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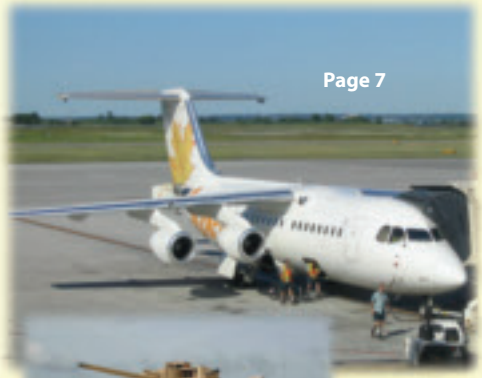

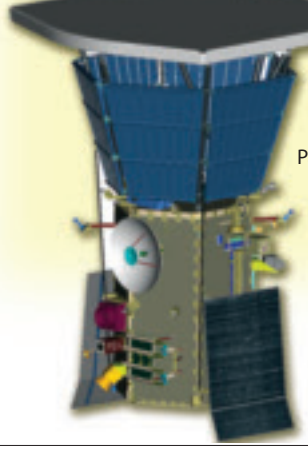

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An F/A-18E Super Hornet reaches the speed of sound. To read about current research in supersonic flight, turn to the story on page 30. DOD photo by Petty Officer 3rd Class Jimmy C. Pan, USN.

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Send materials to Craig Byl, AIAA, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344. Changes of address should be sent to Customer Service at the same address, by e-mail at custserv@aiaa.org, or by fax at 703.264.7606.
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Editorial

Beyond biofuels

Since the first Virgin Atlantic venture in the use of biofuels back in 2008—a successful flight from London's Heathrow airport to Amsterdam using a mix of coconut and babassu oil—there has been a growing contingent of airlines conducting flights with various blends of biofuels, using camelina or jatropha, or algae, or some combination thereof. Airlines from all over the world are now operating test flights, usually without passengers.

The U.S. military has also been experimenting with biofuels in its fighters and helicopters.

More recently, Lufthansa has announced that, beginning sometime in April, it will start flying a local route on biofuel alone. It will be a short flight between Hamburg and Frankfurt, and will endeavor to determine what kinds of effects biofuels will have on an aircraft's engine, and on the environment as a whole, after extended periods of regular flight. The aircraft will be an Airbus A321, modified to take advantage of the use of a blend of biofuels and kerosene.

Most would agree by now that biofuels are a viable option as a jet propellant. However, there are still many issues to be confronted—issues of feedstock sustainability, economic feasibility, and assurance that the development of fuel crops will not negatively impact food sources. As the proportion of biofuels in the fuel mix increases, what kinds of changes will have to be made to aircraft engines? Right now, any biofuel will cost more than jet fuel; will a 'greener' flight result in a higher ticket price, and will passengers be willing to foot the bill? There may be a few who would; however, their numbers would likely not be meaningful.

But biofuel development represents just one window on the possibilities for greener aviation. Small steps, like the addition of winglets, to broad concepts such as the 'more electric aircraft,' which would massively reduce weight and therefore fuel consumption, are all in consideration, under development, or already in use. Others have been examined and discarded. But the search must continue.

And the opportunities are not limited to the aero world. For example, the Peregrine, a sounding rocket using a paraffin liquid-oxygen system, which produces water and carbon dioxide as by-products, is scheduled to launch on a suborbital flight from Wallops Flight Facility in two years.

The research in more energy-efficient propulsion and airframe technologies should not just be supported by the private sector and academia; it should be incentivized by government, through study grants, tax breaks, and other mechanisms. In addition, it is important to provide credits or rapid claim deductions for converting to more expensive biofuels (fuel subsidies), and for converting fleets to be able to utilize biofuels. If the move to greener aviation is not economically viable, it will not happen.

The possibilities for cleaner, greener flight may be limited only by the limits of our collective imagination—which in aerospace is rich and deep—and our pocketbooks—which are less so. Assistance from regulatory authorities, and from government tax incentives, may one day enrich our lives and our planet.

Elaine Camhi
Editor-in-Chief

Workforce problems threaten European Single Sky

IMPOSITION OF A 'STATE OF ALARM' on air traffic management (ATM) services in Spain in December 2010 has resulted in the Spanish military taking over control of the country's ATM system. This has come at a critical stage in the implementation of the SES (Single European Sky) program, Europe's version of the FAA's NextGen.

The move resulted from an industrial dispute between the controllers and the Spanish air navigation service provider (ANSP) Aeropuertos Españoles y Navegación Aérea (AENA). The government said that staff members who failed to show up for work would be charged with crimes punishable by jail terms. The controllers returned to work, but were supervised by military personnel.

The European Commission, the architect of the SES project, has always recognized that the controllers will play a critical role in supporting the transition from national to international ATM provision and in introducing more automated technology. According to Daniel Calleja, director for air transport at the commission, speaking in March 2010, "We acknowledge the human factor as the overriding enabler of change."

But Europe's controllers and their ANSP employers are undergoing a torrid time. Throughout Europe, government employees are facing cuts to their salaries and less generous working conditions. At the same time, there is a general shortage of controllers—though estimates on this vary—and traffic levels in Europe are slowly rising. Air traffic grew by more than 5% on average during the key summer months (June-October) in the core area of Europe, according to figures from the Maastricht Upper Area Control Centre.

But ANSPs are seeing income levels depressed by slow or low traffic growth in other areas and lower yields from navigation charges. According to the International Air Transport Association (IATA), which represents scheduled airlines, "Intra-European market conditions remain depressed as a result of the debt crisis, slow economic growth, government austerity measures, and increasing taxation."

The prospect of the Single European Sky offers more challenges. In December 2010 a committee of experts from European member states issued new performance targets for Europe's ATM system: Between 2012 an 2014, the Europe-wide cost efficiency of the system must improve by 3.5% per year, delays must be reduced, and the navigation charge unit rate will decrease from this year's €59.29 per service unit to €53.93 per service unit in 2014. More work and less income.

Mixed reviews

Although some ANSPs see these targets as tough, airlines believe they are too soft.

"The watered-down 3.5% target is a major disappointment," according to IATA's CEO Giovanni Bisignani. "It is not a serious challenge to ANSPs to reduce costs. Instead it is a license for them to continue with business as usual over the next three years. Targets need to drive change, not support the status quo. Given the independent Performance Review Board's [PRB] assumption of 2.7% traffic growth and inflation of 1.9% over the 2012-14 period, ANSPs can meet the 3.5% cost reduction target simply by containing their costs. To drive real change and achieve the full SES by 2020, we will need much tougher targets from 2015."

In the longer term, the SES will produce more stringent efficiency savings. Europe's ANSPs are aligning their national operations into nine international functional airspace blocks (FABs), where traffic will be managed by international consortia of the ANSPs involved. This will, proponents say, increase system capacity by 70%, reduce average delays to 1 min or less, and cut user costs by 50%. But many argue that these targets will be realized only if duplication of resources is taken out of the system by lowering the number of control centers and the number of controllers. In July 2010 French controllers went on strike in protest at the prospect.

Need for dialogue

In these difficult circumstances, the need for employers and employees to work together on solving these issues is particularly important. "Spain is a classic example of where there has not been effective dialogue," according to Garry Graham, national secretary for aviation of the U.K.'s Union Prospect, which represents 3,000 workers within NATS, the UK's ANSP.

"We need clear dialogue when it comes to talking about jobs, terms and conditions, new technology at a local, national, and EU level. There are examples of good practice—in the U.K., for example, through effective dialogue, NATS has reduced costs by 30%, staff numbers by 22%, and delays from minutes to seconds."

But this is not a typical picture throughout Europe. European ATM performance is currently being heavily impacted not just by the fragmented nature of the system but also by industrial unrest.

Ripple effects of unrest

"In September 2010, the average delay per delayed flight for departure traffic, from all causes of delay, was 31 min," according to Eurocontrol. "This was an increase of 29% compared to September 2009. The percentage of flights delayed by more than 15 min in-

Passengers wait for news about their flights at the T4 terminal of Barajas airport in Madrid. A shortage of air traffic controllers caused Spain's air traffic authority to close several airports. (AP photo/Daniel Ochoa de Olza.)

creased to 22% from 15%. Industrial action had a considerable effect on delays in Europe in September 2010. France saw three separate periods of action, with delays peaking on the 7th, 23rd, and 24th. Belgocontrol airspace suffered from a single day of industrial action on the 28th. Spain also experienced a single day (29th); however, delays were less severe as advance warning enabled operators to plan ahead, resulting in Spain seeing a decrease in traffic that day."

Merely harmonizing ATM systems and procedures, introducing new technology, and developing common regulatory standards will not improve the overall performance of the European ATM network if industrial unrest continues at previous levels—or escalates.

Many within Europe's ATM industry have been worried by what they saw as a lack of progress on 'social dialogue' or 'fifth pillar' issues within the SES project. In November 2010, before the 'state of alarm' measures were introduced in Spain, European ANSP employers through their trade association—the Civil Air Navigation Services Organisation)—and controller workforce ATCEUC (Air Traffic Control European Unions' Coordination) wrote to the European Commission to highlight their concerns: "When the Single Sky package II was adopted in October 2009, the European Commission committed, through a Declaration endorsed by the Madrid conference in 2010, on the need to put the human factor at the core of its activities….Due to the number of challenges we have to face with SES implementation, the social partners are concerned that the Commission does not give high priority to make the SES so-called fifth pillar a reality."

"Following the events in Spain, the fifth pillar, or the social dialogue part of the SES, is effectively dead," said one controller representative. "In many cases ANSPs are facing severe financial difficulties and have to borrow from the commercial markets as there is no money left in the government coffers."

There was also a question mark now over whether European ANSPs would have sufficient funds to invest in new SES technologies, he added.

Polarized views

The action of the Spanish government has certainly crystallized opinions throughout the EU. "I consider these strikes totally unacceptable. These are a defense of privileges. They are clearly disproportionate: A small group is shutting down a big part of the economy," according to the commission's vice president of transport, Siim Kallas.

"Should Spain continue in this assumed refusal to seek a concerted solution with its employees, with or without any form of mediation, we will have no choice but to conclude that Spain has decided to turn its back [on] the most elementary principle underlying the whole European social dialogue," said the ATCEUC in a statement in December.

"In the meantime, the European

Commission did not even voice a word. Although the initiatives taken to solve this crisis by Spain are in total opposition to any principle to be defended for the development of a 'Single European Safe Sky.' We will therefore have no other choice than to refrain from participating [in] any European meeting involving the Spanish state or provider," it continued.

But one view is that the formation of international FABs might have only a minimal impact on current workforce and service provision issues, at least in the short to medium term. Instead of shutting down 10 national en-route and approach control centers and replacing them with two or three new, larger international centers (what the airlines hope for), the process might simply involve the introduction of new efficiency measures in existing facilities, while the workforce retains its current terms and conditions (what many of the continent's ANSPs are aiming for).

"ANSP management may find a work-around that allows them to play national centers off against each other within the FAB in order to comply with the performance and cost-cutting requirements," according to Andrew Charlton, director of Aviation Advocacy, a Geneva-based consultancy.

High stakes for SES

Either way, the Spanish controller dispute is important to the SES. AENA manages 10% of the air traffic controlled in Europe—while it has traditionally accounted for around 16% of its costs—and the performance of the Spanish ATM system is critical to the overall smooth running of the European ATM system. Spain and Portugal have until 2012 to set up a functional airspace block, a deadline set by the European Commission. The current state of alarm makes this process more problematic.

Even as the crisis in Spain unfolded, Belgium, France, Germany, Luxembourg, the Netherlands, and Switzerland signed an agreement to create a new FAB, the third to be created after the U.K./Ireland and the Denmark/Sweden blocks.

The events in Spain will set an important precedent. While the commission is setting out the principles by which working conditions should be agreed between employers and employees, it will be down to the individual ANSPs and their controllers to apply these principles at a national or regional level. Under the Single European Sky II legislation, a commitment to social dialogue is mandatory to the consideration of provision of air navigation services.

But if AENA succeeds in its cost-cutting and efficiency improvement plan with the support of the government and the European Commission, this will send a clear signal that social dialogue has its limits and will not be an impediment to introducing a more efficient ATM system.

For some, the turmoil in Spain has underlined the need for a European-wide ATM system and the urgency of that requirement.

"The fragmentation of the airspace costs the sector €3 billion. Inefficiencies of the air traffic management system in Europe are responsible for 16 million tonnes of unnecessary CO_2 emissions," according to the commission's Kallas. "The implementation of the Single European Sky is therefore not an option—it is an essential requirement for an efficient and sustainable air transport system in Europe."

Philip Butterworth-Hayes
Brighton, U.K.
phayes@mistral.co.uk

Events Calendar

FEB. 7-9
AHS/AIAA Airworthiness, CBM, and HUMS Specialists' Meeting, Huntsville, Alabama.
Contact: Rob King, 256/313-9016; Rob.L.King@us.army.mil

FEB. 7-10
Nuclear and Emerging Technologies for Space 2011, Albuquerque, N.M.
Contact: Shannon Bragg-Sitton, sitton@tamu.edu

FEB. 9-10
Fourteenth Annual FAA Commercial Space Transportation Conference, Washington, D.C.
Contact: 703/264-7500

FEB. 13-17
Twenty-first AAS/AIAA Space Flight Mechanics Meeting, New Orleans, La.
Contact: Peter Lai, 310/336-2367

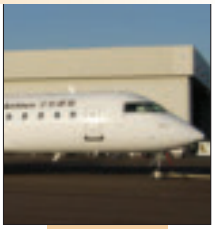
MARCH 5-12
2011 IEEE Aerospace Conference, Big Sky, Montana.
Contact: David Woerner, dwoerner@ieee.org; www.aeroconf.org

MARCH 15-16
2011 AIAA Congressional Visits Day, Washington, D.C.
Contact: Duane Hyland, 703/264-7558; duaneh@aiaa.org

MARCH 21-23
Ninth Annual U.S. Missile Defense Conference and Exhibit (SECRET/U.S. only), Washington, D.C.
Contact: 703/264-7500

MARCH 28-30
3AF 46th Symposium of Applied Aerodynamics, Orleans, France.
Contact: Anne Venables, secr.exec@aaaf.asso.fr; www.aaaf.asso.fr

MARCH 29-31
Infotech@Aerospace 2011 Conference, St. Louis, Missouri.
Contact: 703/264-7500



Slow, slow, quick-quick, slow

As the media would have it, China is dancing its way toward building airliners the world will want to buy. Actually, it is still learning to walk.

The past year or two have been good ones for China: The Beijing Olympics in 2008, the East Asia Games in 2009, the Shanghai Expo in 2010, and in November 2010 the Asian Games in Guangzhou. There have also been successes in space—manned orbits, unmanned shots to lunar orbit, and satellite launches carrying the first part of China's own version of GPS.

Also in November 2010 came the Zhuhai air show, at which much was made of China's prospects—the best and brightest so far—for building and marketing its own medium-size airliner, the C-919. The result was a gush of publicity in China's own state-controlled media, which was to be expected. But the gush spilled over into the international arena, where the buzz continued with very little questioning of what was being claimed.

Pride within China is all very well, but when compliant international media buy into the claims that the country's airliners are about to challenge Boeing and Airbus in world markets, the clatter of stringers' hooves galloping into print and broadcasts becomes irritating.

The C-919 looks, unsurprisingly, a great deal like the Airbus A-320...

Comac, the putative builder of the C-919 (which has not been assembled yet, let alone flown), and Avic, maker of the smaller regional ARJ21 (which took part in the Zhuhai show), are indeed offering a challenge to Boeing, Airbus, Embraer, and others. But this is not yet the head-on battle portrayed in the media—and not for reasons of product quality, either.

Threefold challenge

The Zhuhai air show was actually a very good showcase of what is being made by China both on its own and in partnership with foreign interests. In an approach that closely parallels that of other countries, China is now buying in components and systems for the aircraft it builds.

It now faces three challenging issues: First, it must come up with concepts and technologies of sufficient quality and advancement to match or, preferably, beat the competition. The second issue is systems integration—choosing and putting together the best bits and operating systems that it can buy in or make for itself. The third is supporting and servicing its products, both inside and outside China.

The third issue is the easiest to describe: It is a complete unknown, because China has very little experience selling and then supporting high-tech products operated by companies working in highly competitive commercial environments. Aircraft grounded for want of parts or maintenance turn into holes in the balance sheet, and selling to political allies in Africa or Eastern Europe, where the profit motive might not be particularly sharp, is no substitute for developing proper support networks. That takes experience not easily derived from observing what is done by foreign organizations, so building up such a network takes time.

The second issue, systems inte-

gration, is no problem in and of itself, except, of course, that it depends entirely on the first—each system must be quantified, then either identified for purchase from outside the country or designed and built at home.

Progress on the first issue is still not complete, although China's engineers have made huge strides forward. The ARJ21 is being built in Shanghai in the factory where then-McDonnell Douglas MD-82s were assembled under MDC supervision by the local workforce. It should not, therefore, come as any great surprise that the ARJ21 looks very similar to the MD-82, though its engines and systems are different.

