satellites. But if you look at who is launching regularly, it's basically the same five or six."

Many nations are seeking a toehold in space by providing launch facilities. While the number of spaceports—operational, planned, or just claimed—varies with every source, the 'short list' shows 20 nations operating some 30 launch sites, not including a host of new private ones. The longer list, however, includes one planned in Africa, 18 in Asia (mostly China and Russia), four operated by (but not necessarily in) Europe, 14 in or operated by the U.S. and Canada, two in South America, three in Australia, one in the Marshall Islands, and two at sea—a total of 45.

Finding enough launch vehicles doing enough business to justify the cost of building and maintaining a large number of spaceports, however, remains an uncertain prospect. The odds of new launch customers bringing new rockets into the market are far slimmer than existing countries/companies expanding services to meet any growth in demand.

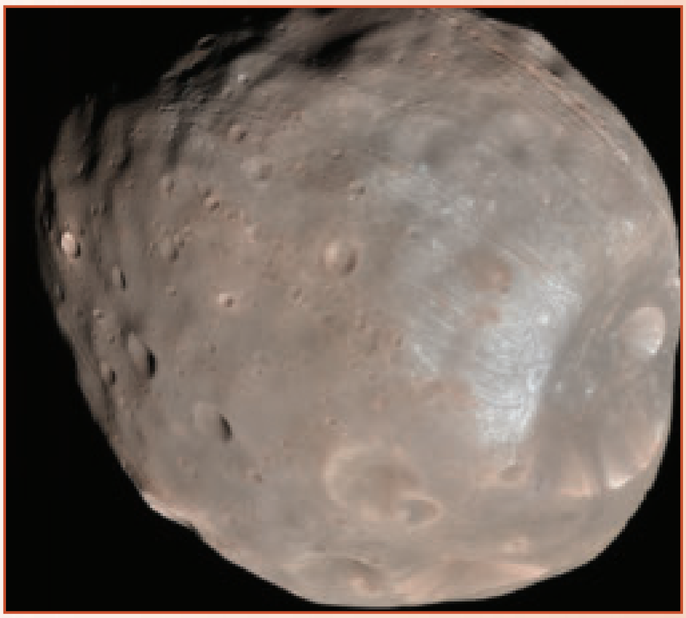
"There probably are 50 or so companies working on launch vehicles, but most won't actually have the capital to do anything more than paper," Cáceres predicts. "China, the U.S., Russia, Europe, Japan, India—maybe South Korea and Israel—but that's about it."

Most experts agree the major U.S. rockets—Atlas V, Delta II and IV, Falcon 9, Minotaur I and IV, Taurus II—will be committed almost exclusively to military and government launch, as will those of China, which will continue to seek a greater degree of commercial diversity.

Of the major players, that leaves Russia, perhaps surprisingly, and ESA's Ariane as the world's primary sources of commercial launches for the foreseeable future, with their greatest challenge likely coming from private industry, primarily in the U.S.

The future is likely to see a widening divide between government and private launchers, satellites and human spaceflight, Earth orbital and interplanetary missions.

Russian lander



to head for Martian moon

Russia will soon launch an unmanned spacecraft to land on the Martian moon Phobos and return a sample of its soil and rock to Earth. Scientists will study the sample for signs of life on Mars, which bombards its moons with debris. The mission has breathed new life into the country's planetary science programs, which had fallen into decline in recent decades. If successful, the effort could add significantly to scientific understanding of the solar system as well as Mars and its moons.

Flight elements of the Phobos sample return include the orbiter/lander that will orbit Mars and match orbits with Phobos until landing is possible. The drilling rig is at left. Atop that is the return vehicle that will fire back toward Earth carrying the descent module with soil and rock samples that will land in 2014.

Russia, which has not flown a successful planetary mission in 30 years, is about to launch an unmanned spacecraft to the Martian moon Phobos to collect rock and soil samples and return them to Earth by 2014.

Also on board will be a small Chinese piggyback satellite to be released into Martian orbit as China's first mission to Mars. It will take images and atmospheric readings.

The Russian mission is set for launch toward Mars from the Baikonur Cosmodrome on board a Zenit rocket around November 8. Two weeks later, on November 25, NASA's Mars Science Laboratory (MSL) rover Curiosity will take off from Cape Canaveral on an Atlas V.

Diverse goals

Russian mission managers hope to score several firsts, the most important of which is the first round trip from Earth to Mars orbit, with a stop on the Martian moon Phobos to gather the samples.

Although the Russian and U.S. flights are designed to do totally different things, they both have important tasks to perform. One goal of the Phobos mission, the robotic return of rock and soil samples, could lead to the discovery of life on Mars. Martian meteoric impact debris has blasted the planet's moons and is sure to be part of any Phobos sample return. And the MSL, which will remain on the surface of Mars, has a powerful suite of instruments capable of characterizing organic carbon that could have been part of past life.

Phobos samples could also put into context the formation of Mars and its moons, helping to scale the formation of the solar system. The samples could make a major contribution to characterizing Mars.

If the mission is successful, the samples will be returned to Earth in 2014, landing at Russia's Sary Shagan missile test center, where advanced radars can track objects approaching from space.

The Russians have quietly sounded out American officials on using U.S. territory for a landing. But political hurdles involving planetary protection could arise—especially if a sphere with samples ruptures over U.S. territory—and will likely keep the target site in Russia.

The Phobos sample return will take place some 20 years before NASA and ESA can return a much more significant sample of Mars rock and soil. A later rover, the NASA Max-C, is set for launch in 2016 and will select Martian samples for later pickup by ESA and NASA spacecraft.

New life for planetary programs

The former Soviet Union, which launched dozens of successful deep space probes in the 1960s through the 1980s, has not flown a fully successful planetary mission of any kind since the 1984 Vega-2 Halley's Comet/Venus mission. And it has launched no successful lunar or Mars missions in 30 years.

In 1988, Russia launched two missions to Phobos, hoping to drop small one-way landers onto its surface. But a software uplink problem led to the loss of Phobos 1, and Phobos 2 died because of an onboard computer error while maneuvering toward the roughly 16x14-mi. moon. The country's robotic Earth orbit and deep space science program has been largely suspended since the mid-1990s in the funding crisis that followed the collapse of the USSR.

Although tiny, Phobos holds great interest for those seeking to understand Martian history as well as the nature of planetary moons and asteroids. Some scientists believe Phobos was formed from material knocked off Mars, and that samples could be genuinely Mars-like. Others think it is a captured asteroid and could instead provide data on those ancient bodies—although it does not much resemble other asteroids seen so far.

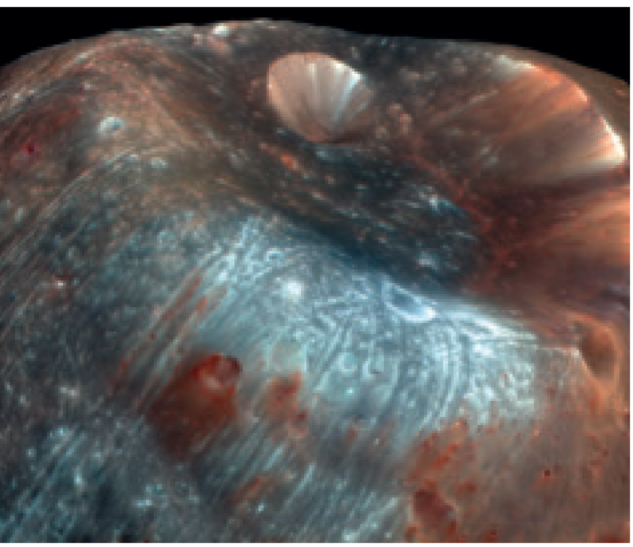
The spacecraft is being completed at NPO Lavochkin, near the Sheremetyevo airport in Northwest Moscow. The facility employs 5,000 people and is Russia's primary Earth-orbit and deep space science development company. It has 40 years of plane-

by Craig Covault
Contributing writer

tary mission experience including 15 successful flights to the Moon.

Lavochkin is beginning to reenergize its robotic capability for both lunar and Mars missions. The company has been tapped by the Russian government to lead all future robotic planetary development. The largest project in development is the Phobos mission, for which the Russian Space Research Center (IKI) is designing the sensor suite.

An ESA Mars Express image of 5.6-mi.-diam Stickney crater on Phobos shows the largest feature on the Martian moon. Scientists believe the brightest material is younger, with the many streaks on the crater rim indicative of landslides and even major fallout of Martian material blasted loose by meteorites.



In addition to the lunar and planetary missions, Russia is currently completing development of several new astrophysics and other Earth-orbit spacecraft, many of which involve IKI and Lavochkin.

Mission and spacecraft design

The spacecraft consists of three stacked vehicles. The lowest vehicle will be the propulsion and systems bus for the trip to Mars, as well as the launch pad for the return spacecraft. It will then serve as a long-life science station on the surface of Phobos, equipped with about 20 science instruments and a drilling-rig/manipulator mounted on the side. The rig has a tube mechanism to transfer the sample up the side of the cruise/lander, past the Earth return spacecraft and into the Earth descent module.

After launch from Earth, the combined vehicles will spend 11 months in transit to Mars. The triple-deck spacecraft will be inserted into Martian orbit, where it will provide imagery and data on Mars and Phobos.

Several weeks later it will be maneuvered to fly in formation with Phobos. After extensive imaging to find a suitable landing site, the spacecraft will be maneuvered to make a gentle landing on the moon. Because Phobos has such minute gravity, the Russian lander could bounce off the moon at touchdown or drift away during surface sampling. To prevent either event, up-firing thrusters to hold the lander down onto the surface will be fired until harpoon-like anchors are spring ejected from the landing pads to physically secure the spacecraft to the surface.

The same side of Phobos always faces Mars. Science managers want to land on the Mars-facing side, because debris blasted at it from the Martian surface may have a greater chance of being sampled there. Such a landing site would also allow continuous observation of Mars from about 5,800 mi. away. But landing there also poses more risk for Earth communications and for spacecraft temperature control. Although the question is still open for review, it is likely the landing will take place on the side facing away from Mars, in the terminator area, where it can still see the planet but can also benefit from some shading.

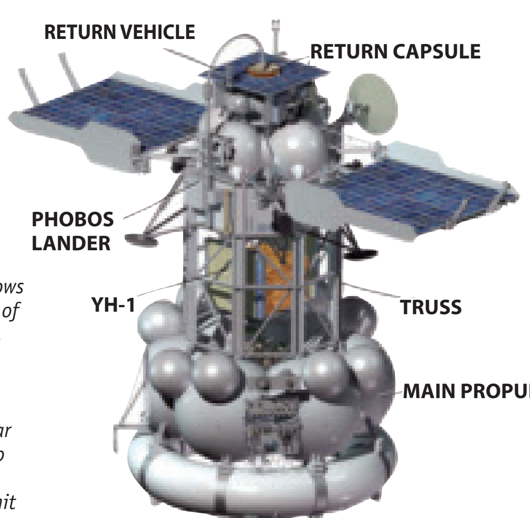
Once the spacecraft is on the surface, its first major task will be to image the stars and Sun to update its navigation platform for an accurate Earth return maneuver.