Up the learning curve

The C-919, built by Comac (Commercial Aircraft Corporation of China) in Shanghai, looks unsurprisingly like the Airbus A-320, real examples of which are being assembled in Tianjin, at what is so far the only Airbus production line outside Europe.

If there were a Boeing 737 production line in China, there might well be a Chinese look-alike heading for the skies shortly. But then again, perhaps not. The 737's fuselage is, after all, very much a clone of the 707, and China produced its own version of that—actually a somewhat smaller one, like a 720—in the late 1970s, called the Y-10. Three examples of that plane, previously known as the 708 because its design was dated August 1970, were built. It was slow and heavy, and not equal to the 707 that was by that time in service with China's state carrier, the only airline there. The project was abandoned, although it was an excellent learning experience for China's aviation industry.

Similarly, the C-919 is actually a proof-of-concept project that does not take technology any further. It is already being widely said that the aircraft will be heavier than planned, slower than desired, and late—it is not due to fly until 2014 and will not enter service until 2016. It will therefore be behind existing, long-running products from both Airbus and Boeing in technology and performance from the start of its assembly-line life. By the time it enters service, both foreign companies will have moved still further ahead, either with totally new aircraft or with upgrades and new engines that will prolong their working lives. The C-919 is going to be left very far behind.

It is probably best looked at as a training exercise. Acquiring new technology from foreign partners or developing it at home can be problematic—as Airbus and Boeing are continuing to show with the Dreamliner, the A-380, and the A-350. Even with all their expertise, research, and experience at the cutting edge, they still run into difficulties.

Bridging the learning gap

For all its progress in aviation—and it is real—China still has a yawning learning gap. Whether or not it raids technology from foreign partners is somewhat moot—those who question its acquisition of technology should perhaps bear in mind the Allies' Operation Paperclip that raided German research after WW II, for instance. It is not so different today; analysis of competitors' products is merely faster

...while the ARJ21 looks similar to the MD-82.

because of computers.

What is different is China itself. It is a command economy, where the direction of research, education, and just about everything is mandated by government policy, unlike the West's commercial imperatives. Now add a huge dose of national pride. Everyone pulls for the home team.

A major handicap for China is that it has been a closed society for so long that, even with access to the outside world growing, it still sees itself as beleaguered by the U.S. to the east, by an uncertain ally of yesteryear—Russia, to the west and north—and by allies of one or the other to the south.

Having allies such as North Korea, a few remnants of Eastern Europe, and desperately poor countries in Africa tends to turn thoughts defensive. New ideas from outside are therefore suspect; they can be adopted only after rigorous and time-consuming checking, and preferably with sufficient modification that they can be claimed as home grown. Thinking outside the box can be dangerous to one's career.

Many years of sending youngsters out to be educated in the West has slowly, slowly changed traditional thinking in China, against natural resistance from the old guard. It used to be that people educated abroad were put into dead-end jobs because they could not be trusted at home, having been "contaminated" by Western ways. Although a lot of that has gone, and people who know and understand the Western world are now in positions of responsibility, there is still bureaucratic and academic inertia generated by the old guard, who need to protect their way of life and, obviously, their power. This of course differs little, except in extent and longevity, from entrenched lines of power anywhere. But it does mean ideas take time to be developed.

Thus the Western approach—analyzing a market, finding a gap, and going for it—simply is not there at the major industrial level. As a result, the C-919 and the ARJ21 are or will be no better than the A320 or the MD-80 on which they are loosely based, and may not have anything like the performance of either. They will, however, be considerably less expensive. And it would not matter if they were made of compressed noodles—they are national projects, and so destined (or doomed) to succeed in one way or another.

The real picture

Much was made of a supposed 100 orders for the C-919 at Zhuhai, though no media were allowed into the signing ceremony. It was later said that China's big four airlines—Air China, China Southern, China Eastern, and Hainan Airlines Group—had each ordered 20, with GE's leasing arm and another leasing company ordering 10 each. Later it was confirmed by Comac itself that half the so-called orders were in fact options, and later still that the four airlines had ordered only five each, plus 15 options.

That the orders were mostly fiction is interesting, because it indicates that top-down pressure for the home team to support the local industry is not as effective as it once was, now that the big airlines have learned how to make lots of money with foreign aircraft.

The real challenge to Boeing and Airbus is that there are orders of any number. Because, even though in the rapidly expanding market within China it is not really a zero-sum game, these are orders lost to foreigners. They are also a signpost to a more uncertain future.

Unfortunately for Boeing, its delays with the 787 have put some of its orders in doubt, in the Middle East as well as in China. Shanghai-based China Eastern broke ranks in late November to say it might cancel its order for 15 copies, although whether this was a negotiating ploy for compensation was uncertain at this writing. It may well be genuine—all of China's major carriers have been making money hand over fist, partly because of major tourism draws like the Olympics, and they cannot afford their expansion plans being shredded by late delivery of new aircraft.

But that is an aside, because neither Chinese airliner is in the 787's market, and the 737 and A320 have been doing extremely well in Chinese hands.

So where are the ARJ21 and the C-919 going to go? Some of the market can be massaged, by "persuading" smaller local carriers to use them for domestic flights. But the market outside China is another story. Then there is the issue of funding and "level playing fields" under the World Trade Organization's rules for fair competition, which will be a vast minefield for the Chinese state-owned aviation industry to negotiate its way through.

It is not only about building shiny new aircraft. Change is happening in China in virtually all respects. For instance, the market for business jets is opening up, in part because the rules for obtaining flight permits have been eased. More airports are to be opened to give airlines access to more destinations. China is gradually upgrading its entire aviation infrastructure. It still has the immense handicap that the sky is "owned" by the military, which can and does close airways at an instant's notice for its own reasons. But the pressure to expand air services is now so great that it has to be guided in the right direction, rather than stifled.

A good start would be a single, unified air traffic control system across the nation, much like what the U.S. and Europe are both trying to achieve. China has the advantage of having relatively little in the way of legacy systems to accommodate; from a technical viewpoint, a greenfield approach would work fine. This would allow space for as many of its own airliners as it can build, while still leaving room for the foreign manufacturers to sell plenty in China, a factor that would spur local designers to reach for quality.

China will get there, and it will build good aircraft. But it will not happen nearly as fast as the media (Western as well as Chinese) would have us believe. Moreover, it won't all be smooth, and it won't be easy.

Michael Westlake
michael_westlake@yahoo.com

Old struggles and new faces

THE 112TH CONGRESS CONVENED on January 4 and began its chores farther behind in the annual legislative cycle than any previous Congress.

Months after the start of the current fiscal year, the federal government was still operating under a series of restrictive continuing resolutions (CRs). The previous Congress had passed what one Hill staffer called 'a fast and furious flurry of legislation" in its final, lame-duck session ending in December—prolonging tax cuts, allowing gays to serve openly in the military, ratifying an arms treaty with Russia, authorizing financial help for September 11, 2001, first responders. But the departing lawmakers failed to enact any of the 12 regular appropriations bills for FY11 and, for the first time since 1974, failed to pass a budget resolution at all.

Federal agencies including DOD, DOT, and NASA were all waiting for appropriations bills that would enable them to spend at planned FY11 levels, which are slightly higher than those of FY10. Operating under a CR means not only less money but also greater confusion, because program decisions need to be made every day.

Defense Secretary Robert Gates warned that ongoing reliance on CRs "would cut defense funding by about $19 billion, but would not reduce or eliminate any of the additional bills we must pay in the coming year." Said Gates, "We will need to cover the military pay raise, increases in military healthcare costs, higher fuel prices, and other 'fact of life' bills. None of these additional costs are covered by a continuing resolution."

In its last action before adjourning on December 22, the outgoing Congress approved the FY11 Defense Authorization Bill. The measure does not permit the Pentagon to spend funds—that requires an appropriations bill—but it sets policy in anticipation of a defense appropriations bill. The authorization covers $548.2 billion for the Dept. of Defense and $158.7 billion for operations in Iraq and Afghanistan. While awaiting appropriations, the Pentagon is operating on CR funding that remains at last year's levels through March 4.

The authorization bill continues to support the F-35 Lightning II Joint Strike Fighter, which has experienced cost overruns and delays. The bill sidesteps controversy over whether to provide an alternate engine for the more than 4,000 JSFs that may eventually be manufactured for use in eight countries.

The administration wants a single engine type, the Pratt & Whitney F135, to power all JSFs. Many on Capitol Hill and in industry want an alternate engine, the General Electric/Rolls-Royce F136, to be available. Under the appropriations measure, spending on the F136 can continue—even as the alternate engine emerges as one of the most contentious defense issues of the new year.

Secretary of Defense Robert Gates

General Electric said it passed a milestone on December 6, when it launched tests on the sixth F136, surpassing a major test goal for 2010. GE and Rolls-Royce have a 60-40 partnership on the engine. Separately, Rolls-Royce manufactures the lift-fan system for the F-35B short takeoff/vertical landing (STOVL) version.

Opponents of the alternate engine say a single engine type for the JSF is sufficient. Bennett Croswell, Pratt & Whitney vice president for engine programs, told this column that a second engine would be wasteful. Said Croswell, "We've exceeded 20,000 hr in test runs while simultaneously powering the F-35 flight test program. This demonstrates the maturity and reliability of the F135 engine for our customers' armed forces around the world."

But retired Air Force Lt. Gen. Stephen G. Wood, who is senior vice president, defense relations, for Rolls-Royce North America, said in an interview that the alternate engine "is 80% complete and will begin flight test this year. Wood added, "The risk is too great to allow only one propulsion system for the JSF, which will make up over 85% of our nation's fighter force in 20 years."

Gates announces broad cuts

On January 6, under direction from the White House to cut projected spending by $78 billion, the defense secretary announced a series of cuts or cancellations, including, beginning in 2015, reductions in troop strength of both the Army and the Marines. Gates said the cuts were mandated by the "extreme fiscal duress" the nation finds it-

The EFV is one of the programs that fell under the budgetary ax.

self in. In addition to the troop reductions, other cuts particularly affect the Marine Corps.

The Pentagon would save $4 billion by further delaying production of the F-35 Joint Strike Fighter. In addition, the secretary placed the Marines' STOVL version, the F-35B, on two-year probation because of delays and cost overruns. The aircraft was already in jeopardy because Britain decided to adopt a different version of the aircraft, and Italy (the only other outside customer) is contemplating a similar switch.

The STOVL version of the JSF may be in some danger, now that it has only one buyer besides the Marine Corps.

The F-35B is intended to replace the AV-8B Harrier II; the Marines have no alternative to fill the decks of amphibious assault ships. Until recently the corps had been touting an ambitious schedule for the F-35B and promising initial operating capability (IOC) as early as 2012. But after some technical hurdles were overcome, others arose, including unexpected wear on door hinges for the F-35B's lift-fan STOVL propulsion system, a general slowdown in software integration, and problems with a fuel booster pump.

Marine commandant Gen. James F. Amos had told Congress the corps "most positively" are staying with the F-35B, but also acknowledged that IOC will be delayed at least two years. The fighter had been progressing ahead of the Air Force F-35A conventional takeoff and landing version but now would enter service at the same time or later.

Gen. James F. Amos

Dropping the STOVL variant was among recommendations made by former Sen. Alan K. Simpson (R-Wyo.) and former White House chief of staff Erskine Bowles, the cochairmen of Obama's National Commission on Fiscal Responsibility and Reform—the deficit commission.

The secretary also cancelled the Marines' expeditionary fighting vehicle (EFV), meant to haul troops from ship to shore. It is currently above cost and behind budget.

The Marines say they need the 39-ton vehicle to bridge the gap between ships and shore, replacing the AAV-7 amphibious assault vehicle. Both vehicles can carry a reinforced rifle squad of 17, but the AAV-7 has a speed of just 8 kt, while the EFV can reach 30 kt. Ship-to-shore transport, potentially while facing an enemy with modern weapons, is crucial to amphibious operations—which in turn are often cited as the raison d'etre for the Marine Corps itself. The EFV is seen as part of a triad of amphibious warfare tools that include the MV-22 tilt-rotor aircraft and the Navy's landing craft air cushion hovercraft. The Marines want 573 EFVs.

The program encountered reliability problems during an operational assessment in 2006, including random breakdowns of components ranging from the hydraulic system to the ammunition feed system. The Marines reorganized the program and extended the operational assessment period.

Rep. Steny Hoyer (D-Md.), the second-ranking Democrat in the House of Representatives, had said the EFV is necessary, and that "solutions can be found" to overcome reliability and scheduling issues.

Rep. Steny Hoyer

Rep. William R. Keating

Among other cuts, Gates also cancelled the Army's short- to medium-range surface-to-air missiles (SLAM-RAAM). Congress, of course, will have the final word on all of these cuts, but amid calls for austerity, some of these changes will be difficult to reject.

A study by the Marines themselves projects that the corps will have to buy all of its equipment and weapons on a ground procurement budget that is expected to drop about 10% to an average of $2.5 billion-$3 billion a year. The numbers amount to an estimate of the corps' portion of anticipated spending cuts.

"This is truly the problem that keeps me up at night," Lt. Gen. George Flynn, the commanding general of Marine Corps Combat Development Command, told reporters in December. "We overreach on technology and as a result, we underestimate the cost and we underestimate the time to be able to do it. That's typically how a program gets in trouble."

Amos is the first aviator ever to serve as Marine commandant—his callsign is "Tamer," as in lion tamer, and he flew F-4 Phantom II and F/A-18 Hornet fighters. He acknowledges that aviation and equipment concerns are at the top of his priorities list.

Airport security

Rep. William R. Keating (D-Mass.), a freshman in the new Congress, hopes to stir up new interest in what he calls an 'overlooked' airport security issue—the seeming ease with which unauthorized people can gain access to a commercial airliner parked on the ramp. A district attorney until joining Congress, Keating investigated the death of a 16-year-old boy who stowed away in the wheel well of a US Airways Boeing 737 on a domestic flight between Charlotte, North Carolina, and Boston. Keating became involved because the case was originally thought to be a homicide. Investigators eventually concluded that Delvonte Tisdale fell from the 737 when it lowered its gear to land at Boston's Logan International Airport on November 16.

"Aside from the tragedy, [there] was a serious breach of security at an airport," Keating told reporters in a statement. The Tisdale youngster was a runaway, not a terrorist, and Keating insists he is sympathetic with the boy's family. But he and others in Washington are concerned about a recent spike in stowaway and other incidents in which people have gained access to aircraft without permission. "What if someone else had had a more sinister motive?" Keating asked.

Jerry Orr, director of the Charlotte-Douglas International Airport, told reporters on December 27 that a security breach had clearly taken place and that an investigation is under way.

Keating said he would take up his concerns with Rep. Jason Chaffetz (R-Utah), incoming chair of the House subcommittee on national security, homeland defense and foreign operations. Although not a freshman (he was elected in 2008), Chaffetz is seen as one of a cadre of newcomer Republicans in Washington linked to the Tea Party movement and burdened with little reverence for the congressional seniority system.

Rep. Jason Chaffetz

Chaffetz will be the new House's most visible overseer of the Transportation Security Administration and of airline security—and has carved out a niche as one of TSA's strongest critics. He has written to President Obama to protest the TSA's use of body-scanning machines and to call for "more realistic and more effective" screening of aircrew and passengers. As for the stowaway incident, Keating told reporters, "If that was someone with a different motive—a terrorist—that could be a bomb that was planted, undetected."

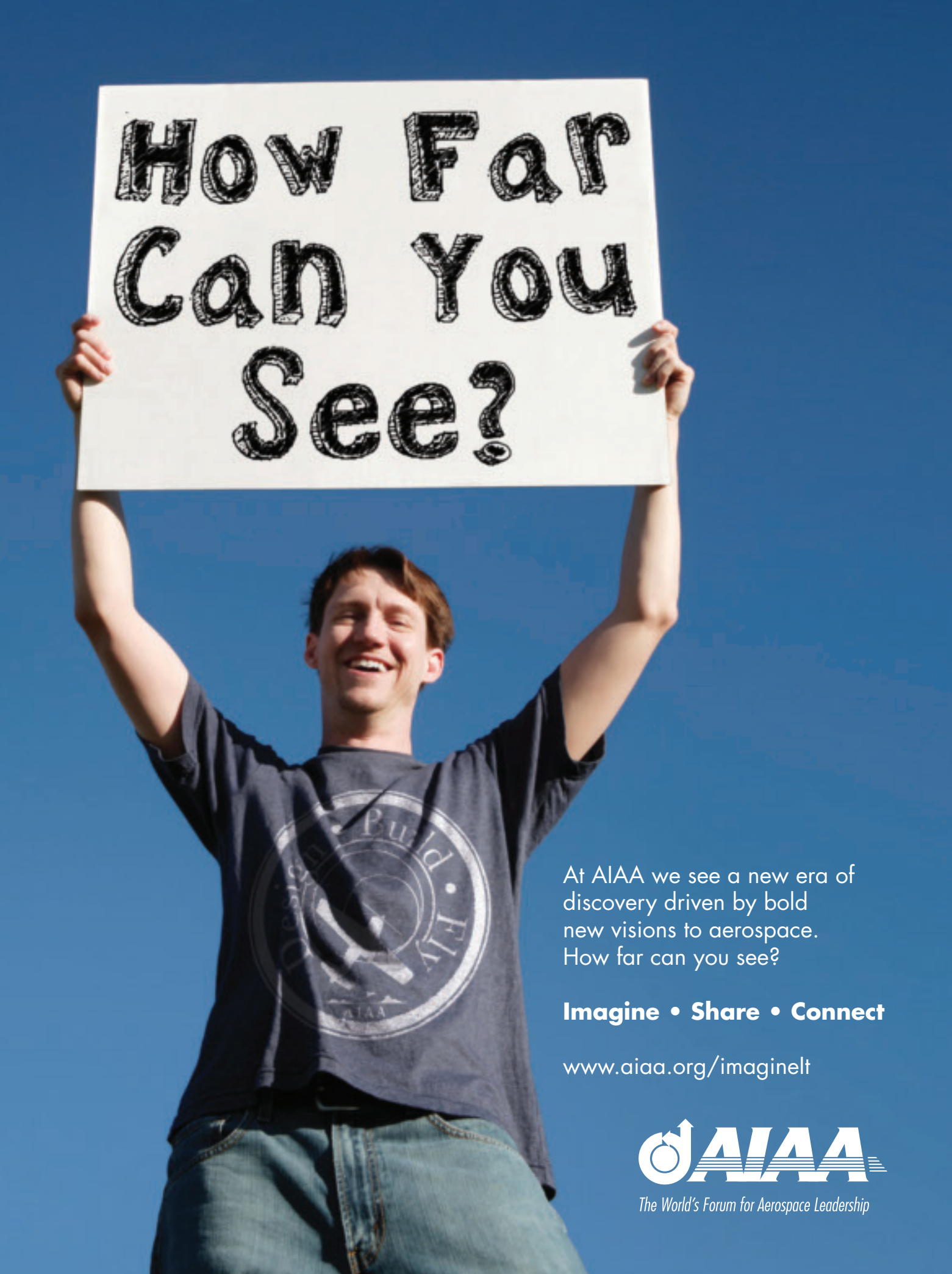
The possible security breach suggested by the incident was "tailor made to fit Chaffetz and his concerns," says Denny Sherwood, an airline pilot who analyzes security issues.

Chaffetz already said he was planning new hearings after an airline pilot, Chris Liu, went viral on the Internet with cellphone imagery of ground crews entering and exiting secure areas at San Francisco International Airport (SFO) without ever undergoing a screening process. Liu said he put the video on YouTube "to identify the disparity between upstairs and downstairs"—a reference to vigorous screening of flight crews and passengers at one level and allegedly lax security toward ground personnel at the other.

SFO manager Joseph Walsh sent a letter to Chaffetz claiming that the Liu video gives a misleading impression and that access to the airport is being properly guarded. The TSA suspended Liu from a federal antiterrorism program that let him carry a gun on planes. His employer, American Airlines, asked him to take his video off the Internet—and he did. Said Chaffetz, "This is not a San Francisco problem. It's a national problem. We think holding hearings will help."

Robert F. Dorr
robert.f.dorr@cox.net

Robert F. Dorr's book Mission to Berlin, *about B-17 Flying Fortress crews in WW II, will be published in March by Zenith Press.*



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Sir Martin Sweeting

Your company claims to be 'changing the economics of space,' which I take to mean you are allowing clients to do more with less. How does it work?

It goes back quite a long way, to the 1980s, when we were a university research team. We spotted that with the advent of microcomputers you could build a very complicated spacecraft based on a small box and running on low power. Out of that developed our modus operandi, which has been to use commercial off the shelf [COTS] technologies developed for the leisure, commercial, communications, and IT industries, and 'hijack' them for space applications. This is somewhat different from 30 years ago, when technologies developed for space were, reputedly, later developed terrestrially. It's turning that model right round.

This allows us to build spacecraft using technologies which are up-to-date—so we can produce very sophisticated, highly capable satellites more quickly, all of which reduces cost. We are doing what the personal computer did for computing. The traditional space model has used tried and proven technologies that may be 10 or 15 years old by the time the mission is launched.

When did you realize that this idea would really work, that the COTS technologies could be made robust enough?

I'm not sure there was a 'eureka' moment; we developed the idea step by step. The gear change happened around the turn of the millennium, when microsatellites moved from being more than interesting research tools. We managed to bring all the bits together so that we could meet real needs with small satellites. The easiest example of this was in Earth observation, where we found that by using a combination of computing and the latest imaging techniques, combined with new control and solid-state memory applications developed in the commercial market, you could start making a satellite the size of a table and that it could do almost anything that Landsat could do, but at a fraction of the price.

And quickly.

Yes. Typically, we go from deciding to do it to ready-to-launch in 15 months—although we have done one recently in just 10 months.

It's mainly taken off in Earth observation. In 2003 we launched a constellation of small satellites for disaster monitoring, and that has turned into an international imaging commercial business. Our latest satellites will have 1-m-resolution capabilities—10 years ago this would probably only have been possible within a classified project and with a satellite the size of a double-decker bus.

It's an overused analogy, but it follows a similar trend in the computing world. Because the unit costs of PCs have come down, you can start to exploit the advantages of networking and other applications. Now, because the unit cost of our satellites is low, we can afford to build many more of them and we can launch them in constellations. That gives you almost the same observational capability [as a larger satellite] but at a much lower cost. And that means you can have a number of these satellites in orbit, giving you another dimension—as well as spatial and spectral resolution, it also gives you temporal resolution, so that the revisit increases from an average of 10 days to every day. It means we can now be very responsive to imaging of disasters, and it opens up a complete new marketplace. By reducing the unit costs we have opened up a new dimension in utility.

I'd add one caveat—these small satellites can't do everything a large satellite can do. They can do perhaps 80% of what Landsat can do, but at a 50th of the cost. The sort of resolution you need for Hubble means you need big mirrors, and you can't get round that. But you can do 1-m resolution with a relatively small telescope, and the surrounding electronics and subsystems are not that big, so you can still have something quite compact.

If you pan forward 10 years, what will you be able to do then?

There are two conflicting drivers here: the desire for better and better resolutions as time goes by—Google Earth has really raised awareness and expectation—but also the desire for more timely information. The most serious applications require fresh data. Small satellite technology has advanced at such a rapid rate that satellites such as SSTL's [Surrey Satellite Technology Ltd.] next generation can offer very high resolutions—smaller than 1 m/pixel—at prices that allow customers to buy constellations. This is the key to making data 'timely.' A constellation of three SSTL high-res satellites could image anywhere in the world within 24 hours.

If you look at Earth observation and you want higher resolution, you need a bigger telescope. Along with our U.S. colleagues at JPL-Caltech, we are researching ways to break up the system, building a series of small satellites, each with a mirror, and then

"The real trick is to identify in the first place which COTS technologies will be sufficiently robust to work in space, to survive the rigors of launch and then operate in a vacuum, which is also a high-radiation environment."

in effect producing a large mirror by launching them as a stack and then bringing them together, assembling them robotically in orbit. That's for 10 or 15 years ahead. If you do that, you can connect or reconfigure them in different shapes, optimizing them for high resolution—at the expense of signal quality—or optimizing the signal-to-noise rather than resolution, depending on what you want to look at. You can look out at the universe, too, and we see this as possibly a potential candidate for a next-generation James Webb telescope.

Is this research your own initiative, or do you have a client in mind?

We have two organizations here. The original work spun out of the research department of the University [of Surrey, U.K.], and that has continued. We formed SSTL 25 years ago, and we currently have about 320 people within the commercial company, with about 100 people in the university research department—the Surrey Space Centre—focusing on small satellites. Essentially they act as the research institute for the company. Their job is to think, with a horizon of between two and 15 years.

The work [the distributed telescope research] is not being done within SSTL but within the Surrey Space Centre. Caltech has expertise on the optics side, and we're looking at the whole spacecraft side—how do you miniaturize the system, autonomous rendezvous, docking, and so on.

How do you evaluate COTS technologies for space applications?

The real trick is to identify in the first place which COTS technologies will be sufficiently robust to work in space, to survive the rigors of launch and then operate in a vacuum, which is also a high-radiation environment. We do some testing, then insert the new technology into a mission as a noncritical function—as a backup unit, for example. If it works, it is promoted to become a primary system on a future mission. In a year or two we can qualify and have confidence in these new technologies, with very low risk.

We've never used a part or a technology which has not fundamentally worked. We've been doing this now for 25 years and had people looking in depth at the space radiation environment and the technologies, so we can screen pretty acutely candidate systems.

The link between the academic and the commercial side of your business seems fundamental to the success of the enterprise.

Yes. Almost every system we have in orbit today, hardware or software, has its genesis in the space center.

Is research funding a challenge?

SSTL is fully commercial; the space center belongs to the university, so it has to pay its way through the normal academic channels—research grants, money for teaching, commer-

Professor Sir Martin Sweeting is executive chairman of Surrey Satellite Technology (SSTL) and a director of the U.K.'s Surrey Space Centre (SSC).

Born in 1951 in London, he holds a Ph.D. in electronic engineering and communications. Sweeting has pioneered the concept of rapid-response, low-cost, and highly capable small satellites. In 1985, after building and launching the U.K.'s first two research microsatellites at the University of Surrey, he formed a spinoff university company, SSTL, which has designed, built, and launched, and now operates, 27 nano-, micro-, and mini-satellites—including the international Disaster Monitoring Constellation, with Algeria, China, Nigeria, Turkey, and the U.K., and the GIOVE-A Galileo satellite for ESA.

SSTL has also developed a successful satellite know-how transfer and training program and has worked with 12 countries, particularly enabling emerging space nations to achieve their first space missions and thus to access space directly to benefit their environment and economies. During the 1990s, as the capabilities of small satellites rapidly increased, the company moved from being a research activity to meeting real applications for Earth observation, communication, and space science.

By 2009, SSTL had grown to 300 commercial staff with a £50-million order book and total export sales of over £140 million. Projects currently under way at SSTL include developing small geostationary communications satellites, radar and navigation constellations, and interplanetary missions to the Moon—and later to Mars and near-Earth objects.

In 1995 Sweeting was awarded the OBE in HM Queen's Birthday Honours, and the Royal Academy of Engineering Silver Medal, both in recognition of his pioneering work in small satellites. He was knighted in the 2002 British New Year Honours for services to the small satellite industry.

cial contracts. Most of the income is generated by contract work rather than [U.K. government-funded] research councils. Research councils typically identify space research as 'space science,' but what we do here is 'space engineering.'

Do you receive any European Union [EU] seventh framework research funding?

We do some, but the problem with the seventh framework is that funding does not cover every overhead, just 70%, so you still have to find 30%. It's good—but it's complicated and time consuming. Most of the center's income comes from research contracts. SSTL has an arrangement with the center by which the company pays the center an unencumbered fee every year—without any specific direction on any particular project—but in return the company gets first refusal on all the IP [intellectual property] work. In addition, the company sometimes sponsors funding for specific areas of research. The center attracts substantial research funds from other companies, too. The combination in funding means that in hard times it is actually doing reasonably well. But it's still quite a struggle.

It's quite a leap from developing microsatellites to playing a major role in the EU's Galileo satellite navigation program. How has that come about, and what's the impact on the company?

Back in 2000 there would have been no possibility that what we were doing here could be applied to Galileo. But the then-science minister Lord Sainsbury set up a research program called MOSAIC, where he put around £15 million of government funds into a competition for three projects, two of which we won and the third in which we were partners.

The first program was to develop satellite technologies for a disaster monitoring constellation. The second was to build a high-resolution (2.5-m pixel) satellite and the third to look at whether it was possible to build a small geostationary communications satellite. This proved to be an incredibly successful program for the government. The Earth observation research program—that catalyzed the whole constellation process—involved using about a third of the MOSAIC investment, since when it has generated around £170 million in exports, a colossal return on the government's investment.

The geostationary research allowed us to build a capability to develop satellites that operate in the higher orbits used by navigation and communication satellites. When ESA urgently needed to get a navigation satellite into space within 30 months or risk losing the appropriate frequencies, we put in an attractive offer. We said we could do this for less than €30 million; our industrial competitors came in at over three times that.

We were given the contract for the GIOVE-A test satellite, which we finished on time and on budget. It was launched in December 2005, was required to last 27 months, and is still operating well nearly five years later. In March 2008 ESA declared this a 'full mission success.' Although GIOVE-A was not all COTS, quite a lot of it was. It made ESA pause for thought, to consider that perhaps there were other ways of doing things.

When the competition for the Galileo operational constellation came, we teamed with a like-minded company, OHB in Germany, and our team won the contract to build 14 satellites.

In terms of fitting in with our philosophy of doing things, we identified that Galileo does require a slightly different approach from that which we would normally apply to our other missions—we have to comply with ESA and EU constraints. We have set up a separate team to do this work, to ensure the program benefits from the way we work to keep down costs and work to the schedule. But we also do not want the necessary approaches the EU and ESA are taking on a program of this size and importance to impact our other way of working.

How is the Galileo work going?

So far so good; we're on schedule. The main expertise we bring comes from GIOVE-A, where we primed the first Galileo test satellite. We're doing all of the navigation payloads here, and the platforms are being built in Germany.

How do you think Galileo will compare with the new GPS system, or the Chinese and the Russian ones? Do we really need all these constellations?

Each system has its own features; but the issue is very simple. When people ask, "Do we really need anything beyond GPS?," the answer is plain. GPS provides timing and positioning for nearly all our European national infrastructure—transport systems, banking, mobile phones, everything. It does not make sense to have your entire economy and infrastructure security linked to just one system. No one in their right mind would do that.

And the more satellites you have, especially if they are interoperable, the better the service will be on the ground. In the grand scheme of things these systems are not unreasonably priced—when you think of what would happen if GPS went down, the economic consequences would be huge. It would pay for Galileo in a week, just in economic loss. In my mind you need a minimum of two and preferably three of these systems.

"It does not make sense to have your entire economy and infrastructure security linked to just one system. No one in their right mind would do that."

How do you see the markets in

which you operate developing over the next few years—is competition increasing? Will you widen your niche or go into new areas?

We've been growing organically. My feeling is that with an organization of fewer than 500 people you can still manage the human interactions. Once it gets above that number, the organization turns into a different animal.

The way that I prefer to see growth happen is amoeba-like, growing through dividing. One of the first examples of this was six years ago when we realized there was a requirement in the Earth observation market for a high-resolution revisit data service. We recognized that while we design and build satellites here, what the customer wants is not satellites but information—a very different type of business that needs different people with different skills—a 24-hr customer-focused operation.

"The way that I prefer to see growth happen is amoeba-like, growing through dividing."

So we set up a subsidiary called DMCii as a new business unit, which has proved very successful. We have also set up an offshoot in the USA, looking at developing into a new geographic market; and it's very hard to do business in the U.S. if you don't speak 'American.'

Why grow at all? Because we see applications for the smaller end of the satellite business growing steadily, principally driven by commercial markets now that small satellite technology has matured to the point where operational missions can be implemented. We also serve other markets such as institutional, educational, and technology demonstration. This diversity is key as it allows us to ride the 'ups and downs' of any one sector.

We are also looking at the communications satellite business. As com-sats get bigger—they are now often in the 10-20-kW range—the opportunity for 'small' comsats is getting stronger. Not everybody needs or wants a large comsat. The market for small comsats is around six per year, and as they are mostly commercial, the market is accessible. One or two of these per year would be a good business for us. The U.S. is a big user of satcoms, and having a U.S. subsidiary company will allow us to address that market more effectively.

In early 2008 SSTL was acquired by EADS Astrium. How has that changed the way you work?

It has certainly brought us a number of benefits. EADS bought us for the same reasons that IBM got into the personal computer market while retaining their mainframe business. They needed to be in that business. Having bought us, EADS Astrium has decided that the last thing they want to do is mess with our business. SSTL sits within the Astrium satellite group with a reporting line into the CEO of EADS Astrium. We are an autonomous business—we have our own way of doing things and our own business plan. Sometimes we compete against our parent, but we also get together with them; we won a contract in Kazakh-stan to build two satellites that neither of us would have won independently.

But competition is growing?

Small satellites are becoming the flavor of the month. There are a lot of companies producing subsystems, and I'm sure some of those bits and pieces are as good as ours. But there are very few people who can manage the whole system, right from the blank sheet of paper to orbital operations, in one house. There are perhaps half a dozen or so who are putting together small satellites, but nearly all of those buy in the subsystems, so they are effectively system integrators. That's not quite the philosophy that we think works most efficiently.

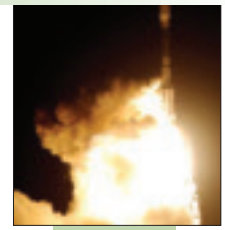
There are one or two companies snapping at our heels in South Korea and South Africa. We take that pragmatically—having people snapping at your heels keeps you fairly sharp. How much business do we lose because of that? Probably one contract in 10—and sometimes we lose contracts for political reasons.