The cruise/lander stage will also begin imaging the surface under the lander to pick a spot for sampling. The drilling rig will be able to swivel several degrees left or right to choose a spot suitable for both soil and rock specimens.

Sampling plans

The drilling and sampling process will require three to four days. The objective is to obtain 200 grams. The amount is not as important as getting below the surface and also finding at least one small stone. Preserving the integrity of the core sample is also desirable, to show layering.

The return spacecraft with the sample sphere will then be ejected off the top of the lander into its own orbit around Mars. Its small rocket engines will be used to



Launch configuration shows the complex integration of multiple flight elements, including the propulsion modules. Extra fuel and component weight contributed to a two-year launch slip from 2009 to 2011 and a shift to the much more powerful Zenit booster instead of the Soyuz. The Chinese YH-1 Mars orbiter box is tucked midway in the truss.

send the vehicle on an Earth return trajectory with the sample sphere riding on top.

A 2009 launch had originally been planned for the mission, but several instruments were not ready, especially the critical sampling mechanism. Managers decided to delay the launch until this year to fix this and address other problems.

According to Anatoly Shilov, deputy director of Roscosmos, the Russian Academy of Sciences realized that the planned sampling system was not powerful enough for the possibly hard surface or the team's desire to have rock samples. It was the same kind of system featured on the three unmanned sample devices used on Earth's Moon, with a tiny auger-type component that moved material into a flexible tube placed in the Earth return device. It also had the potential for overturning the lander during operations in the extremely weak gravity on Phobos, managers say.

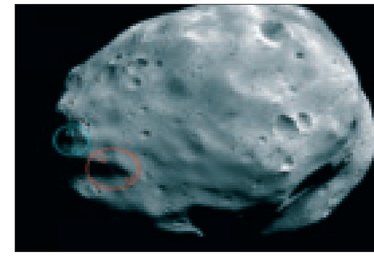
The new sample device will be more of a pounder/crusher that can break soil and small rocks without rocking the lander.

Poland is supplying Lavochkin with its Chomik (Hamster) soil sampling drill, designed originally for the European Philae lander now en route to land on a comet. Chomik will serve as a backup device in case the prime sample mechanism fails.

Approach and return

As the vehicle approaches Earth at the end of the 11-month transit, the descent module with the samples should separate from the Earth return spacecraft. The module should then dive safely through the atmosphere for recovery. About half the sample will be opened and distributed globally for analysis. The remaining 100 g will be held back for a time, for a second wave of analysis after results are in from the first studies.

Meanwhile, back on Phobos, the lander's instrument suite will be obtaining images and direct compositional measurements to complement and back up the sample return. Several spectrometers, heat probes, cameras, and other instruments will take detailed data on Phobos from its surface. The lander is designed to survive there for a year.



Mars Express image of Phobos has two locations annotated as primary spacecraft landing sites as determined by Russian project scientists and engineers. A key consideration will be the ability of the lander to image the stars for mission navigators before liftoff to plot the best route back into Mars orbit and ultimately to Earth.

Out of the

25 Years Ago, September 1986

Sept. 22 Six days after its launch, the Search and Rescue Satellite Aided Tracking (SARSAT) spacecraft receives its first distress signal from stranded Canadians whose Cessna has crashed in a remote region of Ontario. Their location is easily relayed to rescue workers and the Canadians are saved. Part of the COSPAS/SARSAT system, SARSAT includes one U.S. and four Soviet satellites built to locate downed aircraft and ships. NASA, *Astronautics and Aeronautics, 1986-90*, pp. 69-70.

50 Years Ago, September 1961

Sept. 2 The Navy and Air Force agree on specifications for the TFX superiority fighter aircraft to fulfill the requirements of both services. *The 1962 Aerospace Year Book*, p. 471.

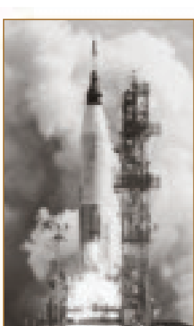
Sept. 7 NASA announces that the government-owned Michoud Ordnance Plant near New Orleans will be the site for the fabrication and final assembly of the Saturn C-3, the first stage of Project Apollo's Saturn launch vehicle and also of larger vehicles. The site becomes NASA's Michoud Assembly Facility. I. Ertel and M. Morse, *The Apollo Spacecraft: A Chronology, Vol. I*, p. 109.

Sept. 9 The first full-scale firing of the Nike Zeus antimissile missile takes place at Point Mugu, Calif. Two of its three solid-propellant stages are fired; however, an internal malfunction causes the missile to explode about 20 sec into the flight. *Aviation Week*, Sept. 8, 1961, p. 34; *Flight*, Sept. 21, 1961, p. 469.

Sept. 11 NASA selects North American Aviation to develop the S-II second stage of the advanced Saturn launch vehicle for Project Apollo. The S-II is to use four LOX/hydrogen J-2 engines, each producing 200,000 lb of thrust. I. Ertel and M. Morse, *The Apollo Spacecraft: A Chronology, Vol. I*, p. 109.

Sept. 11 Air Force and NASA officials inspect a full-scale mockup of the Dyna-Soar boost-glide vehicle at Boeing's Seattle facilities. D. Baker, *Spaceflight and Rocketry*, p. 125.

Sept. 12 Pilots Bell Bedford and Hugh Merewether, flying the prototype of Britain's Hawker P.1127 V/STOL aircraft, conduct the first in-line transition from vertical to horizontal flight and back. The plane is also the first V/STOL type to take off vertically, hover, and translate to forward flight at near supersonic speed. D. Baker, *Flight and Flying*, p. 377.



Sept. 13 The first Earth orbital test of a Mercury spacecraft is made with the Mercury-Atlas 4, which carries an astronaut simulator. The Atlas, with unmanned spacecraft atop, lifts off from Cape Canaveral, Fla., and after a single 85-min 3-sec orbit is successfully recovered. I. Ertel and M. Morse, *The Apollo Spacecraft: A Chronology, Vol. I*, p. 110; *Aviation Week*, Sept. 18, 1961, pp. 32-33.

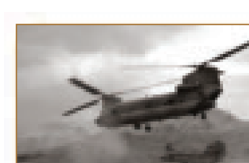
Sept. 13 The Soviet Union begins tests of a larger launch vehicle, "a more powerful and improved multistage carrier rocket," to ranges of more than 12,000 km (7,450 mi.). *Flight*, Sept. 21, 1961, p. 467.

Sept. 18 Bell Aerospace Systems vice president Walter Dornberger, former commanding general of Peenemünde, the famed German rocket development center that produced the V-2, the world's first large-scale liquid-fuel rocket, during WW II, publishes a paper on space as a military area. His paper advocates the development of systems for space bombardment from manned space stations and other military uses of space technology. *Aviation Week*, Sept. 18, 1961, pp. 11, 57-58.

Sept. 19 NASA chooses a site close to Houston, Texas, as the Manned Spacecraft Center for the design, development, and testing of the Apollo spacecraft. The center will also train astronauts for lunar flights. I. Ertel and M. Morse, *The Apollo Spacecraft: A Chronology, Vol. I*, p. 111.

Sept. 21 A Soviet Mil-6 helicopter sets a new world's record, averaging 198.8 mph over a 9.3-15.5-mi. course. This beats the previous mark of 192.9 mph, set by a U.S. Navy Sikorsky HSS-2 over a 1.86-mi. straight-line course. *Aviation Week*, Oct. 2, 1961, p. 32.

Sept. 21 Boeing's Vertol YHC-1 (later CH-47 Chinook) helicopter makes its first flight and subsequently



Past

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

becomes one of the most versatile military transport helicopters ever flown. It features two 57-ft-diam rotors and can carry up to 33 troops, 27 paratroopers, or 24 stretchers. The 51-ft-long craft has a cruising speed of 150 mph and an operating radius of 200 mi. D. Baker, *Flight and Flying*, p. 377.

Sept. 28 The Tory IIA-1 atomic reactor undergoes further successful tests, mounted on a railroad car at the Atomic Energy Commission's Nevada test site. The tests are part of the Pluto nuclear ramjet program, a planned development of a flight-type reactor for use in a cruise missile. The Tory IIA-1 is the world's first nuclear ramjet engine and had its first tests on May 14, 1961. However, the Pluto program, which began in 1957, is eventually canceled, ending in 1964. *Aviation Week*, Oct. 16, 1961, p. 32.

75 Years Ago, September 1936

Sept. 5 Beryl Markham completes the first east-west solo crossing of the Atlantic by a woman, landing near Baleine, Nova Scotia, 24 hr 40 min after leaving Abington, England. Flying a Percival Vega Gull low-wing monoplane, Markham planned to land at New York's Floyd Bennett Field, but headwinds caused excessive fuel consumption and necessitated a landing about 2,000 mi. into the 3,700-mi. route. *Aero Digest*, Oct. 1936, p. 98.

Sept. 7 Louise Thaden sets a new women's transcontinental speed record of 14 hr 55 min 1 sec, flying a Wright-powered Beechcraft in the Bendix Trophy race from Floyd Bennett Field in New York to Los Angeles. *Aero Digest*, Oct. 1936, p. 98.

Sept. 12 Two Deutsches Lufthansa Do-18 flying boats, the Zephyr and Aeolus, successfully inaugurate an experimental transoceanic service between the Azores and New York. The planes are catapulted from the mother ship Schwabenland, which is anchored off the Azores. The Zephyr flies the 2,830-mi. distance nonstop. *Aero Digest*, Oct. 1936, p. 98.

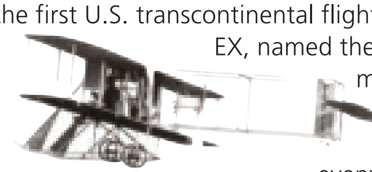
Sept. 19 British aviation pioneer Thomas Campbell-Black dies in an aircraft ground collision at Speke Airport, Liverpool. Born in 1899, Campbell-Black served in the Royal Naval Air Service and RAF during WW I. In 1931 he rescued Ernst Udet, the famed German aviator, who was stranded and starving on an island in the Upper Nile. Campbell-Black achieved his greatest fame as copilot with C.W.A. Scott in the winning De Havilland D.H. 88 Comet at the MacRobertson England-Australia Race of 1934. *Flight*, Sept. 24, 1936, p. 315.

Sept. 19 Benito Mussolini opens the new military airport at his native town of Forli, Italy, after which 250 aircraft of the Aquila Air Division take off and fly around in formation. The new facilities cover an area of about 296 acres and include aircraft sheds, underground fuel and oil tanks for holding several months' supplies, and air raid shelters. *The Aeroplane*, Sept. 30, 1936, p. 416.

100 Years Ago, September 1911

Sept. 9 Following his success in India in sending air mail, Royal Navy Capt. Walter Windham organizes the first such exercise in the U.K., conducting an experimental air mail delivery between London and Windsor. The mailbag, with specially printed cards and envelopes, is flown on a Gnome-Blériot by Gustave Hamel from the London aerodrome at Hendon to Windsor. Additional mail trips follow a few days later. *Flight*, Sept. 16, 1911, pp. 798-799.