What is your perspective on the launcher market? Is more competition driving down prices and increasing reliability?

Back in the mid-1980s, the launcher market was a real problem. It was basically the U.S. and piggybacks, and they were few and far between. In the 1990s Ariane came along, and they had this scheme of piggybacks, and that was excellent—we used Arianes on nine launches. Then Ariane 5 was launched, and it no longer served the orbits we were interested in. But fortunately the Soviet Union opened up, and we were able to access all the Russian launchers. For the last 15 or more years we've been using former Soviet launchers.

Ten years ago they offered very good prices. Now Russia has oil and gas and doesn't need foreign currency quite as much, so they've been ramping up the prices, and they are a lot higher than they were five or six years ago. That's causing us a problem. At the same time Space-X has developed its launcher, and it has been trying to match the prices of Russia five years ago. Which it more or less has. My concern is that Space-X might get seduced into floating up its prices to just under that of the competition—rather than changing the game, which was the original idea. It is getting more difficult to find launch prices that are commensurate to the low cost of the satellites.

In the USA the lack of a reasonably priced indigenous launcher has really held back the development of the small satellite sector. The Space-X Falcon series of launchers certainly addresses this problem and could be the catalyst for a much stronger uptake of small satellite missions in the USA.



Paraffin-fueled rockets: Let's light this candle

ONE SPRING DAY BACK IN 1990, President George H.W. Bush's domestic and economic policy staff received an urgent call from NASA's legislative affairs office. They needed the White House to send a signal to House and Senate negotiators that a major clean air bill should exempt NASA and other agency rocket launchers from regulation. The White House staff, working with Congress, agreed to shield rocket launches from the bill's restrictions, recognizing that while rockets do pollute the atmosphere, their impact is minimal compared to sources such as automobiles and power plants.

Hybrid rockets grow greener

Today, conversations about the 'greening of aerospace' usually focus on aviation fuels, with little attention paid to rockets. Yet promising research may eventually help reduce rocket launch environmental impacts, as well as increasing rocket safety—based on a hybrid rocket design that stores the oxidizer as a liquid and the fuel as a solid that is immune to chemical explosion.

Within just two years, Peregrine, a sounding rocket powered by paraffin-wax-based fuel, is slated to launch on a suborbital flight from NASA's Wallops Flight Facility in Virginia. The rocket was developed in northern California by teams from NASA Ames, Stanford University, and Space Propulsion Group.

If successful, Peregrine will further prove the utility of environmentally friendly hybrid rocket engines for a variety of space launch uses.

Hybrid rockets, first demonstrated in 1933 by Soviet rocket pioneers Sergei Korolev and Mikhail Tikhonravov, are the short leg of a three-legged rocket propulsion stool dominated throughout the space age by the more mature technologies of liquid and solid rocket systems.

In the past two decades, hybrid rocket technology developed in fits and starts. American Rocket (AMROC) and the NASA/industry hybrid propulsion demonstrator program showed interesting results but were not sustainable. In 2004, however, success came with the flight of SpaceShipOne, the first private manned spacecraft, powered by a hybrid rocket burning HTPB (hydroxyl-terminated polybutadiene) with nitrous oxide. SpaceShipTwo, the suborbital passenger-carrying vehicle that will likely be launched this year, is also hybrid powered.

The utility of cheap, clean-burning paraffin to fuel Peregrine is the brainchild of aerospace engineer Arif Karabeyoglu, who studied hybrid rocket stability for his Stanford Ph.D. dissertation. In 1995 Karabeyoglu and Dave Altman, a retired founder of United Technologies' Chemical Systems Division and an advisor to Stanford Ph.D. students, were intrigued by an Air Force Research Laboratory (AFRL) test using frozen pentane in a hybrid rocket motor. The test obtained a burn rate, or regression rate (the speed at which the fuel surface is turned into combustible material) three to five times higher than expected.

A faster burn

NASA Ames research scientist Gregory Zilliac observes that Karabeyoglu "started analyzing those results, and he predicted that the fuel was burning in a different way than traditionally is done in hybrids. Instead of vaporizing and combusting, it was forming a melt layer on the surface, and that melt layer was getting entrained in the port flow, in forms of little droplets. That process was causing the fuel to burn three times faster. That was a very significant result, because the problem with hybrids has always been that the fuel burns too slow to get high thrust."

To stay frozen, a pentane fuel would require a refrigeration system that maintains the pentane at around 200 C below the freezing point of water. "You don't want to take your rocket and put it in a deep freeze before launch," notes Brian Cantwell, Karabeyoglu's Stanford dissertation

With this issue, Aerospace America *introduces a recurring column that will examine new developments in green technologies and engineering.*

This July 2008 firing of the Peregrine motor occurred before the one that resulted in a burst from overpressure. Motor diameter is 11 in.; thrust about 3,000 lb; oxidizer is nitrous oxide.

advisor and former chairman of the Dept. of Aeronautics and Astronautics. "It's not practical."

Together, Karabeyoglu and Cantwell searched for other fuels that might burn rapidly but would be easier to handle than frozen pentane. They discovered that a range of paraffins (especially those of higher molecular weight, with carbon numbers around 32) such as those used in hurricane candles were good candidates.

"Arif's analysis led us to the idea that most paraffin waxes should have a high rate of burning, just like pentane. And they have the advantage, of course, that you don't have to freeze them," says Cantwell. "They are room-temperature solids."

Growing confidence

Prior to 1998, testing with a 50-lb-thrust motor in Cantwell's lab, says Karabeyoglu, "We predicted that paraffin waxes would burn three to five times faster than certain polymeric materials like Plexiglas. The testing showed that the factor of three to five was really there."

In 1999, Karabeyoglu, Cantwell, Altman, and a fourth partner based in Washington, D.C., started a small company, Space Propulsion Group (SPG). Their goal was to develop, through NASA and Air Force contracts, "some practical hybrid rocket systems using paraffin-based fuels by improving the fuel formulation such that we retain the regression rate of these materials, while increasing the structural and mechanical properties," says Karabeyoglu. His group has refined the paraffin with a dye to give the wax the opacity needed to control melting, and with structural additives that increase the wax's strength "by a factor of two to three, and toughness by a factor of six to nine" compared to the baseline paraffin material. "These are essential to making this work."

The following year Karabeyoglu and Cantwell took their findings to Jim Ross, director of the NASA Ames Fluid Mechanics Lab. Soon after that the center's director, Harry McDonald, authorized Zilliac to start up a research program using a 7.5-in. test motor called the Ames Hybrid Combustion Facility. The Ames tests confirmed Karabeyoglu's regression rate theory at increasingly larger scales.

"The other thing we confirmed with the testing was the lack of pressure effects," says Karabeyoglu. They realized that "if you changed the pressure from 100 psi to 1,000 psi, there was no effect on the regression rate. So that was incredibly useful, because it opened up a lot of possibilities for the design of these hybrid systems. Finally, these tests gave us a lot of confidence in terms of the paraffin wax's structural capability."

Parallel efforts fall short

By contrast, says Cantwell, AMROC had been trying in the 1990s to compensate for the low burning rate in existing hybrid fuels such as HTPB "by increasing the surface area of burning. That led people to multiport grains, where you get a large enough surface area that you get enough fuel generation and produce a halfway decent amount of thrust."

But Cantwell adds, "There are several problems with multiple ports. One is that you have a more complex fuel grain design. The other is that you don't have the same volumetric efficiency. In a given volume of motor, you can't put in quite as much fuel, because you have to have all these ports where you are burning fuel. The third thing is that as the ports burn, they don't all burn at the same rate. It's very difficult to distribute the oxidizer perfectly evenly from port to port. They will tend to burn outward toward the case at a different rate, and the first port to reach the case basically shuts down the combustion sequence. The advantage of the high regression rate that paraffin gives is that now you can design a large hybrid with a single circular port. And that effectively makes hybrids practical."

Indeed, because paraffin-based fuels use just a circular port, the fuel sliver weight is lower and the internal fuel shape is simpler and more robust structurally.

Achieving practicality

Following 40 successful tests at NASA Ames, current center director Pete Worden encouraged the paraffin team to mount an actual mission, dubbed Peregrine, that would launch from NASA's Wallops Flight Facility to an altitude of 100 km. After the program's initiation in October 2006, the team faced a setback in 2008 when a test motor using nitrous oxide as an oxidizing agent for the propellant burst at Ames because of pressure oscillations, which were a factor of two over the motor's normal operating pressure. Cantwell says the team has worked to stabilize the motor so that it "doesn't have low-frequency, high-amplitude pressure oscillations."

As ground testing continues, notes Zilliac, the team hopes to "achieve above 95% combustion efficiency, with combustion stability—in other words, peak-to-peak pressure fluctuations of less than ±5% of the mean chamber pressure," leading to "good combustion efficiency and stability" during Peregrine's maiden flight.

Karabeyoglu says because of the single circular port motors used in the hybrid design, Peregrine should demonstrate "up to 99% fuel utilization. As a result of that and the high efficiencies we have shown in our testing at SPG with liquid oxygen motors, we can actually get delivered vacuum specific impulse values around 340 sec. With that kind of performance, combined with the advantages of hybrids—which are safety, incredible simplicity, and the eventual costs advantages—you can have a game-changing propulsion system."

In January, SPG also started testing a 24-in. paraffin-based/LOX hybrid rocket motor that produces approximately 35,000 lb of thrust. If successful, this AFRL-funded testing effort will be a "critical milestone for paraffin-based hybrids and hybrid rockets in general," according to Karabeyoglu.

He sees potential for the future use of hybrid rockets in "niche markets such as suborbital space tourism. For heavy boosters, obviously hybrids are viable," he adds, "but I think the

development or the maturation of the technology at that level will take longer. One area where we think the hybrids can be incredibly useful is in the area of upper-stage systems or motors. There are also cost advantages associated with hybrids, plus their simplicity makes them very favorable for upper stages. Once the technology is proven and matures, I think then we can start talking about much larger propulsion systems."

Environmental and cost benefits

Turning to paraffin's environmental advantages, Karabeyoglu notes that unlike with solid rocket propulsion, "we do not have any chlorine-based compounds in these propellants. The paraffin liquid-oxygen system byproducts are essentially water and carbon dioxide, and the percentages of CO_2 produced by hybrid rocket propulsion is incredibly low compared to the other sources, such as power generation or ground transportation."

"When it comes to the environment, the only really viable high-performance oxidizer for solid rockets today is ammonium perchlorate, and ammonium perchlorate is a known endrocrine blocker. For a number of years there's been a lot of concerns about perchlorate contamination of ground water. Hybrids do not use perchlorates so there's no issue," Cantwell continues.

Looking back on their work, Cantwell observes, "Usually when you do basic research in the lab, your prospects of seeing it in practical applications might be a long way off. It has been a while since the late 1990s. This has been a 10-year development. But I think in the next five years we might see these motors really begin to have an impact. They are going to lower the cost of a whole variety of systems. They are not just suited for replacement of boosters. I think with the very high efficiencies that Space Propulsion Group has been getting recently, they are suitable for building an upper stage. There are a wide range of applications, and the net effect will be lower costs, a much safer system, and a much more environmentally benign system."

✈✈✈

Fifty years ago, to begin this nation's era of human spaceflight, Mercury astronaut Alan Shepard memorably told his launch crew to "light this candle." Perhaps the past is prelude to a new era with a new kind of candle to propel America's rocket fleets.

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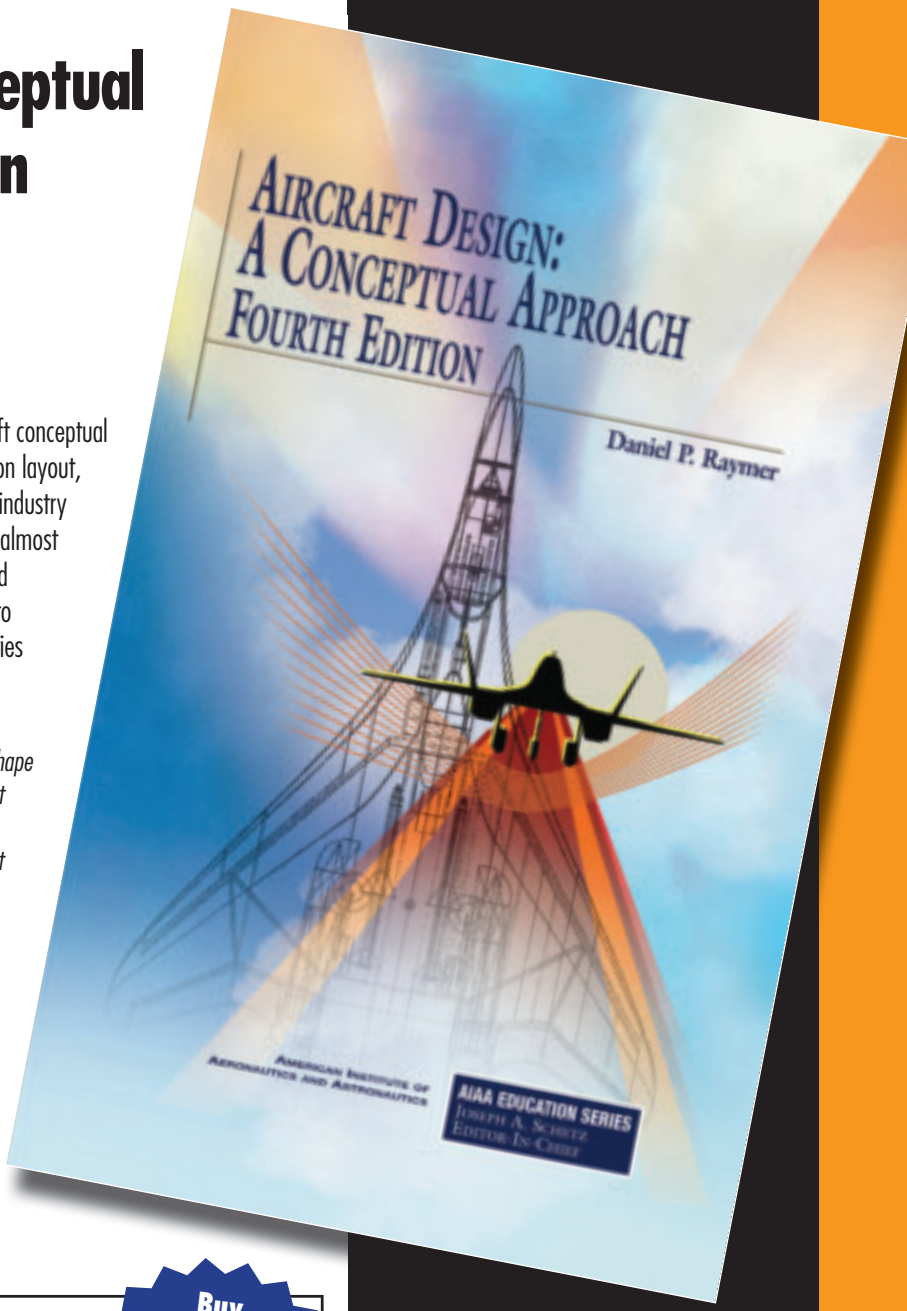

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U.S. launch numbers take a dive

In 2010, the number of launches worldwide totaled 75—exactly the same number as in 2009. This is good news for the launch services industry, because it suggests that this sudden spike in the number in 2009 was not an anomaly, but rather the start of a trend toward a more robust market than that of 2001-2008, when the number of attempted launches averaged 62 per year.

The bad news, at least for the U.S., is that U.S. launch service providers accounted for the lowest number of attempted launches, relative to providers from other countries, in at least the past decade.

Shrinking U.S. share

Of the 75 rockets launched last year, only 15 were of U.S. nationality. That represents a mere 20% of all the rockets launched worldwide. During the past 10 years, U.S. rockets have consistently accounted for more than a quarter, and often more than a third, of annual launch missions. In 2001 and 2003, U.S. rockets accounted for 42% and 39% of the launches respectively. Even as recently as 2009, U.S. rockets represented 37% of the vehicles launched.

The sudden downturn in U.S. launch vehicle activity may appear to validate the concerns of those who have been warning about the impending loss of U.S. space launch supremacy. That loss follows the Obama administration's 2010 decision to terminate the shuttle program, dramatically scale back the Ares/Orion effort, and cancel plans to return to the Moon by 2020. The decision entrusted responsibility for meeting NASA's space transportation needs to vehicles developed and operated entirely by private launch companies such as SpaceX (Space Exploration Technologies) and Orbital Sciences. In reality, though, the administration's decision and the launch downturn have absolutely nothing to do with each other.

If anything, last year marked a major milestone for the shift away from the traditional, U.S. government-led space transportation paradigm toward one that allows private industry to innovate and lead the way.

On June 4, 2010, SpaceX successfully launched its first Falcon 9 rocket, a medium-to-heavy-lift vehicle designed to carry the Dragon capsule. The Falcon 9/Dragon system is one of two tasked by NASA, under the Commercial Orbital Transportation Services program, to eventually take over resupply of the ISS for the U.S. The maiden launch of the Falcon 9 validated the rocket.

On December 8, 2010, SpaceX followed up with a perfect launch of the Falcon 9/Dragon system. The Dragon capsule completed two orbits and then reentered the Earth's atmosphere to splash down in the Pacific Ocean, clearing the way for Falcon 9/Dragon to begin taking over ISS resupply missions after the shuttle performs its last mission, either in April with Endeavour's last flight or sometime this summer with the final flight of Atlantis. Falcon 9/Dragon is scheduled to undertake at least 12 cargo resupply missions to ISS. Eventually it may also carry astronauts to the station, as Falcon 9 is designed for both unmanned and manned spaceflight.

Falcon 9

A better explanation

Perhaps the best explanation for the marked slide in U.S. launch vehicle activity in 2010 is simply that U.S. rockets had an exceptionally active year in 2009, and thus were due for a less active one last year. All but one of the U.S. government and commercial launch systems that were operational as of 2009 were launched that year, including the shuttles Atlantis, Endeavour, and Enterprise, as well as Atlas V, Delta II, Delta IV, Falcon 1, Minotaur I, Taurus XL, and both the sea-based and land-based models of the Sea Launch Zenit program.

The near disappearance of Boeing's Delta II rocket from the scene made last year's U.S. launch numbers look much weaker than they would normally be after a strong year. Because of its long-anticipated phase-out in favor of the larger and more powerful Delta IV family, and consequently its higher per-mission costs, the II launched only once in 2010.

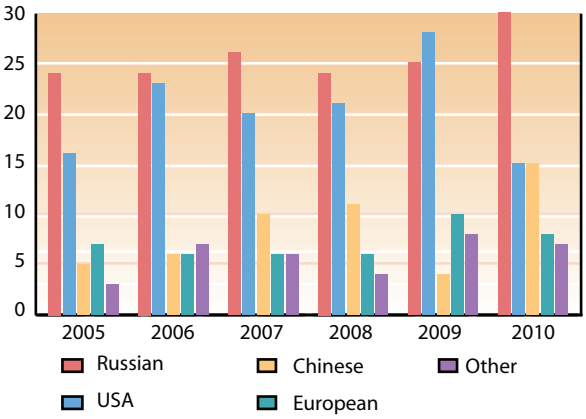
A total of eight Delta IIs flew in 2009, and that may well have been the last significant year for the program—unless a large enough market can be found, one that would allow Boeing to offer the venerable rocket at its more traditional and more competitive price of $50 million-$60 million per mission. With the cost of a Delta II


Delta II

now exceeding $90 million, and likely to reach more than $100 million, the vehicle has become too expensive for NASA and commercial satellite operators to use regularly.

As for the huge drop in the number of U.S. rocket launches relative to rockets from abroad, this can best be explained by the combination of fewer Delta IIs and many more Chinese and Russian rockets launched in 2010.

NUMBER OF ROCKETS LAUNCHED, 2005 - 2010
BY COUNTRY



Russia, led by its Soyuz and Proton programs, normally carries out about 25 launches a year. A total of 30 Russian rockets were launched last year, including 12 Soyuz medium-lift vehicles and 12 heavy-lift Protons. The combined number of Soyuz and Proton rockets launched in a given year usually equals 18-20, but in 2010 the total grew by about 25%, on the increased commercial strength of Proton and continued reliance by NASA and the Russian space agency, Rosaviakosmos, on Soyuz for space station cargo resupply and crew transport services.


Proton

Last year, the Proton rockets launched eight large commercial communications satellites destined for geostationary orbits, including the 2,450-kg Intelsat 16 for Intelsat, the 6,379-kg EchoStar 14 and 5,521-kg EchoStar 15 for EchoStar Communications, the 3,152-kg SES-1 for Société Européenne des Satellites, the 5,420-kg Arabsat 5B for the Arab Satellite Communications Organization, the 5,984-kg XM-5 for XM Satellite Radio Holdings, the 5,390-kg SkyTerra-1 for SkyTerra Communications, and, finally, the 6,150-kg Ka-Sat for Eutelsat.

The other four Protons were used to launch military satellites for the Russian Ministry of Defense. Three of those vehicles carried Glonass-M satellites as part of a renewed effort by the Russian Space Forces to modernize their aging 24-satellite Glonass global navigation system.

Meanwhile, nine of the 12 Soyuz rockets were used to launch Soyuz crew capsules and Progress cargo capsules to the ISS. The high pace of Soyuz launch activity will undoubtedly continue for the foreseeable future, given the lack of support from the space shuttle fleet after this year and the likelihood that it will take time for new systems such as Falcon 9/Dragon and Orbital Sciences' Taurus II/Cygnus to develop their launch rhythm.

Two of the other three Soyuz vehicles launched military satellites for the Russian Ministry of Defense, and the third carried a batch of six Globalstar II mobile communications satellites to begin modernizing the 52-satellite Globalstar costellation. Three additional Soyuz launchers will be used to boost three more batches of six Globalstar IIs within the next two years.

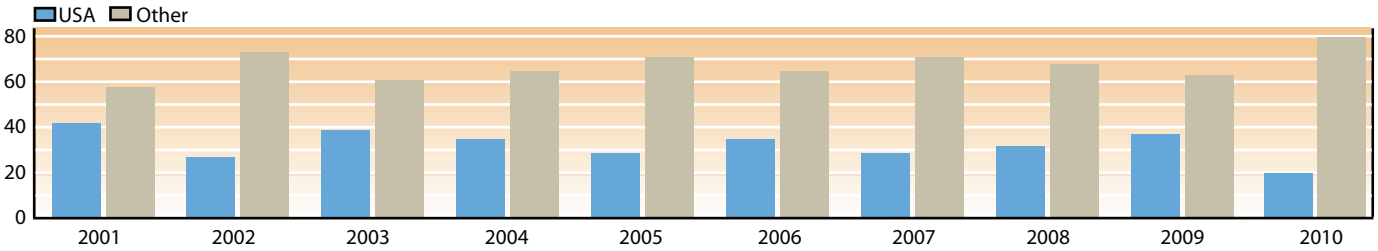
China's long march to dominance

The real news last year, however, was the dominance of China's Long March family of launch vehicles. A total of 15 Long March rockets were launched by China Great Wall Industry, and that is more than any other launch program in the past decade anywhere in the world. The launch activity was spread out among six different Long March models, including the Long March CZ-3A, which launched four missions; the Long March CZ-2D, CZ-3C, and CZ-4C, with three missions each; and the Long March CZ-3B and CZ-4B, with one apiece.

What tended to distinguish last year's Long March missions was the


Long March

PERCENTAGE OF U.S. VS. OTHER ROCKETS LAUNCHED, 2001 - 2010



unusual number of navigation satellites launched. Five of the 15 rockets carried 2,200-kg Beidou satellites for the Chinese government's Compass civil/military navigation system. The country is planning a limited constellation of 12-15 satellites that will offer services to the Asia-Pacific region by the end of next year, which means that at least 10 more Long Marches will launch Beidou satellites during 2011-2012. A global Compass constellation of up to 35 spacecraft is envisioned by 2020, which suggests that navigation satellites will remain a sample of Long March's launch manifest for many years.

LAUNCH MISSIONS ATTEMPTED

	2009	2010
Long March	4	15
Proton	10	12
Soyuz	12	12
Ariane 5	7	6
Atlas V	5	4
Delta IV	3	3
Dnepr 1	1	3
Space shuttle	5	3
Falcon 9	0	2
GSLV 1	0	2
Minotaur IV	0	2
Rockot 1	3	2
Cosmos 3M	1	1
Delta II	8	1
H-2A	3	1
Naro 1	1	1
M-5	0	1
Molniya M	0	1
PSLV 1	2	1
Shavit 1	0	1
Zenit 3F	0	1
Sea Launch Zenit	4	0
Falcon 1	1	0
Minotaur I	1	0
Safir 2	1	0
Taepo Dong 2	1	0
Taurus XL	1	0
Tsyklon 3	1	0
Total	**75**	**75**

Apart from the Beidou missions, Long Marches launched a wide assortment of satellites, including the 5,100-kg Chinasat 6A commercial communications satellite for China Satellite Communications and the 2,300-kg Chinasat 20A military communications satellite for the Chinese Ministry of National Defense (MND), two 2,700-kg Yaogan surveillance satellites, and the 1,500-kg Tianhui 1 imaging satellite for the MND, the 2,495-kg Chaang'e 2 lunar probe and three 1,200-kg Shijian scientific satellites for the China National Space Administration, and the 2,200-kg Feng Yun 3B weather satellite for the China Meteorological Administration's activities.

In other words, China alone has a large enough satellite market to keep Long Marches flying at a robust rate. You can imagine what the rates will look like the day these vehicles start to be contracted on a consistent basis by Western satellite companies.

Not only did Long March outperform all other launch vehicle programs, it demonstrated the ability to launch quickly. By the end of June 2010, there had been only four Long March launches, leading us then to project a total of 10 Long March missions for the entire year. We assumed that China Great Wall Industry would average no more than one Long March launch per month, as that is about the best pace that can be expected of even the busiest programs, such as Soyuz. But in the second half of the year, Long March managed to post 11 launches—nearly two missions per month. You would probably have to go back two decades to find the last time a launcher program logged as many flights over a six-month period.

Lastly, it is worth noting that for the first time in history, China matched the U.S. in the number of rockets launched. In this sense, it is true that the U.S. no longer shares space launch supremacy with Russia only, as has been the case for half a century. However, it is not because the U.S. has ceded ground in this industry, but rather because China has committed itself as a nation to being a major player in space and has invested heavily in developing the necessary technologies since the 1990s. The Chinese have now arrived.

Marco Cáceres
Teal Group
mcaceres@tealgroup.com

Amid cutbacks, Europe's defense firms eye world markets

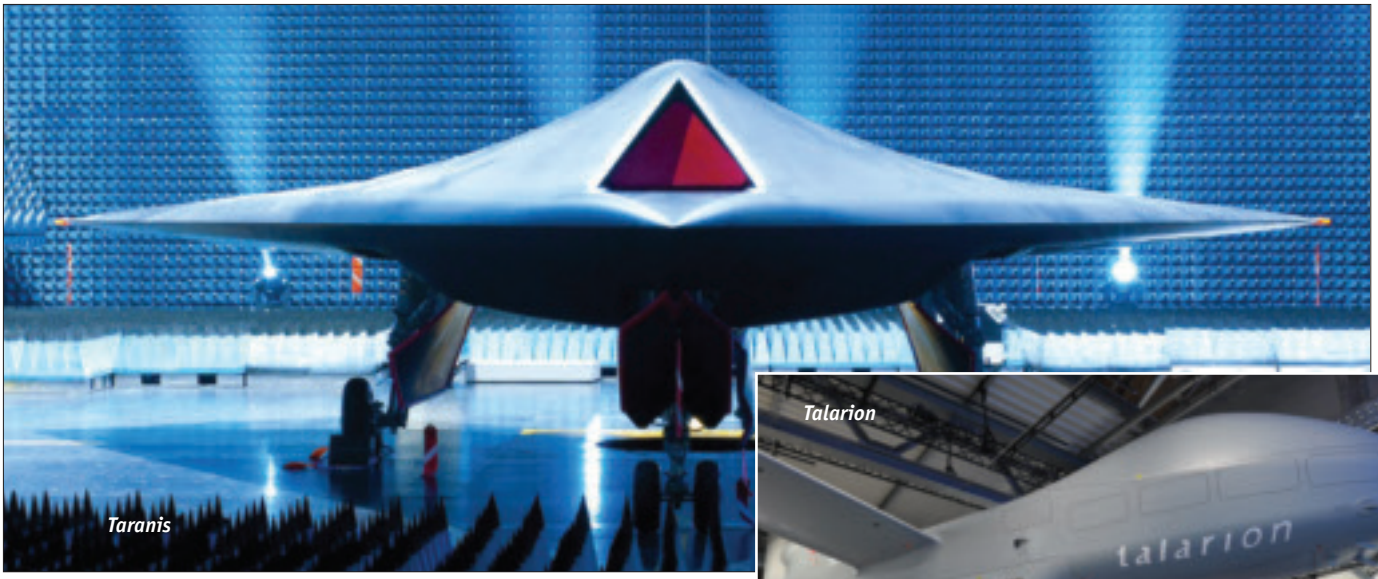
European defense and aerospace companies are placing new emphasis on international and security sales in efforts to offset looming government cutbacks in their home countries.

The results of these budgetary pressures are showing in a reorientation of business planning among Europe's four largest defense firms—BAE Systems, EADS, Finmeccanica, and Thales. Company by company, all are undertaking remarkably similar strategies despite their differing home markets. BAE Systems, the largest defense company in Europe and the second largest in the world, is based in the U.K. EADS, the parent of Airbus and largest European aerospace firm, has home markets in Germany, France, and Spain. Finmeccanica is Italy's defense giant. Thales has home markets in France and the U.K.

A common theme is emerging as plans to accelerate foreign market penetration take shape. International sales are assuming greater importance for all of these companies. Providing more services to buffer cuts in procurement is a common element in preparing plans for tougher domestic budgetary environments. UAVs are being targeted as an area of future defense growth. Homeland security is also gaining importance for all these companies as they plan for domestic and foreign growth.

Austerity measures

Leading European defense firms have a common vision of the difficult environment facing government programs. New fiscal austerity moves will affect



Taranis

Talarion

Watchkeeper

UAVs are a bright spot on the economic horizon for European aerospace companies.

some of European industry's largest customers. Following a national defense review unveiled in October, the U.K. government announced that defense spending would drop by 8% over the next four years. Program cuts, it said, would include early retirement of Harrier jump jets and an aircraft carrier. The Nimrod MRA4 reconnaissance plane program was killed.

Germany plans an €8.3-billion cumulative defense budget cut over the next four years. France is planning a cumulative €3 billion-€5 billion cut over the next three years, and there will be no new programs begun. Spain, another EADS partner country, plans a 6.8% reduction in the defense budget with a draconian 36.7% cut in procurement.

Italy, a rare case of good news, narrowly averted deep cuts in its defense procurement budget. After initial reports of plans for a 10% reduction, this year's proposed defense budget received a modest boost. Still, the country has one of the worst fiscal positions in continental Europe, making future cuts very likely.

In the wake of the U.K. cuts, BAE Systems announced in December that it would terminate about 1,400 employees, many of them directly affected by the Harrier and Nimrod cutbacks. The company also anticipates an impact to operations at six production sites and two military bases. It accelerated the closure of one plant.

The U.K. government decided on early retirement for the Nimrod in the face of a budget squeeze.

Going shopping

As it braced for layoffs in its U.K. home market, BAE Systems moved ahead with several international acquisitions. It already derives more than half its revenues from the U.S., thanks to an aggressive acquisition campaign that began more than a decade ago. The company bolstered that position with its $295-million acquisition in September of L-1 Identity Solutions' Intelligence Services Group. It followed up that purchase with the December announcement of its planned $211-million acquisition of Denmark's ETI. It also acquired Australia's stratsec.net for an undisclosed sum.

In addition to its drive to increase U.S. sales, BAE Systems is expanding in Australia, Saudi Arabia, Oman, and India.

EADS also is actively looking for acquisitions in the U.S. as part of an aggressive expansion plan. Management is seeking to raise its current $1.5 billion in U.S. sales to $10 billion by 2020. Company officials have said that the firm could comfortably make a $1-billion acquisition. EADS is showing particular interest in military services businesses. In addition, it is very active in pursuing new opportunities such as the $40-billion USAF tanker program.

Finmeccanica anticipates that it will achieve a 45% growth in orders from areas outside its core markets of Italy, the U.K., and the U.S. The company is placing high importance on markets in Brazil, Libya, India, Turkey, Russia, subsaharan Africa, and the Middle East. Finmeccanica's AgustaWestland recently established joint production agreements in Turkey, for the ATAK tactical reconnaissance and attack helicopter program, and in Russia, for a civil version of the AW139 and other commercial helicopters.

Thales, which reduced its reliance on France to only 48% percent of its annual €12.9 billion in 2009 sales, plans a drive to further boost its international sales. In the U.S., Thales's management sees opportunities in simulation, avionics, naval systems, air traffic management, air defense, and space.

Thales also has targeted a number of countries in the developing world. In Brazil, it sees prospects in air traffic management, naval systems, security, and the Rafale fighter. India presents opportunities in the €1-billion Mirage 2000 upgrade program and in air traffic management, naval systems, and ground transportation. In Russia, the company is focusing on civil avionics and space. In China, it is looking at civil opportunities. The company sees strong growth prospects in Saudi Arabia for space and security systems, and in the Persian Gulf countries for security systems, air defense, naval systems, and simulation. There are other opportunities in South Korean air defense and air traffic management, and in Singaporean transportation and security systems.