Sept. 17 Calbraith Perry Rodgers—great-grandson of Commodore Matthew Perry, who opened the door to Japan for the U.S. in his 1853 expedition—achieves the first U.S. transcontinental flight. Rodgers flies his custom-built Wright Model EX, named the Vin Fiz, from Sheepshead Bay, New York. In many stages, and with many breakdowns and accidents en route, he flies to Chicago, Kansas City, Dallas, San Antonio, El Paso, and eventually Pasadena, a total distance of 4,231 mi., in 49 days. He lands 69 times and has 15 accidents during the flight. *American Legion*, June 1979, pp. 20-23.



Sept. 24 Earle L. Ovington delivers the first U.S. air mail. Using a Queen monoplane patterned after the Bleriot XI, he transports 640 letters and 1,280 postcards from Garden City, Long Island, to New York City. The authorities name his latter stop the N.Y. Post Office Aerial Postal Section No. 1 and designate Ovington Air Mail Pilot No. 1. *Aero*, Sept. 30, 1911, p. 561.

DEPARTMENT OF AEROSPACE ENGINEERING
WICHITA STATE UNIVERSITY
Positions in Aerospace Structures and Flight Mechanics

The Wichita State University (WSU) Aerospace Engineering department has two faculty positions available in aerospace structures and flight mechanics. The tenure track positions, at the Assistant Professor rank, include teaching, research, scholarship, and service responsibilities.

Applicants must hold a doctorate in aerospace engineering or a strongly related engineering discipline. Additionally, applicants must have at least one degree in aerospace engineering or have notable aerospace industry/research lab experience. A demonstrated ability to teach, conduct research, publish, communication effectively, and a commitment to diversity are also required.

WSU, located in the Air Capital, has a proud history. The department's undergraduate and graduate (MS & PhD) programs are strong and play an important educational and research role in the city, region, and nation. In fact, the National Science Foundation ranked WSU third among all U.S. universities in aerospace research and development expenditures (for fiscal year 2007). Furthermore, the department and National Institute for Aviation Research (NIAR) are home to an outstanding collection of wind/water tunnel, aircraft icing, composites, structural testing, fatigue/fracture, flight mechanics, crash dynamics, and computational laboratories.

The WSU campus is an attractively landscaped architectural showplace with approximately 15,000 students. Wichita, a community of approximately 450,000 people, is home to aerospace leaders Cessna Aircraft, Hawker-Beechcraft, Bombardier Learjet, Boeing, Airbus, and Spirit AeroSystems.

U.S. citizens or permanent residents with an undergraduate degree in aerospace engineering are preferred. Applicants should clearly state their status or ability to work in the US. Salary is commensurate with qualifications and experience.

If interested, apply online - submitting a resume, a letter of introduction discussing your teaching and research philosophies, and contact information for at least six references located in the United States. The closing date for these positions is September 30, 2011, or the end of each successive month until the position is filled. WSU is an EEO/AA employer.

Offers of employment are contingent upon completion of a satisfactory criminal background check as required by Kansas Board of Regents policy. Candidates must go online at http://jobs.wichita.edu to apply for the positions.

VirginiaTech
Invent the Future

DEPARTMENT HEAD SEARCH
Aerospace and Ocean Engineering Department
www.aoe.vt.edu

Nominations and applications are being solicited for the position of Head of the Aerospace and Ocean Engineering Department (AOE). Candidates should have demonstrated intellectual leadership and management skills to further elevate this department, which is one of the premier aerospace engineering and ocean engineering departments in the nation. Candidates must qualify for tenure in the rank of professor and should have achieved international distinction in university-level teaching and research and have a record of superior scholarship, administrative ability, and academic leadership.

Virginia Tech, a land-grant university of the Commonwealth, is located in Blacksburg, Virginia. The University has a total student enrollment of 26,000, with approximately 7,500 students in the College of Engineering. The AOE Department offers B.S., M.S., and Ph.D. degree programs in both Aerospace Engineering and Ocean Engineering with a current enrollment of 400 undergraduate and 130 graduate students. The department has 19 full-time faculty members with research expenditures exceeding $4 million annually.

Blacksburg is consistently ranked among the country's best places to live **(http://www.vt.edu/where_we_are/blacksburg/index.html)**. Home to the Blacksburg Electronic Village, it is a scenic and vibrant community nestled in the New River Valley between the Alleghany and Blue Ridge Mountains. The town is proximal to state parks, trails, and other regional attractions of Southwest Virginia, renowned for their history and natural beauty.

Interested persons should apply on the Internet at **http://jobs.vt.edu** (**Posting No. 0110789**). Applicant screening will begin February 1, 2012 and continue until the position is filled. Applications should include a curriculum vitae, a cover letter, and contact information for at least five individuals providing references. References will only be contacted concerning those candidates who are selected for on-campus interviews.

Inquiries about the position should be directed to:

Professor Roger L. Simpson
Chair, Search Committee for the AOE Department Head
215 Randolph Hall, MC 0203
Blacksburg, VA 24061
rosimpso@vt.edu 540-231-5989

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. It 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 is an Equal Opportunity/Affirmative Action Institution.

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

An endowed Chair/Professorship with a tenure track faculty position at the level of Professor or Associate Professor is available with starting date negotiable, but beginning no earlier than January 2012. Applicants should have teaching and research interests and experience in area 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.

UNIVERSITY OF MIAMI

COLLEGE of ENGINEERING

The Mechanical and Aerospace Engineering Department (MAE) at the University of Miami (UM) invites applications and nominations for tenure-track positions at any professorial level in all areas of mechanical and aerospace engineering, with the emphasis on aerodynamics, energy, and biomechanics.

MAE is seeking candidates with a strong record of scholarship with a focus on obtaining external funding, a demonstrated excellence in graduate and undergraduate teaching, and a thoughtful commitment to university and professional service. For a senior-level appointment, a proven record of extramural funding support is required.

A Ph.D. in mechanical engineering, aerospace engineering, or a related discipline and one year work related experience is required prior to the appointment. Salary: Competitive. Qualified applicants should mail (a) a letter of interest, (b) a resume and (c) at least three (3) references to:

Dr. Shihab Asfour, Associate Dean for Academics
College of Engineering
University of Miami
1251 Memorial Drive, McArthur Engineering Bldg., Room 247
Coral Gables, FL 33146.

The University of Miami offers competitive salaries and a comprehensive benefits package including medical and dental benefits, tuition remission, vacation, paid holidays and much more. The University of Miami is an Equal Opportunity/Affirmative Action Employer.

Full-Time, Tenure-Track Faculty Position in Aerospace Engineering Department at California State Polytechnic University, Pomona

The Aerospace Engineering Department invites applications at the assistant- or associate-professor level for a tenure-track faculty position beginning September 2012 or January 2013 to teach a broad range of courses in aerospace engineering with primary responsibility in the following areas: aerospace structures, finite-element analysis and mechanics of composite materials. A Ph.D. in aerospace engineering or a closely related discipline is required. A B.S. Degree in aerospace engineering from a U.S. accredited institution as well as U.S. industrial and teaching experience are preferred. A strong interest in curriculum development, computer-based static and dynamic structural modeling and analysis (such as NASTRAN), design of aircraft and spacecraft structures, laboratory development in our B.S. and M.S. programs, pursuing grants and supervising student research, and demonstrated ability to provide hands-on education in a multidisciplinary environment, as well as excellent oral and written communication skills are required. Research, consulting, and summer employment in aerospace industry are available in the local area. Initial review of applications will begin January 9, 2012 and will continue until the position is filled. Applicants should send a curriculum vitae and a list of teaching and research interests to:

Dr. Ali Ahmadi, Chair
Aerospace Engineering Department
California State Polytechnic University
3801 W. Temple Avenue
Pomona, CA 91768

Request applications from Ms. Carol Christian, Aerospace Engineering Department, at (909) 869-2470 or at cmchristian@csupomona.edu. The University hires only individuals lawfully authorized to work in the United States. The university is an equal opportunity, affirmative action employer. For full ad see: http://www.csupomona.edu/~engineering

Click on faculty positions.

West Virginia University

TENURE TRACK FACULTY POSITIONS
Department of Mechanical and Aerospace Engineering
College of Engineering and Mineral Resources

The Department of Mechanical and Aerospace Engineering (MAE) at West Virginia University (WVU) seeks applications for six (6) tenure-track faculty positions at the rank of Assistant or Associate Professor with demonstrated teaching and research experience in the following areas:

- **Unmanned Aerial Vehicles (#71101)**: aerodynamics, propulsion, structures, aircraft design.
- **Space Systems (#71102):** orbital mechanics, spacecraft systems, stability, controls, launch, reentry.
- **Hybrid Electric Transportation (#71103):** vehicle drive-trains and controls, auxiliary power units, alternative fuels, lightweight structures.
- **Clean Energy Harvesting, Storage and Distribution (#71104):** solar, wind, geothermal, or hydro systems, batteries, reservoirs, smart distribution and control, lightweight storage tanks.
- **Multi-Scale Computational Modeling (#71105)**: advanced methods with applications to energy sciences, materials science, aerodynamics, propulsion, biomedical sciences and bio engineering.
- **Robotics and Mechanical Systems (#71106) (joint position with the Lane Computer Science and Electrical Engineering Department):** autonomous aerial or ground systems, vehicle guidance, navigation and controls, sensor fusion.

All positions require strong oral and written communication skills along with a proven commitment to innovative engineering education and a clearly demonstrated potential to develop externally funded interdisciplinary research programs. The successful candidates will be expected to assume leadership roles in the development of corresponding specialty tracks in the undergraduate curricula offered by the department in either Aerospace or Mechanical Engineering. An earned doctorate in engineering or applied sciences is required, with preference given to Aerospace, Mechanical or related engineering fields, depending on the specific selection criteria for each of the above positions.

WVU is a comprehensive land-grant institution with an enrollment of more than 29,000 students. We are a Carnegie High Research University at the center of a developing high-technology corridor. The MAE Department is nationally ranked by the National Science Foundation in the top 25 departments of mechanical engineering in research expenditures (NSF, 2008, 2009, 2010). It currently employs 31 tenure-track or tenured faculty members and is offering B.S., M.S., and Ph.D. degrees in both Mechanical and Aerospace Engineering to about 450 undergraduate students, 80 M.S., and 75 Ph.D. students. Additional information may be found on the website of the MAE Department at www.mae.cemr.wvu.edu or by contacting Dr. Jacky Prucz, Professor and Chairman, via e-mail at Jacky.Prucz@mail.wvu.edu, or by regular mail at P.O. Box 6106, Morgantown, West Virginia 26506-6106.

Review of applications will begin on August 16, 2011 and will continue until the positions are filled. Electronic applications are required and should be sent to MAEDept@mail.wvu.edu. They should include a cover letter specifying the position title and number that the applicant is applying for, highlighting his/her qualifications for that position, the curriculum vitae, concise descriptions of a research plan and a teaching plan, as well as contact information for three references.

West Virginia University is an Affirmative Action/Equal Opportunity Employer and encourages applications from women, minorities, and individuals with disabilities, in commitment to building a diverse body of faculty and staff. West Virginia University is the recipient of an NSF ADVANCE award for gender equity.

AIAA Bulletin

Aeroacoustics Award recipient Martin Lowson (center) with Walter Eversman (left) and Brian Testor (right) at the 17th AIAA/CEAS Aeroacoustics Conference in Portland, Oregon.