UAVs: A growing niche

European companies are not giving up completely on the hope of finding growth niches within European defense budgets. In particular, UAVs are coming into prominence as a high-profile expansion area.

BAE Systems is approaching UAVs from a worldwide perspective. It is seeking to establish a presence on both sides of the Atlantic so that it can move technologies and systems to different markets. BAE Systems' purchase

of Arizona-based Advanced Ceramics, a small firm with three small UAVs, was a key element of this strategy.

In the U.K., BAE has been working on larger UAVs with government backing. The company hopes it will be able to sell small types from its U.S. facility to the U.K., while using its positioning in larger UAVs to possibly pursue systems in the U.S. BAE has had sufficient confidence in the importance of its Taranis unmanned combat aircraft that it has been willing to invest its own funds as a part of an industry consortium.

EADS is pushing to become the continental European leader in UAVs with its Talarion medium-altitude long-endurance craft, which was being developed under a Franco-German-Spanish program. After government funding ran out, EADS invested its own money in hopes of getting additional government support. That began to look increasingly unlikely, leading EADS to halt work in the second half of 2009.

Thales, which is building the U.K. Watchkeeper tactical UAV in a joint venture with Israel's Elbit Systems, also sees the prospect of growth in its UAV sales.

Finmeccanica, faced with Italy's tight defense budget, is looking to other countries to help foster its UAV technological development. The company has signed agreements assisting UAV technological development for Jordan, the United Arab Emirates, and Malaysia, and has begun coproduction of its Falco tactical UAV in Pakistan.

Service and security prospects

Major European contractors also recognize the importance of boosting their service revenues to achieve stability during spending downturns. EADS' Vision 2020, the company's long-term strategic plan, seeks to establish more balance between equipment sales and services. It targets 25% or €20 billion of service revenues by 2020. Currently 85% of EADS' sales are of aircraft or other platforms, while services account for only 10% of sales.

EADS' Eurocopter, for example, is extending its position in the latter area, recognizing that services can provide 40 years of revenue from each aircraft sold. The strategy is to expand Eurocopter's service offerings in established areas such as power-by-the-hour, to offer new services, and to offer services in new geographical areas.

Similarly, BAE Systems is putting strong emphasis on support, in agreements such as the five-year Typhoon Availability Support contract signed in 2009. That contract is intended to cut the lifetime support costs of the aircraft by £2.5 billion.

Security is assuming added importance in European prime contractors' strategies. While defense outlays may come under pressure, homeland security spending in Europe is expected to grow in the coming years. Moreover, as developing countries improve their infrastructures, they are likely to increase spending on security.

EADS is ahead in setting aggressive targets for the growth of its security business, which company projections show will account for 50% of the sales of its Cassidian unit (formerly EADS Defense and Space) by 2020, compared to 20% in 2009. By 2015, EADS projects security will reach 36%.

The company is focusing on large integrated security projects and has made a key win in Saudi Arabia, where it signed a $2-billion border security contract in March 2009. This is the largest ongoing border security program worldwide. In Romania, EADS also developed a border security system, the largest in the European Union.

Finmeccanica seeks to build on successes already achieved in developing nations in homeland security projects. In Libya, the company already has a €153-million border control contract, which it plans to fulfill by establishing a new joint venture for work on security and communications projects. In Brazil, Finmeccanica sees €8 billion in government-to-government agreements as a basis for security work, with additional possibilities in security systems for the Rio de Janeiro Olympics and the World Cup in the 2011-2014 period. In India, Finmeccanica sees homeland security prospects in communications, mobile surveillance vehicles, unattended sensors, and security centers. In addition, India's airport, port, and mass transit networks are all being rapidly expanded, creating opportunities in biometrics, screening, and surveillance systems.

In Italy, Finmeccanica plans to focus on more security work as defense spending comes under pressure. It has already won a €200 million program to build an integrated civil protection system and another to make Italy's identification document secure.

Like Finmeccanica, Thales is targeting some of the same key countries for its security systems, including Singapore, Saudi Arabia, the Persian Gulf states, and Brazil.

Challenging hurdles

Despite their relatively common vision, these industry growth plans face serious hurdles that may undermine key assumptions.

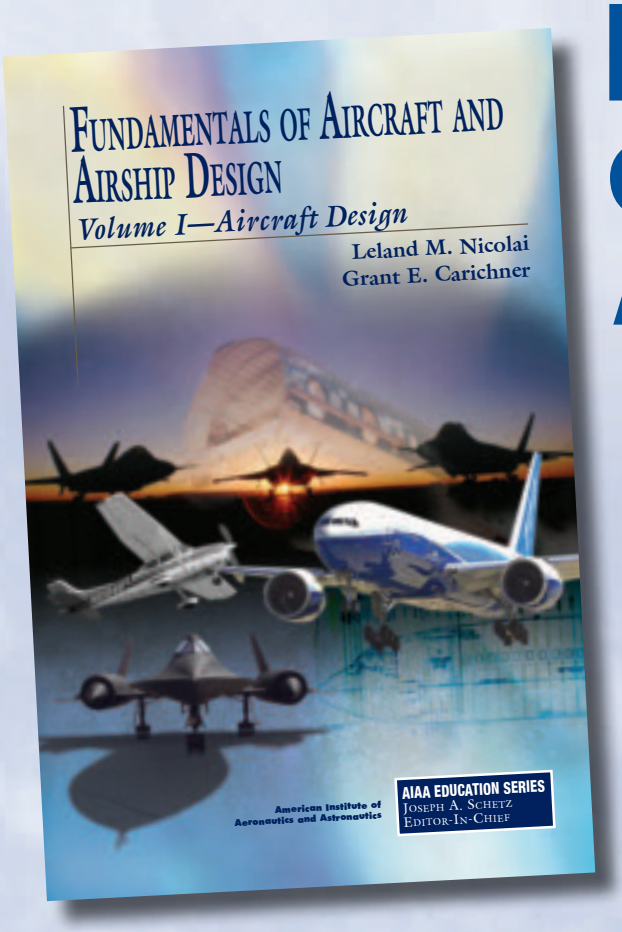
For example, although international defense markets are growing, not all companies will be winners in the quest to boost sales. U.S. firms have their own vision of increasing defense sales to compensate for projected weakness in that arena.

Compared to defense, security remains an uncertain area, one where budgets are more in flux. Competition is intense from both international and local companies. Profit margins in security have often been disappointing.

Defense services growth, which is certainly an admirable goal, has often proved difficult for companies more comfortable with manufacturing.

UAVs are a particularly challenging area for European firms. Europe's governments have often been more comfortable with purchasing or leasing cheaper U.S. or Israeli systems rather than developing their own. The serious problems that some European companies have had with UAV development programs have further reinforced those attitudes. In a tough budgetary environment, changing those priorities promises to be more difficult than ever.

Philip Finnegan
Teal Group
pfinnegan@tealgroup.com



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Volume I– Aircraft Design

Leland M. Nicolai and
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This book is a fantastic collection of history, philosophy, analysis, principles, and data relating to the design of aircraft. I predict it will become a 'classic' and will be found on the desk of anyone concerned with aircraft design.—**Dr. Barnes W. McCormick,** The Pennsylvania State University

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10-0430



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

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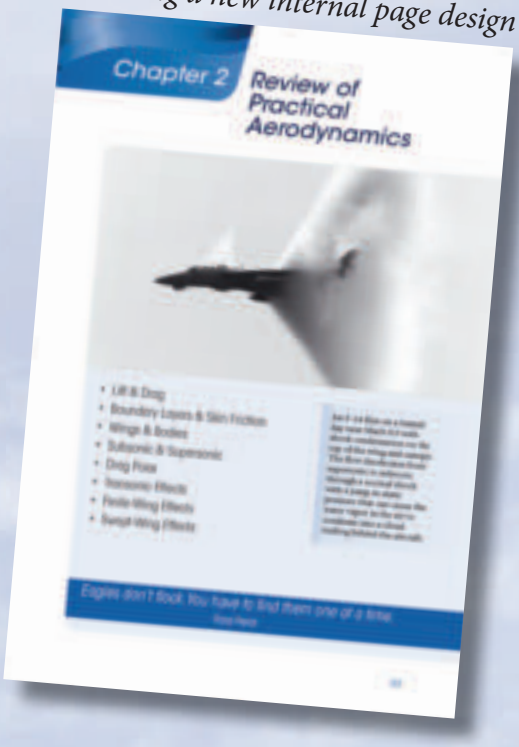

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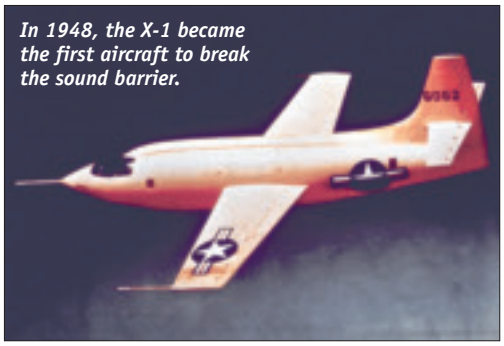
A new BOOM in supersonics

Renewed interest in supersonics has begun shining the spotlight on an area long overshadowed by space projects—the first 'A' in NASA. Technical, environmental, and fiscal challenges remain, but advances such as 'reshaping' the sonic boom into a low rumble have boosted prospects for routine commercial supersonic flight, a dream that refuses to die.

by J.R. Wilson
Contributing writer

From its 1958 founding in the wake of Sputnik to the triumphant lunar landing, from space shuttle missions to ISS construction, from revelations from the Hubble Space Telescope to rovers on Mars, NASA has been known primarily as America's 'space agency.'

But it is also the nation's premier aviation agency. Despite the back seat aeronautics has taken for a half-century, NASA has continued to push the technology of flight, which four of its 10 centers around the nation are dedicated to advancing.



In 1948, the X-1 became the first aircraft to break the sound barrier.

It has been a frugal undertaking. In recent years, even with proclamations of renewal in aviation work, less than 3% of NASA's budget has gone to aeronautics. In the past two decades or so, about $1.5 billion—less than 1% of the total budget for the period—has been used for research into the commercial viability of supersonic flight.

"NASA aeronautics in the past has always supported space activities by looking at some of the fundamental concepts of aeronautics across the speed range—aerothermodynamics, hypersonic reentry, retropropulsion, inflatable supersonic accelerators, and so on," says Peter Coen, principal investigator-supersonics at NASA's Aeronautics Research Mission Directorate.

"I believe that will continue, but with more from the aeronautics side, which is receiving renewed attention and support

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As an F/A-18 breaks the sound barrier, the resulting vapor cone is visible.

from both the administration and Congress. And our supersonics project remains a key element of NASA's aeronautics research efforts in general. So while we're not getting any specific new attention, we are part of an effort that is recognized for its success and is growing," Coen tells *Aerospace America*.

Centers of expertise

In the years between the end of WW II and Sputnik, the National Advisory Committee for Aeronautics (NACA), NASA's predecessor, focused its efforts on the new realm of supersonic flight. That began with a historic milestone in October 1947, when the X-1 flown by famed test pilot Chuck Yeager became the first aircraft to break the sound barrier. The flight occurred over the NACA Muroc Unit, later renamed Dryden Flight Research Center, the agency's new primary aeronautics test flight installation.

Now four NASA centers operate world-class research facilities dedicated to the agency's aeronautics test program, each focused on a specific area of expertise. Each has also made and continues to make advances in supersonics.

NASA Ames in Mountain View, California, includes the Simulation Laboratories, among the world's most sophisticated facilities in the field, as well as supersonic and transonic wind tunnels for scale model testing. NASA Glenn in Cleveland, Ohio, includes one hypersonic and three supersonic wind tunnels and the Propulsion Systems Laboratory, providing true flight simulation for supersonic airbreathing propulsion systems. Research at NASA Langley in Hampton, Virginia, has included wind tunnel tests on a needle-nosed model of the Quiet Spike supersonic jet concept.

Aerodynamic paradox

A major part of what those four centers have focused on in recent years is the 'low

Test engineer Mark D'Aprile checks out a small, needle-nosed model of a supersonic jet concept in the Langley Unitary Wind Tunnel. Gulfstream Aerospace and the NASA supersonics project conducted wind tunnel tests at speeds from Mach 1.5 to Mach 1.8 to study sonic boom characteristics of the unusual configuration.

boom/high drag' paradox—aircraft configurations that decrease sonic booms tend to increase drag.

"Developing a 3D design approach and validating it both with wind tunnel experiments and, eventually, with larger scale in flight is the number one challenge to supersonic overland vehicle development," Coen says. "Aerodynamics, structures, propulsion, and control systems—all interact in a phenomenon called aeroservoelasticity. We must not only build a structure that gives us high stiffness and low weight, but also a control system that can be used to minimize and damp out structural vibrations and loads introduced by wind gusts and flight maneuvers. Those are done to a certain extent today on commercial jetliners, but this takes it to a whole new level.

"Just this past year we've completed a series of wind tunnel tests with a model about half the size of the airplane. For the first time, we demonstrated control laws that simultaneously suppress flutter (the uncontrolled structural motion), reduce gust loads, and improve ride quality. So we are beginning to get a handle on how to do those pieces. We're also developing unsteady models of the propulsion system, so we can determine how it reacts to changes in the airstream. The next step is to put those two pieces together."

Research being performed at NASA Glenn could help alleviate the sonic boom produced by supersonic aircraft. Testing was recently completed for the large-scale low-boom supersonic inlet model with microarray flow control in Glenn's 8x6-ft Supersonic Wind Tunnel. Gulfstream Aerospace and the University of Illinois-Urbana Champaign partnered with Glenn for this testing. Rod Chima, a NASA aerospace engineer, is in the tunnel with the inlet model. Credit: NASA/Bridget R. Caswell.

Overall vehicle characteristics need to be studied using a ground-based flight simulator. To that end, NASA has begun updating its simulation capability to include the effect of elastic structures and known problems.

"If the airplane is flexible enough, and if the pilot is located far enough from the center of gravity and pushes the stick to a new command, the fuselage might make it feel as if the airplane is doing something else, which is an undesirable characteristic," Coen says. "So we have to design the control system to counteract that, which must be tested and evaluated as part of the aircraft's overall handling qualities."

Funding and other challenges

Even limited simulations on new design and propulsion efforts require funding. But when NASA Administrator Charles Bolden announced his first budget since taking charge of the agency, the former astronaut spoke almost exclusively about the space program, with only two sentences about aeronautics in his February 2010 statement.

Two months later, in outlining new mission parameters for the NASA centers, references to aeronautics were largely limited to continued work on NextGen (Next Generation Air Transportation System)—a sweeping overhaul of the FAA's national air traffic management system—and increased research into 'green' aviation under the agency's Environmentally Responsible Aviation project.

NASA's budget proposal for FY11 did devote two pages to supersonics, pledging to continue research to "enable the completion of a multidisciplinary analysis and design system that enables the simultaneous achievement of high cruise efficiency and low sonic boom in future civil supersonic cruise aircraft.

"Supersonic air travel has been possible for decades, but has not been commercially viable because of the significant environmental and performance challenges inherent in this speed regime, including overland sonic boom annoyance, high fuel consumption, and NO_x emission at high altitudes," the proposal stated.

"Efforts in this area consist of conducting long-term, cutting-edge research in the

core competencies of the supersonic regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline, and system levels that will address the technical challenges for practical supersonic cruise aircraft."

NASA says it has organized supersonics research along four primary areas of technical challenge: Efficiency (supersonic cruise, light weight, and durability at high temperature); environment (airport noise, sonic boom, high-altitude emissions); performance (aero/propulso/servoelastic analysis and design, cruise lift/drag ratio); and multidisciplinary design, analysis, and optimization. Looking to enable overland supersonic cruise by both military and civilian aircraft, NASA set 10-year research goals to improve airframe and propulsion system cruise efficiency, reduce noise to about 15 EPNdB (effective perceived noise, in decibels), and minimize high-altitude emissions.

Commercial prospects

The world's only supersonic passenger jet, the French/British Concorde, entered commercial service in 1976 and flew for four airlines—British Airways, Air France, Singapore Airlines, and Braniff International—before being retired by BA and Air France in 2003. Throughout its 27 years, however, it was restricted to subsonic flight over land.

"The technology has been there since before Concorde, so it's really an economic problem," according to Teal Group senior analyst Richard Aboulafia. "Mass supersonic transport is brain dead; the only way to make it happen is in a fully socialistic environment, which is why the U.S. stepped rapidly away when NASA canceled its program in the 1960s.

"There's a lot to be said for long-term interest in a supersonic business jet, however, because commercial economics don't apply there. And I have no doubt there will be something there someday—and perhaps NASA research will play an enabling role. But it will be part of the private transport market, not the public one."

Lowering the boom

NASA continued research along the peripheries of commercial supersonic transport from the 1970s through the end of the century, primarily as part of the High Speed Research (HSR) program, which was phased out in 1999.

"It was a major part of NASA's aeronautics research effort at the time, and NASA stayed involved in supersonics; but the effort got a lot smaller after HSR," Coen points out. "We participated with DARPA when they started the Quiet Supersonic Platform, looking for a low-boom, quiet, 100,000-lb Mach-2.4 airplane. That demonstrated a portion of a key technology for sonic boom reduction—the idea of sonic boom shaping, using a modified F-5 in a program known as the shaped sonic boom demonstrator.