SEPTEMBER 2011

AIAA Directory

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* Also accessible via Internet. Use the formula first name last initial@aiaa.org. Example: megans@aiaa.org.
† U.S. only. International callers should use 703/264-7500.

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

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

Meeting Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
2011				
20–22 Sep	**11th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference** (**Jul/Aug**) **including the 19th AIAA Lighter-Than-Air Technology Conference and the AIAA Balloon Systems Conference**	Virginia Beach, VA	*Sep 10*	**7 Feb 11**
21–22 Sep	**AIAA Centennial of Naval Aviation Forum** (**Jul/Aug**) **"100 Years of Achievement and Progress" (Jointly held with ATIO)**	Virginia Beach, VA	*Sep 10*	**7 Feb 11**
27–29 Sep	**AIAA SPACE 2011 Conference & Exposition** (**Jun**)	Long Beach, CA	*Sep 10*	**25 Jan 11**
3–7 Oct†	**62nd International Astronautical Congress**	Cape Town, South Africa (www.iac2011.com)		
13–14 Oct†	**Acoustic Liners and Associated Propagation Techniques**	Lausanne, Switzerland Contact: H. Lissek, herve.lissek@epfl.ch, http://x3noise.epfl.ch		
23–26 Oct†	**20th International Meshing Roundtable**	Paris, France Contact: Jacqueline Hunter, 505.284.6969, jafinle@sandia.gov, www.imr.sandia.gov,		
24–27 Oct†	**International Telemetering Conference USA**	Las Vegas, NV Contact: Lena Moran, 575.415.5172, info@telemetry.org, www.telemetry.org		
26–28 Oct†	**2nd Aircraft Structural Design Conference**	London, UK Contact: Hinal Patel-Bhuya, Hinal.patel@aerosociety.com, www.aerosociety.com/conferences		
2–4 Nov†	**6th International Conference "Supply on the Wings"**	Frankfurt, Germany Contact: Prof. Dr. Richard Degenhardt, +49 531 295 3059; richard.degenhardt@dlr.de; www.airtec.aero	*Feb 11*	**31 Mar 11**
28 Nov–1 Dec†	**Japan Forum on Satellite Communications (JFSC) and 29th AIAA International Communication Satellite Systems Conference (ICSSC)**	Nara, Japan Contact: http://www.ilcc.com/icssc2011		
2012				
9–12 Jan	**50th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition**	Nashville, TN	*Jan 11*	**1 Jun 11**
23–26 Jan†	**The Annual Reliability and Maintainability Symposium (RAMS)**	Reno, NV Contact: Patrick M. Dallosta, patrick.dallosta@dau.mil; www.rams.org		
24–26 Jan	**AIAA Strategic and Tactical Missile Systems Conference AIAA Missile Sciences Conference (SECRET/U.S. ONLY)**	Monterey, CA	*Jun 11*	**30 Jun 11**
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**
3–10 Mar†	**2012 IEEE Aerospace Conference**,	Big Sky, Montana Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org		
23–26 Apr	**53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** **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		
4–6 Jun	**18th AIAA/CEAS Aeroacoustics Conference (33rd AIAA Aeroacoustics Conference)**	Colorado Springs, CO	*Jun 11*	**9 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
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		
19–21 Jun	**AIAA Infotech@Aerospace Conference**	Garden Grove, CA	*Jun 11*	**21 Nov 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**
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**
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 & Expostion**	Pasadena, CA	*Sep 11*	**26 Jan 12**
23–28 Sept†	**28th Congress of the International Council of the Aeronautical Sciences**	Brisbane, Australia Contact: http://www.icas2012.com		**15 Jul 11**
24–27 Sept†	**30th AIAA International Communications Satellite Systems Conference (ICSSC) and** **18th Ka and Broadband Communications, Navigation and Earth Observation Conference**	Ottawa, Ontario, Canada Contact: Frank Gargione, frankgargione3@msn.com; www.kaconf.org		
1–5 Oct	**63rd International Astronautical Congress**	Naples, Italy Contact: www. iafastro.org		

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.

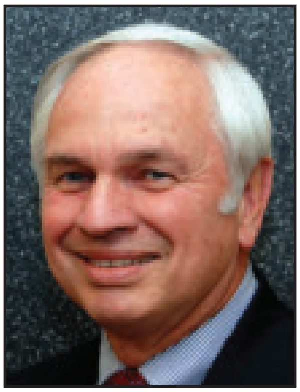
†Meetings cosponsored by AIAA. Cosponsorship forms can be found at http://www.aiaa.org/content.cfm?pageid=292.

AIAA Courses and Training Program

DATE	COURSE	VENUE	LOCATION
2011			
18–19 Sep	**Missile Design and System Engineering**	ATIO/LTA/Balloons & Weapons Conf w/Naval Aviation Forum	Virginia Beach, VA
19 Sep	**Fundamentals of Lighter-Than-Air Systems**	ATIO/LTA/Balloons & Weapons Conf w/Naval Aviation Forum	Virginia Beach, VA
25–26 Sep	**Introduction to Space Systems**	SPACE Conference	Long Beach, CA
25–26 Sep	**Systems Engineering Verification and Validation**	SPACE Conference	Long Beach, CA
25–26 Sep	**The Space Environment: Implications for Spacecraft Design**	SPACE Conference	Long Beach, CA

To receive information on courses listed above, write or call AIAA Customer Service, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344; 800.639.2422 or 703.264.7500 (outside the U.S.). Also accessible via the internet at www.aiaa.org/courses.

From the **Corner** Office



REACHING OUT OF OUR COMFORT ZONE

Several coincident, or perhaps serendipitous, recent events have made me increasingly aware that both AIAA and the entire aerospace community must really focus on outreach to the non-technical public much more than we do. Of course, we all talk about outreach quite a bit. And many in our community are already very proactive. But the net result is that all of these efforts are not having much of a noticeable impact.

A recent poll I saw indicated that almost 47% of Americans either did not think the U.S. space program generated enough benefits to justify the cost (38%) or else were unsure (9%) (*Investor's Business Daily*, July 25, 2011). To me, that's a stunning number! It's even more remarkable when the same poll had 78% of Americans believing that it was "very important" (36%) or "somewhat important" (42%) that the United States maintain its leadership in space exploration. So the public thinks leadership is important, but doesn't know what they get out of it. I think that's amazing!

Some are starting to see the handwriting on the wall. Recent focus group studies conducted by AIAA among Young Professionals and students indicated that AIAA should be more of an advocate in public policy issues and general education of the public. It appears that the next generation of aerospace professionals has realized that although our chosen profession consists of technical and engineering endeavors, we must tell (and sell) our story better and more often if we hope to maintain U.S. aerospace leadership and the concomitant funding that enables us to practice our profession. The public wants to know "What's in it for me?"

These indicators of not understanding the contributions of our aerospace endeavors are hard for those of us in the industry to understand. Consider that in early October, the Global Positioning System will be recognized by the International Astronautical Federation with a special award as the "space program having the greatest benefit to humanity" over the first 60 years of the space age. Everybody uses it—in their car, in their boats, while hiking, even walking in new neighborhoods—but most don't know its source or origins. The same thing can be said for the communications satellite constellations enabling our wired world where everybody has at least one cell phone at all times. That also holds true for the weather satellites that save countless lives by making our hurricane, tornado, and other severe weather warnings possible. And the list goes on.

AIAA is initiating some small steps to try to address these challenges in public awareness. A few years ago, we sponsored a daily radio program initiated by the National Institute of Aerospace for national broadcast on public radio. Now AIAA is initiating an interstitial distributed for unlimited broadcast to Public Television Stations nationwide with cross-promotional segments on Discovery, CNN, Fox News, CNBC, MSNBC, or equivalent networks. These are all good starts, but we must do more—much more!

Help us explore not only the universe, but also the very tough challenges of public awareness. How can we get non-technical professions to understand what we do and what's in it for them? We need to start in the schools, but not only with the students. We need to convince teachers and parents too. Then we need to continue those awareness activities throughout the public domain. All these efforts won't be effective, but some will be. The national level of exposure and the duration needed make this a daunting task, but we need to start. If you have any thoughts on what we can do to have a national reach, let us know. We are looking for ideas. Contact me at klausd@aiaa.org. Let's see if we can start an effort that will make a difference in the long run!

Lisa Bacon, who manages AIAA's STEM K–12 Programs, sent the following e-mail to the volunteers with whom she works as Atlantis *launched on her final journey. Her sentiment of thanks and inspiration is shared by many on the AIAA staff; therefore, we would like to communicate it to all our members.*

From: Lisa Bacon
Sent: Friday, July 08, 2011 12:19 PM
To: AIAA Volunteers
Subject: Thank You!

What a beautiful launch……and what a way to end 30 years. I want to thank each of you for educating and inspiring me about the wonders of space exploration. From being a little girl with my face pressed to the black and white TV, to being a theater major, I never dreamed of the big part that space exploration would play in my life so many years later. Thank you for the job that each of you do every day to press on and continue the dreams of many. Thank you for using your talents to explain the little details that mean so much and inspire others to realize that math and science are so much more than what the "book" says. Thanks for sharing a little bit of your day over the years with me…..and for helping me be that little excited girl again.

I know for some the next few weeks are bittersweet….. and one thank you doesn't quite say it all……but you are all amazing talented people and I am so happy that I wandered into the AIAA doors 15 years ago and became friends and associates with all of you!—Lisa

AWARD RECOGNIZES INTERNATIONAL COOPERATION

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

An ideal candidate for this award must have demonstrated a personal and long-term commitment to the encouragement of international cooperation among individuals and/or organizations within the worldwide aerospace community. This commitment to cooperation should be demonstrated by more than a professional assignment, and should involve unique and innovative leadership of such cooperation, and/or voluntary contributions to internationally cooperative efforts or even personal writings or speeches advocating this cause.

Nominations are encouraged from both the aeronautics and astronautics communities. The nominee does not have to be an AIAA member. To download a nomination form, please visit **http://www.aiaa.org/content.cfm?pageid=292#Honors and Awards**.

Supporting letters from appropriate individuals from countries other than that of the nominee are strongly encouraged.

Nominations for the 2012 award must be submitted to AIAA no later than **1 October 2011**. The recipient will be invited to receive the award during AIAA Aerospace Spotlight Awards Gala in May 2012. For further information, contact AIAA Honors and Awards at carols@aiaa.org.

AIAA WESTERN OFFICE CLOSES

The Western Region Activities Committee met on 4 June at the AIAA Western Office in El Segundo, CA. The office is scheduled to permanently close as of 31 August 2011. This ends 70 years of continuous Institute presence on the West Coast, beginning with the establishment of the Pacific Aeronautical Library by the Institute for Aeronautical Sciences. (Front row: Jane Hansen, Stephen Brock, Ryan Carlblom, Emily Springer, Karen Thomas; back row: Ranney Adams, John Rose, Larissa Noutong, Richard Van Allen, Corrine Cho, Charlie Vono, Eliza Sheppard, Steve Goad, Brian Holm-Hansen, Bruce Wilson; not pictured: Kirk Hively, Matthew Angiulo, Dean Miller, Scott Beatty, Steven Cerri, Karl Rein-Westin, Kimberly Castro)

AIAA HAMPTON ROADS SECTION AWARDS SCHOLARSHIPS

Paresh Parikh, Ph.D., Chair, AIAA HRS Scholarship

During its Annual Awards Banquet on 26 May 2011, the Hampton Roads Section (HRS) of AIAA awarded two $2,000 scholarships to two outstanding graduating high school seniors. The AIAA HRS “Futures in Aerospace” scholarship program is funded through a fully endowed scholarship fund and from proceeds from a yearly golf tournament. Beginning with a single scholarship award of $1,000 in 1985, to date 54 awards have been made totaling $84,850. The scholarship is open to graduating seniors from all high schools located in the area served by the Hampton Roads Section, who plan to pursue undergraduate studies in the field of engineering, physical, or applied sciences.

This year the committee received 21 applications. The qualifications and academic and extracurricular achievements of the applicant pool were spectacular. The average weighted GPA of the top five applicants was 4.5 and an average SAT score of 2100 out of the possible 2400.

Katelyn Fariss receiving the certificate from Dr. Chris Rumsey, Chair of the Hampton Roads Section, and Dr. Paresh Parikh, Chair of the Scholarship Committee. The other winner (not shown) was Eric Swenson.

The two winners were Eric Swenson from Tabb High School, Yorktown, VA, and Katelyn Fariss from Norfolk Christian School, Norfolk, VA. In addition to the scholarship check, the winners each received a certificate, and their names were added to a plaque that is on permanent display at NASA Langley Research Center.

AIAA’s Aerodynamic Decelerator Technical Committee with Edwin Vickery (2nd from left)—2011 recipient of the Theodor Knacke Aerodynamic Decelerator Award at the 2011 Conference in Dublin, Ireland.

MEMBERSHIP ANNIVERSARIES

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

40-Year Anniversaries

Kumar Bhatia	Pacific Northwest
John Brizendine	Orange County
Brian Cantwell	San Francisco
Raymond Colladay	Rocky Mountain
William Colley	Tennessee
Vincenzo Conticelli	Italy
Jonathan Coopersmith	Houston
Roy Cox	North Texas
Mark Craig	Houston
Willy Crans	San Fernando Pacific
Peter Curran	Hampton Roads
Raymond Curts	National Capital
Donald Daniel	Tennessee
Gerry Daugherty	Dayton/Cincinnati
Robert Davey	Orange County
Jay DeJongh	Dayton/Cincinnati
Peter Downes, Jr.	Arrowhead
Rodney Dreisbach	Pacific Northwest
Tadeusz Drzewiecki	Northwest Florida
Robert Duerr	Cape Canaveral
Howard Eisner	National Capital
Charles Ernst	Mid-Atlantic
Richard Fling	Los Angeles
John Fosness	Columbus
Roger Foster	Twin Cities
Michael Francis	San Diego
Peretz Friedmann	Michigan
Alon Gany	Israel
Robert Gardner	Wichita
Larry Godby	San Fernando Pacific
Gustav Goetsch, Jr.	St. Louis
William Goldberg	Alabama/Mississippi
Marvin Goldstein	Northern Ohio
Armand Gosselin	Central Florida
William Griffin	Los Angeles
Anthony Gross	San Francisco
Donald Hagen	New England
David Hall	Vandenberg
Wayne Hamilton	San Diego
Jack Heberlig	Carolina
Preston Henne	Savannah
Thomas Honeycheck	Houston
John Horine	Wichita
Larry Howell	Michigan
Frank Hughes	Houston
Ned James	
Susan Johnson	Northern Ohio
J. Jost	Orange County
Robert Kalny	Long Island
James Karam, Jr.	Central Florida
Clarence Kitchens, Jr.	National Capital
John Klineberg	San Francisco
Gerhard Kriechbaum	Germany
James Kruse	Tucson
Terrel Kuhn	Phoenix
Donald Kunz	Dayton/Cincinnati
Kyoichi Kuriki	Japan
Frederick Kuster	Southern New Jersey
Jaynarayan Lala	National Capital
Michael Landy	Pacific Northwest
Russell Lenz	Cape Canaveral
David Lilley	Oklahoma
Carlos Lopez	Central Florida
Thomas Loucks	
James Luckring	Hampton Roads
Michael Mackowski	Phoenix
Lucio Maestrello	Cape Canaveral
Frithjof Mastrup	Los Angeles
Thomas Matoi	Pacific Northwest
William Maxwell	Indiana
Robert Mc Fall	Wichita
Ajax Melo	Brazil
Miroslav Mokry	Canada
John Montgomery	Orange County
Charles Nardo	Vandenberg
John Niles	Northern New Jersey
Ronald Nishinaga	Los Angeles
Colin Osborne	New England
David Ostrodka	Wichita
Avery Owen, III	Central Florida
Larry Pinson	Hampton Roads
Scott Pitcher	Palm Beach
David Poland	Los Angeles
Jeffry Purse	Connecticut
Herbert Rabin	National Capital
William Ragsdale	Hampton Roads
James Raisbeck	Pacific Northwest
Edward Rice	Northern Ohio
Tommy Rickords	San Fernando Pacific
John Rivers	Houston
Jeffrey Rubin	Cape Canaveral
Edward Ruth	San Gabriel Valley
Lester Sackett	New England
Oddvar Sangesland	Pacific Northwest
Kent Schreyer	North Texas
David Secomb	Australia
Frederic Smalley	St. Louis
Carolyn Smith	New England
Henry Snodgrass	Cape Canaveral
Darrell Stamper	Houston
James Stassinos	San Fernando Pacific
Demetri Telionis	Hampton Roads
Gary Thompson	Phoenix
Richard Traverse	Palm Beach
Philip Turner	Albuquerque
Frank Vigneron	Canada
Roger Wagner	Los Angeles
Terry Weisshaar	Indiana
James Wilson	Dayton/Cincinnati
George Wright, Jr.	Albuquerque
Kevin Yelmgren	National Capital
Mohamad Yousef	San Francisco

Philip Morris (left) of The Pennsylvania State University receives an AIAA Sustained Service Award to recognize more than 30 years of service to AIAA. With Morris is K. Viswanathan (right).

OBITUARIES

AIAA Fellow Edwards Died in June

John W. Edwards, an internationally respected NASA aeronautics engineer, passed away on June 3, 2011. He was 71 years old.

Dr. Edwards graduated from Yale University in 1961, and held a Ph.D., in aeronautics and astronautics from Stanford University. He served in the Peace Corps in Ethiopia as a physics teacher from 1963 to 1965. In 1965, he began work for NASA, in aircraft flight control systems, at Dryden Flight Research Center. In 1980, he transferred to NASA Langley Research Center in Hampton, where he was a senior research engineer in the Aeroelasticity Branch. After retiring in 2007 from NASA, he continued his research there as a Distinguished Researcher, Emeritus. He was recognized as an international authority in the fields of flight control systems analysis and design, and aeroelastic analysis and testing. His career achievements included more than 80 technical publications, and solving critical problems in programs ranging from the B-2 bomber to the Space Shuttle.

His unique expertise played a significant role in the Space Shuttle program. He designed a digital filter to quench pilot-induced oscillations upon landing, which has been active on all orbital missions of the Space Shuttle and for which he received a patent and several awards. After the loss of the Space Shuttle *Columbia*, he led a team in testing and analysis of the foam ramps on the external tanks, which contributed to decisions that allowed the Shuttle return to flight.

AIAA Fellow Widmer Died in June

Robert H. Widmer died on 20 June, at the age of 95. He led the design and development of major aircraft such as the F-111 “Aardvark” and the F-16 “Fighting Falcon,” as well as the Tomahawk cruise missile.

Attending Rensselaer Polytechnic Institute, he built a small racing biplane as his thesis project and was named the outstanding aeronautical engineer in his class. Mr. Widmer also earned a master’s degree at the California Institute of Technology.

Working for Convair, he honed the wing of the B-24 “Liberator,” the most-produced American military aircraft. Mr. Widmer also presided over wind-tunnel tests for the B-36, which became the Air Force’s largest bomber ever. Convair won the contract for the B-58 bomber with Mr. Widmer’s design. He named the plane the Hustler. Able to fly as high as 15 miles and at a speed twice the speed of sound, it carried some of the most sophisticated military systems yet developed. The Russians had nothing that came close.

Mr. Widmer later defied his bosses by secretly pushing ahead on the F-16, a lightweight fighter, even though there seemed to be no market for it. When the Pentagon decided it wanted such a fighter, the company, now General Dynamics, was ready. With the success of the F-16, Mr. Widmer was promoted to vice president for science and engineering for all of General Dynamics. Among his later projects was the Tomahawk cruise missile, which was used extensively in the Persian Gulf War and the Iraq war, and a more fuel-efficient engine for automobiles that carmakers declined to buy.

In 1962, Mr. Widmer was awarded the Spirit of St. Louis Medal by the American Society of Mechanical Engineers for his work in aeronautics. He was honored by AIAA in 1983 when he was presented with the Reed Aeronautics Award for having pioneered “the eras of supersonic cruise and fly-by-wire computerized flight control.”

CALL FOR NOMINATIONS

Nominations are now being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 October**. A nomination form can be downloaded from **www.aiaa.org**, or AIAA members may submit nominations online after logging in with their user name and password.

Premier Awards & Lectureships

Distinguished Service Award gives unique recognition to an individual member of AIAA who has distinguished himself or herself over a period of years by service to the Institute. (Current national officers and directors are ineligible for this award.)

Goddard Astronautics Award is the highest honor AIAA bestows for notable achievement in the field of astronautics.

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

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

Reed Aeronautics Award is the highest award an individual can receive for achievements in the field of aeronautical science and engineering.

Dryden Lectureship in Research emphasizes the great importance of basic research to the advancement in aeronautics and astronautics and is a salute to research scientists and engineers.

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

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

Wright Brothers Lectureship in Aeronautics emphasizes significant advances in aeronautics by recognizing major leaders and contributors.

Technical Excellence Awards

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

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

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

Aerospace Communications Award is presented for an outstanding contribution in the field of aerospace communications.

Aerospace Design Engineering Award recognizes design engineers who have made outstanding technical, educational, or creative achievements.

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

Air Breathing Propulsion Award is presented for meritorious accomplishment in the science of air breathing propulsion, including turbomachinery or any other technical approach dependent on atmospheric air to develop thrust, or other aerodynamic forces for propulsion, or other purposes for aircraft or other vehicles in the atmosphere or on land or sea.

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

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

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

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

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

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

Jeffries Aerospace Medicine & Life Sciences Research Award is presented for outstanding research accomplishments in aerospace medicine and space life sciences.

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

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

Propellants and Combustion Award recognizes outstanding technical contributions to aeronautical or astronautical combustion engineering.

Jay Hollingsworth Speas Airport Award is presented to the person(s) who have contributed outstandingly during the recent past toward achieving compatible relationships between airports and/or heliports and adjacent environments. The award consists of a certificate and a $10,000 honorarium.

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

Survivability Award is presented to recognize outstanding achievement or contribution in design, analysis implementation, and/or education of survivability in an aerospace system.

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

Wyld Propulsion Award recognizes outstanding achievement in the development or application of rocket propulsion systems.