Supersonic air travel has been possible for decades, but, as with the Concorde, has not been commercially viable.

"That got companies excited that they might be able to build a supersonic airplane with a boom low enough to enable flight over land. The business jet community thought the next product they could bring to market might be a supersonic airplane. And it was really their interest that, when NASA reformulated its aeronautics research back in 2006, drove us to include a supersonic research program as part of our fundamental aeronautics research in general," he continues.

Today NASA supersonics is a much smaller program, about $40 million a year, including in-house research at the four primary aerospace centers, according to Coen, with little evidence that this will change in the near term.

"We haven't seen an expansion in supersonics in the past couple of years, although aerospace in general is expanding," he says. "There are a number of things in the supersonics program we feel are ready to move toward an integrated study, but we haven't been funded to do that yet."

Joining forces

One possible solution, which NASA has used extensively throughout its full range of R&D programs, is partnerships. Coen credits these arrangements, whether with the Air Force, FAA, other nations, or organizations such as ICAO (International Civil Aviation Organization), for much of the agency's success to date in supersonics.

"The Air Force goes back and forth on whether a future long-range strike vehicle should have supersonic cruise or be a subsonic aircraft with supersonic dash capability, but they are pursuing technology for potential supersonic vehicles, which overlaps with our effort—especially with concern to engine materials, such as ceramic

A Dryden F-15B flew in the supersonic shockwave of a modified F-5E jet in support of the Shaped Sonic Boom Demonstration project. The F-5 demonstrated a method for reducing the intensity of sonic booms.

turbine blades and components," Coen says.

"We also work closely with the FAA on what the next generation of our National Airspace [System] will look like. We want that to be friendly to different types of aircraft, including, from our unique perspective, supersonic. And we want those aircraft to be able to use their high speeds as long as possible while inserting themselves safely into the terminal environment."

NASA also is providing the FAA and ICAO with its perspective on what research is needed to fully understand all of the aspects of community response and eventual acceptance of reduced sonic boom noise.

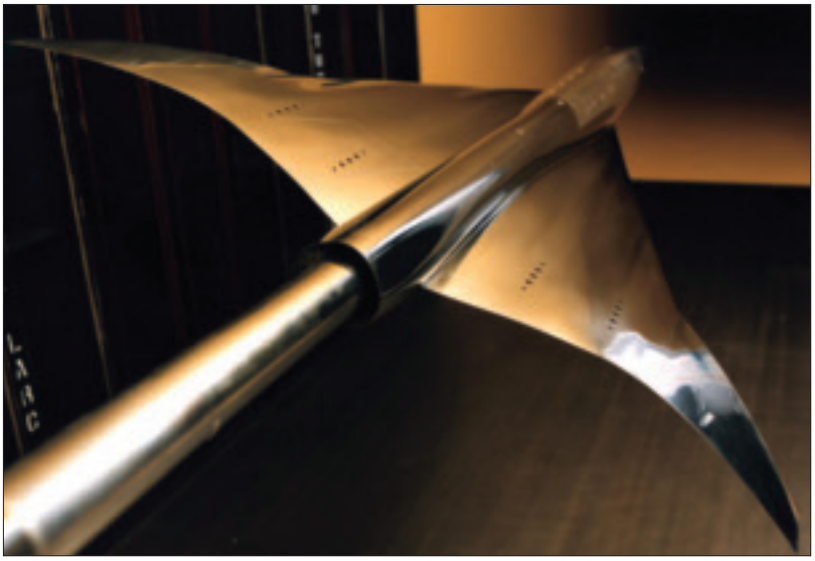
"That is clearly an international concern, and we are looking for more partners. One partner we have there is the Japan Aerospace Exploration Agency, which has a small but dedicated group working on supersonic aircraft technology," he says. "We have two cooperative agreements with them, one looking specifically at the interaction of sonic booms and structures—how people indoors react to booms—the other on the performance side, foundation concepts on how to achieve low-drag laminar flow on as much of the aircraft as possible."

Internally, he sees possible help from NASA's Integrated Systems Research Program, which stood up in 2009 and currently has one project—Environmentally Responsible Aircraft (ERA), intended to bring technologies for 'green' airplanes to a higher level of technology readiness.

"Some of the technologies related to lightweight, flexible supersonic aircraft could be explored, to some degree, as part of that effort. Higher temperature engine materials and low-emissions technologies also are among efforts the supersonic budget could benefit from if pursued in ERA," Coen says. "We proposed a flight research effort that would demonstrate some of our key boom reduction and boom efficiency technologies as a separate project for ERA, but that was not approved and is not directly under consideration at the moment.

"But we hope to have an opportunity to introduce a sonic boom flight research effort as a new project, if our budget continues to expand, so we can validate some of these key technologies in flight. And while we have looked at exploring how people react to low-amplitude sonic booms, using a dive maneuver with an existing F/A-18, it is clear that to change the rules on supersonic flight over land we will have to demonstrate these low-noise booms over an arbitrary community not used to sonic booms and measure their reactions. So we see a dual use for a flight research program—technology validation and community response. But that is not currently funded, either."

1n 1998, Langley researchers conducted supersonic tests in the Unitary Plan Wind Tunnel on a nonlinear design for a supersonic transport. Although the drag reduction measured during the tests was not as great as that predicted using computational methods, significant drag reductions were achieved.



Passenger plane possibilities

Despite an apparent consensus that any likely commercial supersonic plane in the foreseeable future will be a business jet, not an airliner, NASA is continuing to fund studies on developing a passenger plane, one that would be smaller than the 300-seat aircraft envisioned earlier.

"One thing we are doing now is looking at a smaller airplane, more along the lines of 100-150 passengers," Coen explains. "That makes the sonic boom problem lighter. It also is a lower Mach number, around 1.8-2.0, which makes both the airframe material and propulsion system challenges much more solvable than when we were looking at Mach 2.4.

"The key technology that really has proven itself is the concept of shaping the sonic boom so that it becomes a sound more like distant thunder than the disturbing, very loud booms all supersonic aircraft to date have made. In terms of PLdB [per-

ceived loudness, in decibels], you go from over 110 to somewhere around 70. It's hard to describe it as a sonic boom, because all of the boom really has gone out of it. If we can achieve that for a larger airplane, then we possibly could get the rules changed to allow us to fly supersonic over land, which would really make the airplane more economically appealing and could lead to industry pursuing such projects. That is the longest pole in the tent."

Seeing the whole picture

Lou Povinelli, a supersonics project scientist at Glenn, says accomplishing that will require resolving issues involving all elements of the vehicle.

"No one discipline can be treated separately if we want to get a low boom signature on the ground," he tells *Aerospace America*. Povinelli adds, however, that sonic booms also are only a part of the problem. "Certainly there is concern over the effects such an aircraft would have if put in service. Things we have to look at include airport noise—an engine system that will meet current noise requirements—and engine emissions, primarily at high altitudes, as we have other programs looking at subsonic aircraft. We are focusing on what happens at 45,000-50,000 ft, in terms of introducing particulates into the atmosphere and the effects that might have on climate.

"We're also faced with an operational problem with the engine itself. When we climb and accelerate to higher Mach numbers, we will be operating at higher temperatures throughout the supersonic portion of the flight. So we are concerned about the durability of materials used in the engine, as it will be operating on the order of 2,500-3,200 F. We need higher temperature capabilities to come up with engines that will have sufficient life to be used in a commercial aircraft."

Pushing the state of the art

Aircraft that are state of the art in sustained supersonic flight are the fifth-generation F-22 Raptor and the F-35 Joint Strike Fighter. The materials they incorporate, as well as some design elements, may be applicable to commercial aircraft.

"In a supersonic design, I think we would be looking at inlets that are much more blended, to the extent possible, than you have in any commercial aircraft today. There are problems if you bring the engines in closer, but I think the gain that can be achieved with streamlining will drive us that way," Povinelli says. "If you look at the F-22, for example, you have a good example of blending inlets closer to the fuselage. But we aren't ruling out suspending off the pylons—closer to the fuselage, yet still suspended."

The F-22 has supersonic design elements that may be applicable to commercial aircraft.

Fighter programs are only partly applicable, however, as they are intended to go supersonic intermittently, primarily in dash mode, despite having a supersonic cruise capability, he adds. Nor do they fly with the frequency or range that would be required for a commercial aircraft.

"Another concern is the variability required for the engine at takeoff, where you would like it to look like a high bypass—as we now have on commercial subsonic aircraft—to meet noise requirements on takeoff and landing. But for supersonics, the optimum regime is no longer high bypass but turbojet, where you put all the propulsive flow through the main engine nozzle. That introduces a need for variability in takeoff and landing with flight at high altitudes," he says.

"We also want to minimize the diameter of the engine so it does not contribute to the sonic boom signature. Hanging four large engines under a wing does not help us in terms of minimizing the boom signature on the ground. So we have a significant number of problems to work on."

The funding question

The question is whether the small amount of money NASA is devoting to supersonic research—from the already tiny share of the funding allocated for all aeronautics—is sufficient to move forward in any of the desired areas. Even the active involvement of industry could do more harm than good, according to Aboulafia.

"Noise is the one place where NASA research may play a key enabling role, but economic and market concerns must be solved before you ever get to the point of needing to resolve speed or noise issues," he says. "I think it would be possible only with massive subsidies at all levels, and

more for rich thrill-seekers than for mass transport users. At present, there is enough [market potential] to sustain a viable program, but not an industry—and two programs probably would kill each other."

Business jet hopes

At this point, Teal Group and NASA agree the most likely market, at least through the next two decades, is for business jets.

"As it evolves after 2020, we've done long-term studies based on various assumptions, and it looks like a 20-25 per year program for an $80-million aircraft, in today's money," Aboulafia says, noting that this is about one-third more than the new Mach 0.9225 Gulfstream G650, scheduled to begin delivery in 2012 as the fastest subsonic commercial jet.

The Gulfstream G650 is scheduled to begin delivery in 2012 as the fastest subsonic commercial jet.

"The supersonic business jet profile also includes a comfortable stand-up cabin—not a Learjet cabin, but something more equivalent to a Gulfstream 250. It depends on configuration, but probably around six to 12 passengers and two or three crew, which any good business jet can do today."

With some 90% of business jet purchases based on cabin and range, past attempts to compete solely on speed have had little success, he adds.

"The G650 launch decision was predicated on the idea that a little speed goes a long way, but even then they put the emphasis on range and cabin. A supersonic also would need to be transatlantic and at least one-stop transpacific—around 4,500 n.mi. The G650, at 7,000 n.mi., also is the longest range business jet; the Dassault Falcon 7X is next, at about 5,000 n.mi. So you would have to convince people to pay a significant premium, to say nothing of the additional operating costs."

A dream that won't die

But the dream of speeding 100-300 commercial passengers around the globe—in greater comfort than Concorde offered, and with the ability to fly supersonic over land as well as sea—refuses to die.

"The economic slowdown has slowed the introduction, but I think there will be a supersonic business jet in the decade of the '20s—and I think we will still be making progress on the technologies that will enable a larger supersonic airliner in the 2030-2035 timeframe. There are many factors, but I think the technology will certainly be there," Coen predicts. "NASA really is looking long term, to the introduction of more capable supersonic airliners that are more accessible to use by the general public.

"Our vision includes an N+2 vehicle [two technology generations into the future], which is a 35-75 passenger, transatlantic-capable small supersonic airliner with sonic boom characteristics that will enable it to fly over land in the 2025 timeframe—a business-class-type airliner. Beyond 2030, we're looking at an N+3—100 to 200 passengers at supersonic speeds over water and, hopefully, in at least limited corridors, over land and, eventually, with unrestricted overland operations."

For Aboulafia, prospects for a full-size commercial supersonic airliner remain faint and distant, certainly compared with what is starting to be seen as an inevitable development in the business jet market. But he is perplexed at the failure to develop one other market—one that could do for supersonic airliners what development of the KC-135 Stratotanker did for the Air Force in furthering Boeing's introduction of the 707, the world's first commercially successful jet airliner, the same year NASA was born.

"It is still surprising to think this is one of those great unmet military and government needs. You can bomb someplace in a matter of hours, but you can't transport a strike or hostage rescue or disaster relief team any faster than a commercial jetliner can," he says. "I would have thought the government would regard this as an essential capability to pursue. So while they tend to belittle SST research as some form of clueless socialism catering to the rich, in reality there is a compelling national interest in having that capability. We've built all sorts of programs that did not make nearly as much sense.

"When was the last time the government spent money on a military airframe other than a fighter? And nonrecurring cash has been very hard to come by. For years, there may have been a view that they could use the Concorde in an emergency, or, more likely, that world trouble spots were relatively confined, and it was easier to preposition in the old days. Today, things are a bit more diffuse. So there does appear to be an even more compelling reason now for the government to get involved in this technology."

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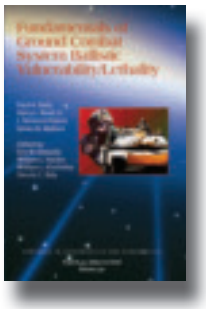

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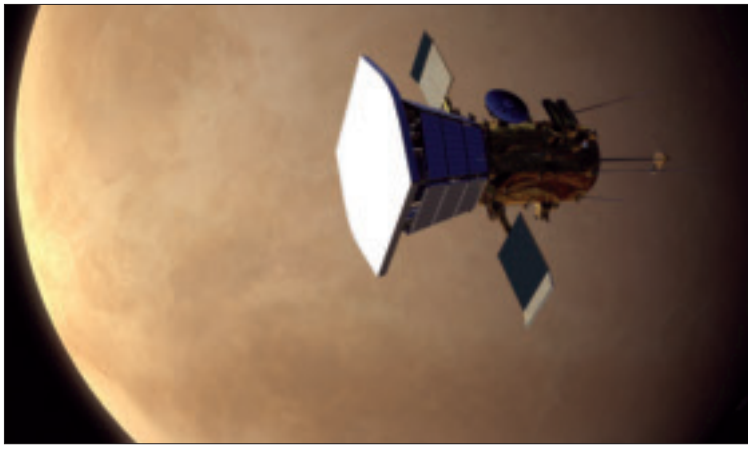
In the tradition of *Star Trek*, NASA's Solar Probe Plus (SPP) will go where no spacecraft has gone before, on a daring and technologically demanding adventure that will take it to our nearest star, the Sun.

At its closest approach, the probe will fly by Earth's fiery neighbor at a distance of just 7 million km. It will be the first robotic craft to dive into the low solar corona—the Sun's extended outer atmosphere. To do this, the probe itself hides behind a specially developed carbon-composite heat shield that must beat the heat as the spacecraft pumps out science data.

Because of its proximity to Earth, the Sun is among the most fully studied stars. Yet there are some secrets it still holds tightly. SPP is designed to help solve two fundamental mysteries: How the Sun's corona is heated, and how the solar wind is accelerated.

SPP's mission is part of NASA's Living With a Star program. The small, auto-sized spacecraft now under development at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, is slated for launch no later than 2018. APL is responsible for formulating and conducting the probe's mission. NASA Goddard manages the program, with oversight from the Heliophysics Division of the agency's Science Mission Directorate.

The booster for the spacecraft is based on an Atlas V 551, with an upper stage that is still being defined. The NASA budget for SPP is $1.2 billion for the entire mission, out to 2018, plus seven years—to 2025. That tally—in 'spend year' dollars—includes the launch vehicle and operations, along with money already spent on the project.



SPP, fully deployed in cruise configuration, will fly past Venus during one of the seven gravity assists that sends it closer to the Sun. Credit: JHU/APL.

WALK RIGHT IN

Since the mid-1970s, NASA has stacked up reviews and reports to characterize a solar probe mission. Now, decades later, bolstered by a 2003 National Research Council decadal survey report that put priority on solar and space physics studies, the agency has given the green light to such a project, to be executed "as soon as possible."

Over the years, several changes have made SPP a doable mission, explains Richard Fisher, director of NASA's Heliophysics Division. Early plans had the spacecraft use a gravity assist from Jupiter in order to achieve a very highly inclined orbit.

"I think the second thing that has changed to enable this mission is the abandonment of a nuclear power system…needed because of the Jupiter gravity assist," Fisher tells *Aerospace America*. "You can use solar panels, but they have to be quite large. The key event that enabled us to think about this mission," he says, was finding "that we can achieve the scientific goals by being near the plane of the ecliptic...and use an assist from Venus."

by Leonard David
Contributing writer

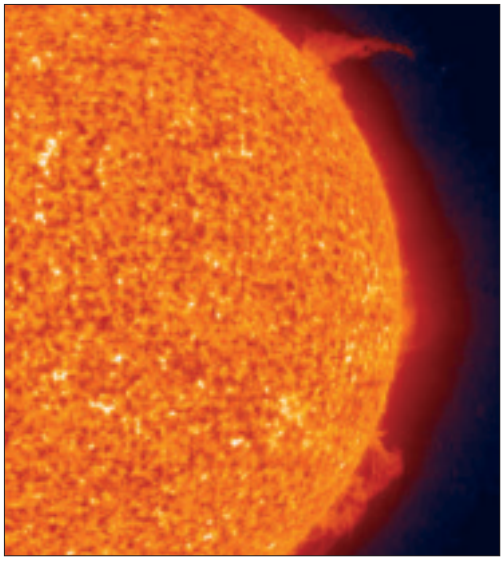
Fisher portrays SPP's mission as "much more exploratory" than what NASA typically attempts. "Usually, we're aiming at a well-enunciated scientific problem. There's a lot of exploration and discovery in this mission…it's going to be quite an advance in space physics, I think."