Service Award

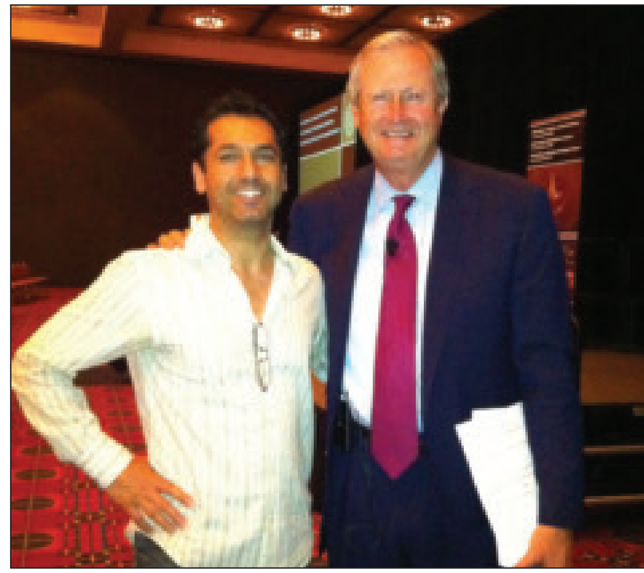
Sustained Service Award recognizes sustained, significant service and contributions to AIAA by members of the Institute. A maximum of 20 awards are presented each year.

Answers to frequently asked questions or guidelines on submitting nominations for AIAA awards may be found at **http://www.aiaa.org/content.cfm?pageid=289**. For more information on AIAA's awards program, contact Carol Stewart, Manager, AIAA Honors and Awards, at 703.264.7623 or at carols@aiaa.org.

CALL FOR PAPERS
ICNPAA 2012 World Congress: Mathematical Problems in Engineering, Sciences and Aerospace
Vienna, Austria, 11–14 July 2012

On behalf of the International Organizing Committee, it gives us great pleasure to invite you to the ICNPAA 2012 World Congress: 9th International Conference on Mathematical Problems in Engineering, Aerospace and Sciences, which will be held at Vienna University of Technology, Vienna, Austria. This is an AIAA and IFIP cosponsored event.

Please visit the Web site: **www.icnpaa.com** for all details.



Jim Albaugh, executive vice president of The Boeing Company and president and chief executive officer of Boeing Commercial Airplanes, spoke with attendees, including Dr. Ramin Eshaghi, AIAA Senior Member, after his plenary address at the AIAA Modeling and Simulation Technologies Conference on 9 August in Portland, OR. He praised attendees for all that modeling and simulation has enabled the aerospace industry to achieve.

New and Forthcoming Titles

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, and 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

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

Encyclopedia of Aerospace Engineering: 9-Volume Set
Richard Blockley and Wei Shyy, University of Michigan
2010, 5500 pages, Hardback
ISBN-13: 978-0-470-75440-5
AIAA Member Price: $3,375
List Price: $3,750

View complete descriptions and order 24 hours a day at www.aiaa.org/new

AIAA SPACE 2012 Conference & Exposition

11–13 September 2012
Pasadena Convention Center
Pasadena, California

Abstract Deadline: 26 January 2012
Final Manuscript Deadline: 21 August 2012

Event Overview

The AIAA SPACE 200X Conference is AIAA's premier event on space technology, policy, programs, management, and education. Nowhere else will you get the depth and breadth of sessions and information-sharing on space systems and technology. At this three-day event, attendees can expect discussion with government and industry leadership in plenary panel and keynote sessions; interactive exhibits, demonstrations, presentations, and poster sessions in the exposition hall; networking activities for all participants, including students and young professionals; and fun and unique learning opportunities in the capstone events, AIAA Education Alley and the William H. Pickering Lecture. Participation at the 2012 event is beneficial for industry executives, government and military officials, program managers, business developers, engineers and scientists, government affairs staff, consultants, professors, and students.

Technical Topics

The conference organizers welcome the submittal of abstracts on all aspects of space systems and technologies. The program is structured around 14 technical tracks:

1) Commercial Space
2) Intelligent Systems (AIAA ISTC)
3) National Security Space
4) Robotic Technology and Space Architecture (AIAA SARTC and AIAA SATC)
5) Space and Earth Science
6) Space Colonization and Space Tethers (AIAA SCTC and AIAA STETC)
7) Space Exploration
8) Space History, Society, and Policy (AIAA HISTC, AIAA SATTC, AIAA LA3TC, and AIAA IAC)
9) Space Logistics and Supportability (AIAA SLTC)
10) Space Operations (AIAA SOSTC)
11) Space Resources (AIAA SRETC)
12) Space Systems and Sensors (AIAA SSTC and AIAA SENTC)
13) Space Systems Engineering and Economics (AIAA SETC and AIAA ECOTC)
14) Space Transportation and Launch Systems (AIAA STTC and AIAA RLVPC)

Track Descriptions

Commercial Space

The established community of commercial space companies tracing their lineage to the mid-1960s is being joined by an emerging new group of entrepreneurs. The newer companies (called NewSpace) have characteristics very different from their predecessors, and partnerships between the old and the new are developing. The Commercial Space track is soliciting papers that document the various aspects of emerging commercial space sectors and their collaboration with the established commercial space community. Discussions of NewSpace successes and challenges encompass a large number of topic areas, including:

- Suborbital and orbital transportation and tourism
- Orbital commercial facilities, propellant depots, and infrastructure
- Orbital transfer vehicles
- Microgravity commerce and research
- Commercial lunar and NEO
- National space policy
- Legal and regulatory
- International markets and cooperation
- Business and financing

For questions, please contact:

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Bruce Pittman
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Intelligent Systems

Papers are sought on applications of Intelligent Systems across the spacecraft development and operations lifecycle. Topics of interest include, but are not limited to:

- Autonomous payloads
- Autonomous telemetry monitoring systems
- Data fusion and reasoning
- Decision support systems
- Human-machine interaction
- Integrated System Health Management and Intelligent Fault Management systems
- Intelligent and adaptive control
- Intelligent data/image processing
- Knowledge-based systems and knowledge engineering
- Machine learning
- Planning and scheduling algorithms
- Robust execution and sequencing systems

For questions, please contact:

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Intelligent Systems Technical Committee
The Aerospace Corporation
E-mail: christopher.r.tschan@aero.org

National Security Space

The National Security Space track invites papers in the following areas:

- Advanced concepts: Including advanced CONOPS, material solutions, and architectural solutions
- Technology transition: Including updates on existing programs working on technology transition from any partner toward the NSS customer
- Enterprise architecting analysis: Including requirements analysis, military utility analysis, multi-mission analysis and one-on-one engagement analysis, acquisition simulation analysis, and procurement
- Emerging trends: Including descriptions of the latest trends affecting the MIL space applications and development
- Prototypes and demonstrations: Including updates on existing prototypes in the NSS pipeline

Co-Chaired by
NASA Jet Propulsion Laboratory — U.S. Air Force Space and Missile Systems Center

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Technical Program Co-Chaired by
AIAA Technical Activities Committee (TAC) Space & Missiles Group
The Aerospace Corporation

Executive Chairs

Charles Elachi
Director
NASA Jet Propulsion Laboratory

Lt Gen Ellen M. Pawlikowski, USAF
Commander
U.S. Air Force Space and Missile Systems Center

Technical Program Chairs

Jeffrey R. Laube
Northrop Grumman Aerospace Systems
Northrop Grumman Corporation

Michelle Permann
The Aerospace Corporation

Program Committee

Col. Scott W. Beidleman
U.S. Air Force Space and Missile Systems Center

Joseph Betser
The Aerospace Corporation

Roberta Ewart
U.S. Air Force Space and Missile Systems Center

Randy Kendall
The Aerospace Corporation

Virendra Sarohia
NASA Jet Propulsion Laboratory

Trevor Sorensen
University of Hawaii at Manoa
AIAA TAC Space & Missiles Group Director

- Science and technology efforts: Including those aimed at key science and technologies for revolutionary MIL applications

For questions, please contact:

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Kary Miller
U.S. Air Force Space and Missile Systems Center
E-mail: kary.miller.ctr@losangeles.af.mil

Robotic Technologies and Space Architecture

This track will explore robotic technologies for orbital and planetary surface applications and space architectures, including systems supporting robotic construction techniques. Abstracts are being solicited on the following technical topics:

- Advanced technologies for space robotics
- Unique applications of space robotics
- Self-sustaining/self-repairing systems
- Robotic EVA or IVA servicing
- Robot and spacecraft automation
- Crew cabin architecture
- Orbital and planetary surface construction
- Unique space architecture design

For questions, please contact:

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Steven E. Fredrickson
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Space and Earth Science

Sessions for the Space and Earth Science track are by invitation only. If interested in participating, please contact:

Virendra Sarohia
NASA Jet Propulsion Laboratory
E-mail: virendra.sarohia@jpl.nasa.gov

Space Colonization and Space Tethers

The goal of space colonization is to create permanent human settlements beyond Earth. A logical implementation approach to would be to develop outposts and colonies in key locations in space (e.g., Lagrange points) and on the moon, near-Earth asteroids, and Mars, as technological advances enable progressively more ambitious missions. The Apollo missions demonstrated that humans can land on and explore other bodies in our solar system. The Shuttle and ISS missions demonstrate that humans can live and work in LEO for extended periods of time. Humanity is ready for exciting and challenging exploration missions beyond LEO that will open the door for future expansion into the solar system. The development of advanced science and technologies needed for space settlements will help humanity improve life on Earth and shape a better future. Space tethers show great promise for enabling a variety of future space missions, both as engineering components and as scientific components. Applications of space tethers include propulsion, space structures, remote sensing, and artificial gravity, among others. To date, several tethered missions have flown and many more have been proposed for flight. This track will include missions enabled and the technologies necessary for exploiting the use of space tethers. Papers are invited that address the following topics related to space colonization:

- Drivers: Desires for exploration, commerce, tourism, and adventure
- Destinations: Space, the moon, asteroids, and Mars, including missions
- Challenges: Environment, distance, isolation, logistics, and financing
- Designs: Concepts for robotic and human vehicles, outposts, and colonies
- Exploitation: Mining, utilization of in-situ resources, and terraforming
- Enablers: Needed research and development of key technologies
- Space law: Claims, property rights, extraction of resources, and commerce.

Papers are invited that address the following topics related to space tethers:

- Theory: Physics, kinematics, dynamics, and material requirements
- Applications: Advantages gained by using space tethers
- Missions: Unique missions enabled by space tethers
- Enablers: Needed research and development of key technologies

For questions, please contact:

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Sven G. Bilén
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The Pennsylvania State University
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Space Exploration

The Space Exploration track spans mission architectures, advanced technologies, and flight systems to enable robotic precursor and human exploration missions to the moon, Lagrange points, Near Earth Objects (NEOs), and Mars and its moons. Abstracts are being solicited on the following topics:

- Mission architectures: Studies, systems analysis, and operational scenarios for human exploration missions beyond Earth orbit
- Enabling technologies: The development of critical technologies to enable human exploration missions, including advanced propulsion; cryogenic propellant storage and transfer; high-efficiency space power systems; life support and habitation systems; radiation shielding; entry, descent, and landing technology; EVA technology; advanced robotics; autonomous systems and avionics; high-data rate communications; in-situ resource utilization; and lightweight structures and materials
- Robotic precursor missions: Mission concepts and plans for robotic precursor missions to characterize space environments and scout potential destinations for future human activity
- Flight systems: Flight experiments to demonstrate critical capabilities, and development of crew exploration vehicles and in-space transportation systems
- Using ISS for exploration: Using ISS as an analog for long-duration missions, and as a test bed for demonstrating technologies and operational concepts for exploration

For questions, please contact:

Chris Moore
Space Exploration Program Committee
NASA Headquarters
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Space History, Society, and Policy

The Space History, Society, and Policy track examines the history of our time in space, space law and policy, international cooperation, the societal impacts of aerospace technologies and an educated and trained workforce, and the evolution of our spacefaring society. Topics addressed include:

- History of aerospace—Legacy and lessons learned: Collection, preservation, and analysis of historical materials related to spaceflight and space technology, manned space programs, launch systems, unmanned programs—with an emphasis on understanding the significance of people and organizations, programs, facilities, and infrastructure
- Space law and policy: Current and emerging policy and legal issues affecting space acquisition, operations, sustainment, and the future of space activities; national space policies of the United States, other countries, and the United Nations; the U.S. National Space Strategy; liabilities and legal obligations associated with space debris and end-of-life and orbital operations; space warfare; insurance, contracting, and liability issues; jamming threats and telecommunications regulation, and legal institutions
- International cooperation: Risks and opportunities of cooperative engagement; recognizing and surmounting legal impediments to cooperation, including ITAR and technology transfer control regimes; successful and unsuccessful international approaches to acquiring, organizing, operating, and sustaining space systems; international institutions
- Space science, technology, engineering, and mathematics (STEM) perspectives: Shortfalls in the space workforce's STEM education and training and their impact; and policy, programmatic, and economic solutions to education and workforce shortfalls
- Spinoffs and technology transfer: Space technologies and discoveries transferred or commercialized outside of the industry; policies enabling technology transfer and technology transfer lessons learned; analyses of the societal impacts of space technology spinoffs
- Interactions with society: Impact of space systems on communication, trade, and access to information; the impact of space systems and technology on global emergency response to

disasters or acts of terrorism; space stakeholder risk tolerance and perceptions; analyses of the intangible benefits of spaceflight and of space themes in media and literature
- Astrosociology: Social, cultural, psychological, ethical dimensions, and the institutional responses associated with space medicine and isolated long-duration space missions; psychological, sociological, and anthropological perspectives on space-based natural disasters

In addition, this track will host a Best Student Paper Competition. Submitted and accepted papers by student authors will be presented within a session of the Space History, Society, and Policy track. Papers will be judged based on merit with the winning paper(s) receiving a certificate and a monetary award. For further information, including the complete rules and guidelines of the competition, please visit the SATTC Web site at **https://info.aiaa.org/tac/ETMG/SATTC**, or contact the competition administrator, Brad Steinfeldt, at bsteinfeldt@gatech.edu.

For general track questions, please contact:

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AIAA International Activities Committee
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Brad Steinfeldt
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Space Logistics and Supportability

Space Logistics is the theory and practice of driving space system design for operability, and of managing the flow of materiel, services, and information needed throughout a space system lifecycle. It includes management of the logistics supply chain from Earth and on to destinations throughout the solar system. Supportability considers system architecture strategies to minimize both logistics requirements and operational costs of human and robotic operations. Supportability strategies include processes and technologies to minimize maintenance complexity, exploit in-situ resources, scavenge and reuse flight hardware, and recycle consumables. Representative areas include the servicing and sustainment of the International Space Station, lunar and planetary outposts, the optimization of logistics launch vehicles for responsiveness and serviceability, and modeling of the supply chain in space for human and robotic mission campaigns. Technical topics include:

- International Space Station on-orbit resources management
- In-space spacecraft and satellite servicing
- Advanced supportability concepts: In-situ repair, in-situ fabrication, flight hardware scavenging and reuse, resource prepositioning, consumables recycling
- Advanced destination logistics: Outpost management and provisioning, in-situ resource logistics, EVA logistics
- Advanced space logistics infrastructures: Solar power stations; on-orbit fuel depots; refueling in space, planetary, or asteroid resource infrastructures
- Logistics of NASA, DoD, and commercial programs: Space operations affordability, design for commonality, integrated logistics concepts
- Space logistics campaign planning: methods, modeling, simulation, and cost analysis tools
- Automated spaceflight supply chain asset tracking and monitoring
- Spaceport ground processing and launch logistics
- Commercial space logistics opportunities

For questions, please contact:

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Leif Anderson
AIAA Space Logistics Technical Committee (SLTC)
The Boeing Company
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Space Operations

This track is calling for papers in a number of areas that are key to the success of spacecraft and launch systems, with an emphasis on the operational aspect. Technical topics include:

- Space operations in the 21st century
- Space operations automation and reducing cost of operations
- Future human and robotics space exploration operations
- Mission operations assurance
- Responsive space operations
- Human factors in space operations
- Advanced technologies for space operations
- Network-centric space operations
- Space operations policy
- Improving space operations (Panel)
- Spaceport operations (Panel)
- Future satellite operations (Panel)

For questions, please contact:

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MorganFranklin Corporation
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Space Resources

Utilization of the natural resources found in space offers a uniquely sustainable approach to human exploration. By leveraging available materials on planetary bodies, the constraining supply chain can be broken. The Space Resources track will examine alternatives to the classic resupply challenge by providing many of the needed commodities for human sustainment using locally available resources. The current focus on developing technology for multiple exploration destinations has renewed interest in Mars in-situ resource utilization and sparked new interest in prospecting and utilizing resources on near-Earth objects. Papers are solicited on all aspects of the resource utilization cycle, from prospecting and precursor missions through production, storage, and delivery. Technical topics include:

- Resource prospecting and precursor missions
- Resource collection and transport
- Lunar resource utilization technologies
- ISRU for Mars and beyond
- ISRU for fabrication and repair
- ISRU hardware demonstrations

For questions, please contact:

Leslie Gertsch
AIAA Space Resources Technical Committee (SRETC)
Missouri University of Science and Technology
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Space Systems and Sensors

The Space Systems and Sensors track seeks to present important findings from recent work on emerging space systems, space science, and sensor technologies. In particular, papers are sought that address technical, operational, and economic feasibility of current and future space systems that address the full range of civil, military, and international applications. Papers by students are especially encouraged. Technical topics include:

- Architectures and concepts of operation
- New and emerging technologies and applications
- Remote sensing for climate and weather
- Space and planetary science missions and technologies
- Rapid and responsive space systems
- Enabling technologies for distributed or fractionated space
- Proximity sensing of space objects and orbital space situational awareness (SSA)
- Space sensor technologies
- Laser communication
- Cubesats
- Workforce development for space systems and sensors engineering (Panel)
- Space systems lessons learned (Panel)

For questions, please contact:

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Space Systems Engineering and Space Economics

The role of systems engineering in space programs has become more important as systems have become increasingly complex, architectures have become expansive, and integration across architectures has become commonplace and essential. As the utilization of space increases, driven by technological advances and mission need, the cost and economics of space will remain a formidable challenge. These challenges can be met by analyzing data and developing models to clarify the best value and key economic insights for decision makers. A goal of the systems engineering and space economics community is to develop and apply capabilities to facilitate robust future space systems. Aspects of systems engineering and space economics that may be included in this track are:

- Definition and application of space system architectures
- Advances in systems engineering processes and tools applied to space systems
- Systems engineering lessons learned from current and previous space programs
- Space systems requirements generation, verification, and validation
- Space systems integration and associated tests
- Systems engineering for autonomous space systems
- Space systems risk management
- Evaluating and balancing space systems cost, performance, schedule, and risk
- Space workforce development and industrial base challenges
- New developments in economic analysis and cost models
- Examples of trade studies incorporating economic analysis, affordability, or value engineering
- Space systems engineering efficiencies in a constrained budget environment

For questions, please contact:

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Jairus M. Hihn
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Space Transportation and Launch Systems

The success of all space endeavors—military, scientific, exploration, and commercial—depends upon low-cost, highly reliable access to space. Since the retirement of the Space Shuttle, current worldwide space deployments are achieved through expendable launch vehicles (ELVs). New emerging space companies have offered the promise of low-cost space access, and some of them are proceeding with development and testing efforts. NASA's Commercial Orbital Transportation Services Demonstration Program is designed to demonstrate low-cost, reliable commercial cargo delivery, and potentially crew delivery, to the International Space Station (ISS). NASA has contracted for ISS Commercial Resupply Services for resupply and return of ISS cargo. NASA's human exploration program promises to continue the U.S. civilian human spaceflight effort by developing and operating new vehicle systems for human exploration of the solar system and continuing missions to the ISS. Within the U.S. DoD, RLV activity is gaining momentum with the Air Force's pursuit of a Reusable Booster System (RBS) as seen with the release of the broad agency announcement for the Reusable Booster System Flight and Ground Experiments program. Papers are invited that address the issues and challenges associated with space transportation. Papers may be submitted within, but are not limited to, the following categories:

- Space transportation system, technology, design, and integration challenges
- In-space transportation systems and architectures, including propellant depots
- Advanced concept vehicles and systems
- Launch vehicles
- Designs, concepts, and developments (ELVs, RLVs, or partially reusable LVs)
- RLV development, programmatic (including economics), and industry-related strategies
- Lessons learned from previous RLV-related programs and design studies
- Operationally responsive space
- Operations of spaceports and ranges
- Space transportation for space tourism
- Space transportation analytical tools, materials, and technologies
- Suborbital vehicles and systems

For questions, please contact:

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E-mail: adam.f.dissel@lmco.com

Proposals for Special Sessions

Individuals who wish to organize special sessions embedded within the technical program (e.g., invited oral presentations, panels, or demonstrations) should submit a short proposal describing the nature of the session as it relates to a specified technical track. Be sure to include the names of the organizers and participants. Please e-mail your proposal by **17 January 2012** to Jeffrey R. Laube, AIAA SPACE 2012 Technical Chair, at laube.jeff@gmail.com. Please do not upload an abstract for the proposal.

Abstract Submittal Procedures

Abstract submissions will be accepted electronically through the AIAA Web site at **www.aiaa.org/events/space**. Once you have entered the conference Web site, on the right-hand side, click "Submit a Paper" and follow the instructions listed on the screen to follow. This Web site will be open for abstract submittal starting **3 October 2011**. The deadline for receipt of draft manuscripts and abstracts via electronic submission is **26 January 2012**. Authors will be notified of paper acceptance via e-mail by **10 April 2012**. Please note: Abstracts meeting the high standards for inclusion in the conference technical program may be assigned to either poster or podium sessions. Poster presenters will have the opportunity to present their work in two separate poster sessions, while podium presenters will have the opportunity to present in a single technical session.

All final manuscripts will be published in the conference proceedings if uploaded by the final manuscript deadline. An Author's Kit, containing detailed instructions and guidelines for submitting papers to AIAA, will be made available to authors of accepted papers. Authors of accepted papers must provide a complete manuscript online to AIAA by **21 August 2012** for inclusion in the online proceedings and for the right to present at the conference.

The electronic submission process is as follows:

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

STEP 1: Type or paste the title of your abstract into the Title field and the presenting author's biography (if requested by the conference) into the Presenter Biography field. Upload your abstract file. Accepted file types are .pdf (preferred), .doc, and .docx. Scroll down to read through the Rules and Reminders section and check the box noting you agree. Click "Save & Continue" to proceed to the next step.

STEP 2: Select your Presentation Type, and the Topic Area, of your abstract. Click "Save & Continue" to proceed to the next step.

STEP 3: In this system, affiliations are added before author information. The information will be filled in for the person logged in to the site. Add additional author affiliations, if necessary, by clicking the "Add" button after each new affiliation. Click "Save & Continue" to proceed to the next step.

STEP 4: To create a list of co-authors for this submission, click the "Add Author" button and enter the required information. Click "Save" after entering each one and then associate each author with their respective affiliation by entering the appropriate reference number from the drop-down boxes to the right of each name. When you have finished entering all authors ***YOU MUST*** put them in the order they should appear on the abstract and program. Use the drop-down boxes in the far left column of the list to do this. Failure to order the authors properly will result in them being incorrectly listed when the submission is published. After you have reordered the authors, click the "Save" button at the bottom of the list. Click "Save & Continue" to proceed to the next step.

STEP 5: Select at least one technical area that best represents your work. While only one selection is required, you may list up to six for your submission. Click "Save & Continue" to proceed to the next step.

STEP 6: If you have no errors or omissions in your abstract, a "Submit" button will appear at the end of the proof. If the Error Box appears, you must correct all errors before the abstract can be submitted. Once the errors have been resolved the "Submit" button will appear at the bottom. If you exit the system without submitting the abstract, it will be logged in the system as a draft and will appear in the "Draft" section of your "View Submissions" page when you reenter the system. After you submit the abstract, you will receive a confirmation e-mail.

Special Notes

1) If authors wish to revise an abstract that has already been submitted, they must go to "View Submissions" and select "Return to Draft" to make any corrections. This removes the abstract from the organizers' view. Authors then need to submit the abstract again for it to be considered. An abstract cannot be returned to draft if it has been reviewed.

2) Once the abstract submission deadline passes, authors will no longer be able to submit new submissions or return previous submissions to draft for revisions. Be sure that all of your submission data—authors, keywords, title, and abstract file—are accurate before finalizing your submission as no modifications can be made to this data after the submission site closes.

Authors having trouble submitting abstracts electronically should contact ScholarOne Technical Support at **ts.acsupport@thomson.com**, or at 434.964.4100 or (toll-free, U.S. only) 888.503.1050. Questions about the manual abstract submission or full draft manuscript themselves should be referred to the appropriate Track Chair.

"No Paper, No Podium" and "No Podium, No Paper" Policies

If a written paper is not submitted by the final manuscript deadline, authors will not be permitted to present the paper at the conference. It is the responsibility of those authors whose papers or presentations are accepted to ensure that a representative attends the conference to present the paper. If a paper is not presented at the conference, it will be withdrawn from the conference proceedings. These policies are intended to eliminate no-shows and to improve the quality of the conference for attendees.

Publication Policy

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

Please note: AIAA policy precludes an abstract or paper from being submitted multiple times to the same conference. Also, once a paper has been published, by AIAA or another organization, AIAA will not republish the paper. Papers being submitted to the Student Paper Competition being held in conjunction with this conference may not be submitted to the general sessions. Author(s) must choose to submit to the Student Paper Competition **OR** to the conference. If your paper is selected for competition, it will be published along with the conference proceedings.

Warning—Technology Transfer Considerations

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

International Traffic in Arms Regulations (ITAR)

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

Exposition

AIAA SPACE 2012 is AIAA's premier conference on space technologies, systems, programs, and policy. Exhibit space is available to showcase your company's products and services before an audience of aerospace decision makers and practitioners. To reserve your booth space now, please contact Fernanda Swan, AIAA Exhibit Sales Manager, phone: 703.264.7622; cell: 703.835.5798; e-mail: fernandas@aiaa.org.

Sponsorship Opportunities

Raise the profile of your company by becoming a prominent industry sponsor of AIAA SPACE 2012. A variety of sponsorship opportunities are available to achieve your overall branding objectives. For information regarding AIAA SPACE 2012 sponsorship, please contact Cecilia Capece, AIAA Sponsorship Program Manager, phone: 703.264.7570; e-mail: ceciliac@aiaa.org.

Upcoming AIAA Professional Development Courses

18–19 September 2011
Free Conference Registration to the 11th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, including the AIAA Balloon Systems Conference and 19th AIAA Lighter-Than-Air Technology Conference in Virginia Beach, Virginia, when you sign up for the two-day Course!

Missile Design and System Engineering (Instructor: Eugene L. Fleeman)

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

19 September Only: Fundamentals Of Lighter-Than-Air Systems (Instructors: Rakesh Kapania, Ron Hochstetler, Brandon Buerge, and Rajkumar S Pant)

Lighter-Than-Air (LTA) systems belong to a class of aerospace systems that get most of their lifting capability from “static” lift using gases that are lighter than air, unlike heavie-than-air systems that derive lift because of their relative motion with ambient air. Airships and Aerostats are the most commonly used LTA systems. In essence, a large fraction of the energy expended by conventional aerospace systems is used to overcome gravity, while most of the energy used by an airship is used to propel it forward.

LTA systems are gaining attention all over the globe because of widespread concerns about climate change, the effects of economic and political turmoil on the price of petroleum, and the need for security organizations to maintain cost-effective persistent surveillance. This course is aimed at people who are interested to update themselves with the current developments and future trends in design, development, operations, and applications of Lighter-Than-Air Systems.

25–26 September 2011
Free Conference Registration to the AIAA SPACE 2011 Conference & Exposition in Long Beach, California, when you sign up for a two-day Course!

Introduction to Space Systems (Instructor: Mike Gruntman)

This two-day course provides an introduction to the concepts and technologies of modern space systems. Space systems combine engineering, science, and external phenomena. We concentrate on scientific and engineering foundations of spacecraft systems and interactions among various subsystems. These fundamentals of subsystem technologies provide an indispensable basis for system engineering. This introductory course is designed for engineers and managers—of diverse background and varying levels of experience—who are involved in planning, designing, building, launching, and operating space systems and spacecraft subsystems and components.

Systems Engineering Verification and Validation (Instructor: John C. Hsu)

This course will focus on the verification and validation aspects that are at the beginning, from the validation point-of-view, to the final verification of the systems engineering process for a program/project. It will clarify the confusing use of verification and validation. This course will be of interest to researchers, engineers, program/project managers, software engineers, and other professionals that involve in verification and validation work, especially for complex system.

The Space Environment: Implications for Spacecraft Design (Instructor: Alan C. Tribble)

This course is designed to provide an introduction to the subject of spacecraft-environment interactions, also known as space environments and effects or space weather effects. The course addresses each of the major environments: vacuum, neutral, plasma, radiation, and micrometeoroid/orbital debris. In each section, the basic physics behind the environment is reviewed, but the emphasis is on quantifying the magnitude of the various interactions and identifying mitigation techniques and design guidelines. This course would be of interest to spacecraft designers and operators, payload providers, space scientists, and anyone having an interest in the space environment and its effects.

AIAA Courses and Training Program Registration Form

REGISTRATION FORM (or register online at www.aiaa.org)

B0911

All registrants please complete the information below.

1

Conference Badge Name First/Given Name M.I. Last/Family Name

Organization Name/Division/Mailstop

Address

City State Country/Zip/Postal Code

E-mail Address Daytime Phone Number

Fax Number (include country code) Job Title/Rank

2

Select your registration options below. Payment by check, credit card, or money order—payable to AIAA—must accompany registration. To pay the member rate, your membership must be in good standing.

—REGISTRATION OPTIONS—

	AIAA Member	Non-Member	AIAA Member	Non-Member	AIAA Member	Non-Member
COURSES OFFERED AT ATIO CONFERENCE						
	Early Bird by 12 Aug 2011		*Advance (13 Aug–9 Sep)*		*10–18 Sep 2011*	
Missile Design and System Engineering	☐ $995	☐ $1145	☐ $1195	☐ $1345	☐ $1345	☐ $1495
Fundamentals of Lighter-Than-Air Systems	☐ $250	☐ $400	☐ $350	☐ $500	☐ $450	☐ $600
COURSES OFFERED AT SPACE CONFERENCE						
	Early Bird by 19 Aug 2011		*Advance (20 Aug–16 Sep)*		*17–27 Sep 2011*	
Introduction to Space Systems	☐ $995	☐ $1145	☐ $1195	☐ $1345	☐ $1345	☐ $1495
Systems Engineering Verification and Validation	☐ $995	☐ $1145	☐ $1195	☐ $1345	☐ $1345	☐ $1495
The Space Environment: Implications for Spacecraft Design	☐ $995	☐ $1145	☐ $1195	☐ $1345	☐ $1345	☐ $1495

Please indicate if you qualify for the:

__ Prepaid Group Discount (One 5% discount per registrant)

TOTAL DUE: $ ____________________

3

AIAA MEMBERSHIP: If you are registering for one of the collocated professional development short courses at the nonmember rate, included with your registration fee is one year of AIAA membership.

Included in your AIAA membership will be periodic communications about AIAA benefits, products, and services. Check here ☐ if you prefer not to receive membership information via e-mail.

From time to time, we make member information available to companies whose products or services may be of interest to you. Check here ☐ if you prefer not to have your name and address used for non-AIAA mailings.

Signature____Date________________

Check here ☐ if you are renewing or reinstating your membership. (You must pay the full nonmember conference fee.)

4

RETURN FORM TO:

1) For fastest, easiest service, register online at **www.aiaa.org/courses**

2) By mail: return completed form with payment to AIAA, Professional Development 1801 Alexander Bell Dr., Ste 500 Reston, VA, 20191

3) By fax: send the signed, completed form with credit card payment to 703.264.7657

Cancellations Substitutions may be made at any time. Cancellations must be postmarked four weeks before the course start date and are subject to a $100 cancellation fee to cover administrative overhead. AIAA reserves the right to cancel any program due to insufficient registration or any situation beyond its control. Each course will be reviewed three weeks prior to the start date and may be canceled if a minimum enrollment has not been reached. Participants will be notified immediately and a full refund will be issued. AIAA cannot be responsible for expenses incurred because of course cancellation. AIAA reserves the right to substitute speakers in the event of unusual circumstances. For additional information, call Chris Brown at 703.264.7504 or 800.639.2422; FAX 703.264.7657; E-mail: chrisb@aiaa.org.

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☐ Check here if you need to make special arrangements due to a disability. Attach requirements on a separate sheet of paper.

6

FORM OF PAYMENT:

AIAA Member Number: ________________________

- ☐ Purchase Order
- ☐ Check
- ☐ Travelers Check
- ☐ Wire Transfer
- ☐ American Express
- ☐ VISA
- ☐ MasterCard
- ☐ Diners Club

Credit Card Number:

____

Expiration Date:________Month _______ Year _____

Signature: ________________________________

E-mail address of cardholder for receipt:

____

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

5% Group Discounts

Deduct 5% for three or more students from the same organization, if registered simultaneously, prepaid, and postmarked four weeks before the first day of the course. Please register each person on a separate form. Photocopies are acceptable.

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.