As now defined, SPP is a compact, solar-powered vehicle that will tip the scales at about 1,350 lb. Preliminary designs include an 8-ft-diam., 4.5-in.-thick carbon-foam-filled solar shield atop the spacecraft body. At its closest passes of the Sun, SPP must stay alive while beating the heat—thwarting a solar intensity more than 500 times what spacecraft encounter while orbiting Earth.

The mission plan calls for the craft to orbit the Sun 24 times over a seven-year period, steadily 'walking in' more closely with each orbit. Seven Venus gravity assists are needed to gradually reduce perihelion, the closest point to the Sun. On the final three orbits, SPP will fly to within 8.5 solar radii of the Sun's 'surface,' or about 3.7 million mi. In doing so SPP will eclipse the closest solar pass to date, made by the Helios 2 spacecraft, a joint venture of the Federal Republic of Germany and NASA.

"Solar Probe Plus is going where no spacecraft has gone before," says Lika Guhathakurta, SPP program scientist at NASA Headquarters. "For the first time, we'll be able to 'touch, taste, and smell' the Sun."

The point is that what SPP will find by perusing unexplored territory is unknown. "The possibilities for discovery," Guhathakurta adds, "are off the charts."



NASA's STEREO mission returns images of solar prominences. Credit: JHU/APL.

SHADOW DANCING

The reasons that SPP fits within the guidelines of NASA's Living With a Star effort are clear: We live in the extended atmosphere of an active star. While sunlight enables and sustains life, the Sun's variability produces streams of high-energy particles and radiation that can affect life.

Moreover, under the protective shield of its magnetic field and atmosphere, the Earth is an island in the solar system where life has developed and flourished. The origins and fate of life on Earth are intimately connected to the way Earth responds to the Sun's variations. Understanding the changing Sun and its effects on the solar system, life, and society is NASA's mantra in examining the connection between the two bodies.

Under the Living With a Star projects, SPP is part of a developmental approach to sorting out what is changing with time and what is changing with space, as Fisher sees it. Nevertheless, he points out, the SPP mission is rife with technical 'gotchas.'

What is Fisher keeping an eye on as the project moves forward from PowerPoint to probe development?

"I think it's the integrated system of the spacecraft. It's going to a strange place that is really exotic. We're attempting to hide everything behind a shield. So there are all kinds of things that crop up as a result of that," Fisher says.

Fisher confirms the view that the SPP's thermal protection system is vital, as are the craft's power system, navigation, and stability. "They are very important, because you can't have this thing wobble very much…or have something that is going to pop out from behind the shadow and melt. I think it's the environmental challenges that are the real stressor for this mission," he says.

There are countless cross-your-fingers features, Fisher observes, both in building the spacecraft and in the activity it is destined to carry out. "It is the first time that we'll be that close to a star. There are a lot of firsts…and a lot of unknowns. We know that it's going to be significant from the outset, just in the discovery mode. It might be, in some sense, one of the riskiest missions we've ever undertaken," he believes.

TOP-PRIORITY SCIENCE OBJECTIVES

Clearly SPP is an ambitious mission, one that will require significant technology development in several major areas. After the decades it has taken to pull such an en-

deavor together, the project today has come about because of two factors, notes Brian Morse, SPP project manager at APL. The first is "getting the technology in place to be able to do the mission in an affordable and technically viable manner," Morse tells *Aerospace America*. "The other is the overall mission design, which has evolved over the years. Solar Probe Plus is notably less expensive than previous concepts and yet is able to achieve the desired science. It took a while, I think, to come around to something that would fit within budgetary constraints and was technically viable."

Morse adds that one major SPP milestone that APL is pushing toward is a mission design review, now targeted for this summer.

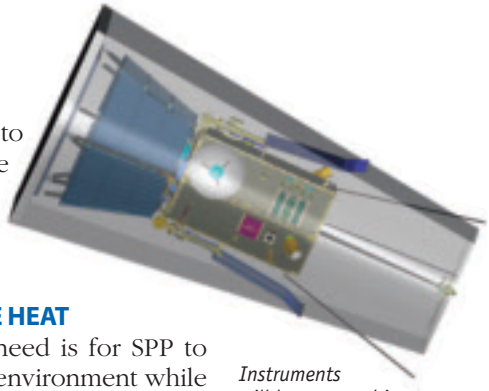
SPP will be able to take advantage of advances in instrumentation that have occurred over the years. But its top-priority science objectives date all the way back to the late 1950s, and these have not changed, says Andy Dantzler, APL's civilian space program area manager. They are:

- Determine the structure and dynamics of the magnetic fields at the sources of the fast and slow solar wind.
- Trace the flow of energy that heats the Sun's corona and accelerates the solar wind.
- Probe the mechanisms that accelerate and transport energetic particles at the Sun and in the inner heliosphere.
- Explore the dusty plasma phenomena in the near-Sun environment and their influence on the solar wind and on energetic particle formation.

Jim Kinnison, APL's SPP mission system engineer, says much of the spacecraft, especially in the electronics, avionics, and power systems, is derived from a heritage of work done earlier at APL. SPP will draw from the New Horizons spacecraft now en route to Pluto; the MESSENGER (Mercury surface, space environment, geochemistry, and ranging) mission to Mercury; STEREO (solar terrestrial relations observatory); and another APL undertaking now in the works, the Radiation Belt Storm Probes mission.

"So there is a continuum of technologies there from mission to mission, in the areas of structures and avionics, power system control, and guidance and control," Kinnison says. "It is true that we've got some new technologies to develop. Those are limited to a few areas."

That being said, Morse notes that SPP is a 'purpose-built' craft, one that necessitates new technologies but also endeavors to use heritage hardware to save money and reduce risk, "even when you do have a unique mission like this."



Instruments will be retracted inside the umbra of the thermal protection system to limit solar exposure. Credit: JHU/APL.

BEATING THE HEAT

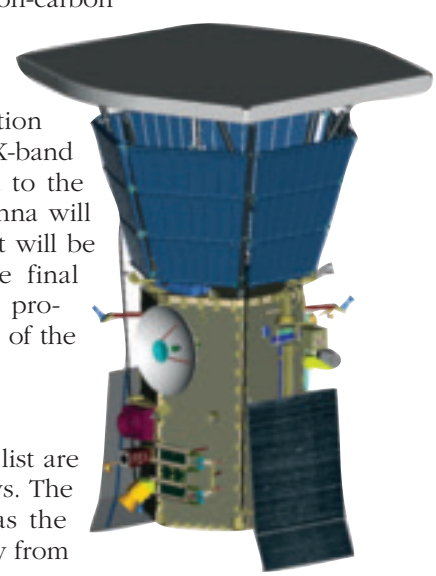
An obvious technology need is for SPP to survive an extreme solar environment while operating at standard space temperatures. The 3-m-high spacecraft will be packaged behind a carbon-carbon thermal protection system, which will experience temperatures of 1,400 C on its Sun-facing surface. This solar shield concept was partially influenced by designs of MESSENGER's sunshade. In addition, SPP is to use actively cooled solar arrays for power generation.

"The shield itself is basically a carbon-carbon shell that's filled with carbon-carbon foam," says APL's Kinnison. "Where we are pushing the boundary is in mass efficiency for that material," and also in using a very low-density foam that has little pedigree in terms of space application. Getting close scrutiny is how best to shape the foam and bond all of the material to the carbon-carbon composite shield.

That thermal protection system shield is 2.3 m in diameter. Struts are used to attach the shield to the tightly packaged spacecraft, protecting the bus and payload within its own self-cast umbra during solar encounter. The science instruments are fastened either directly to the bus, on a standoff bracket near the fairing attachment, or on a science boom extended from the rear of the spacecraft.

As diagrammed through trade studies, the three-axis-stabilized SPP would be outfitted with three deployable carbon-carbon plasma wave antennas mounted 120 deg apart on the side of the hexagonal bus that houses the probe's subsystems. A combination Ka-band high-gain antenna and X-band medium-gain antenna is affixed to the craft's body. The high-gain antenna will pump out 128 Gb of science that will be downlinked during each of the final three solar encounters. SPP also provides that high data rate for most of the earlier 21 orbits.

Solar Probe Plus starts out with solar array panels in a stowed position. Credit: JHU/APL.



INSTANT GRATIFICATION

Also on the key SPP technology list are the specially designed solar arrays. The arrays will retract and extend as the spacecraft swings toward or away from

the Sun during several loops around the inner solar system, making sure the panels stay at proper temperatures and power levels. When the spacecraft is close to the Sun, the solar-cell-laden hardware is extended out.

"We refer to it as our secondary array," says Morse. "It's really the tip of the solar array that is extended…out into the penumbra of the Sun," exposed to extremely high heat loads. "Obviously, we have to get that heat away from the cells. So the cell development is another key technology, as is the cooling system for the solar arrays."

The bulk of the solar array panel is filled with 'primary cells' similar to the cells used on the MESSENGER mission to Mercury; the angled panel on the end of the solar arrays uses cells designed to withstand the high illumination during perihelion.

"It's impossible to reject the level of heat through simple passive radiation. So we have an active cooling system that circulates water behind the solar arrays, up through radiators that radiate the heat out," Morse says. "So that's a new development that we're working on…taking a step-wise advancing technology approach." A number of configurations have been reviewed—systems that need to work well not just near the Sun, but also in cold regimes that the SPP encounters on its swing-outs to grab gravity assists from Venus.

APL spacecraft engineers are also focusing on the solar environment itself. "We are flying through an area around the Sun that's never been visited before. So the exact environment is not known. We have to extrapolate that from data that we have…and determine the environment that we're going to see," says Morse. With SPP speeding along at nearly 200 km/sec, he says, running into dust at that velocity has to be taken into account in the design of the spacecraft.

"Staying pointed at the Sun is so important," Morse notes, with SPP having a backup safe-mode system that is independent of the main control systems. "So if something does go awry with the main control system, the safing system will prevent SPP from coming off the Sun by enough to hurt the spacecraft."

In terms of additional engineering marvels for SPP, APL's Dantzler tells *Aerospace America*, "This is a very instant gratification kind of mission, unlike your typical planetary mission. The good news is that 90 days after launch we'll already be making our first pass around the Sun. The bad news is that we won't have time for a long checkout campaign…if we want that first pass to do real science."

ACCOMMODATING UNKNOWNS

"A major concern that we have for the mission, one we've been working on for quite a while, is how end-to-end testing is done for something like this," says Kinnison. "And the bottom line…there isn't a facility that's big enough to do a full-up, 512 Sun exposure on the entire shield, plus spacecraft, and everything that goes along with it."

A multistep process will involve building test coupons from which prototypes are to be fabricated, likely not full-scale. "We again test the heck out of those and understand their properties," he adds. "By the time you get done with this process, you build up a confidence in your modeling, so that you believe you understand how the system works. On top of that, we have the ability to simulate the heat input from the heat shield into the spacecraft itself."

Normal thermal vacuum testing also is on tap, along with simulator runs on the SPP's shield and solar arrays that will test the overall system. "In doing all this testing,

Key investigations

Last September, NASA announced the suite of science investigations selected for the Solar Probe Plus mission. The total dollar amount for the five investigations is approximately $180 million, for preliminary analysis, design, development, and tests.

The experiments seek to solve two key questions in solar physics: Why is the Sun's outer atmosphere so much hotter than the visible solar surface? What propels the solar wind that affects Earth and our solar system?

"We've been struggling with these questions for decades, and this mission should finally provide the answers," says Dick Fisher, director of NASA's Heliophysics Division in Washington, D.C.

The selected investigations are:

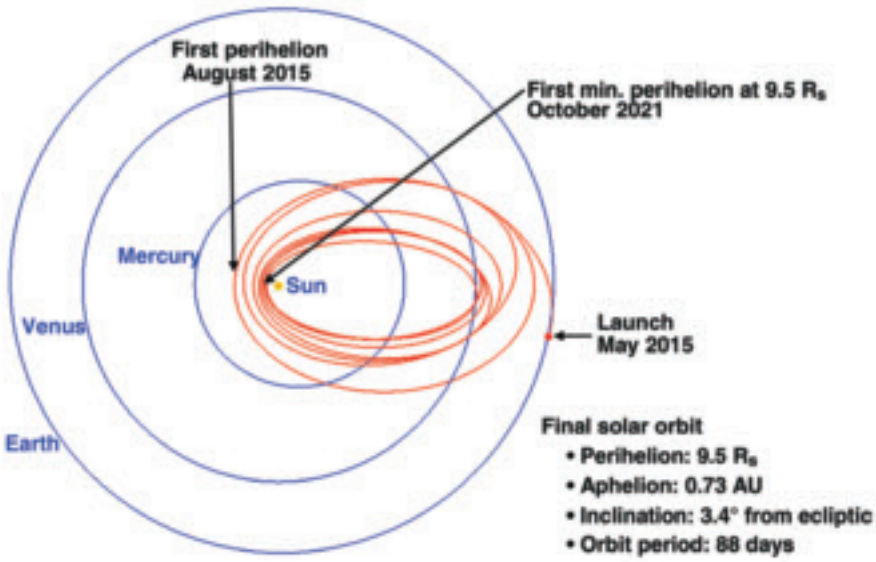
•Solar Wind Electrons Alphas and Protons Investigation: This will specifically count the most abundant particles in the solar wind—electrons, protons, and helium ions—and measure their properties. The investigation also is designed to catch some of the particles for direct analysis. The principal investigator (PI) is Justin Kasper of the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

•Wide-field Imager for Solar Probe Plus: This telescope produces 3D images of the Sun's corona. The experiment will also provide 3D images of the solar wind and shocks as they approach and pass the spacecraft. The PI is Russell Howard of the Naval Research Laboratory in Washington, D.C.

•Fields Experiment: This will make direct measurements of electric and magnetic fields, radio emissions, and shock waves that course through the Sun's atmospheric plasma. The PI is Stuart Bale of the University of California, Berkeley.

•Integrated Science Investigation of the Sun: This investigation consists of two instruments that will monitor electrons, protons, and ions that are accelerated to high energies in the Sun's atmosphere. The PI is David McComas of the Southwest Research Institute in San Antonio, Texas.

•Heliospheric Origins with Solar Probe Plus: This noninstrument investigation will be led by a PI who guides 'big picture' science tasks as the spacecraft penetrates the Sun's atmosphere. Another duty of the PI is to ensure that adjacent in-situ instruments do not interfere with each other as they sample the solar environment. Marco Velli of JPL in Pasadena, California, is the PI and the mission's observatory scientist.



The baseline SPP trajectory uses seven Venus flybys to reach a minimum orbit perihelion of 9.5 solar radii in 6.4 years. Credit: JHU/APL.

all this modeling, all this validation, you build up the confidence you need that your systems are going to work," Kinnison continues. "Plus you appropriately build margins into the system that will accommodate unknowns."

Morse adds that from the thermal capability and properties standpoint, SPP testing can be done at the subscale level. The shield also can be assessed at that level. "Then we still build a full-scale prototype, but that is more to address the issues of manufacturability, mechanical properties of the overall shield, and so forth. We'll do simulations, but it's not unusual to have a number of things that fly in space that can't be tested completely as an assembly."

PUTTING THE PLUS INTO SOLAR PROBING

In various conceptual forms, SPP has been five decades in the making. It is viewed as the keystone of NASA's Living With a Star program and as one of history's most significant solar research initiatives.

The original mission, says NASA's Fisher, was a kind of one-shot effort—the probe would pass the Sun and yield on the order of 10 days of prime data operation, then head back out toward Jupiter. Hence the current name reflects its expanded mission. "Solar Probe Plus gives an observer several hundred days, rather than just a few," says Fisher. "So the 'plus' is better and richer data.

"This is a fairly long mission to start with; it isn't over the first time it goes past the Sun. We intend to use the spacecraft in a number of encounters, to raise the amount of time that we're really near the Sun…to a scientifically significant amount."

SPP will be the defining mission in solar physics for the next several decades, "and one of the definitive science missions of the 21st century," says Gary Zank, Pei Ling Chan eminent scholar in physics and director of the University of Alabama at Huntsville's Center for Space and Aeronomic Research.

UA at Huntsville is one of six institutions selected by NASA to provide scientific leadership on SPP. "This is an opportunity to better understand the Sun's atmosphere, one of the great scientific mysteries in our universe," Zank says.

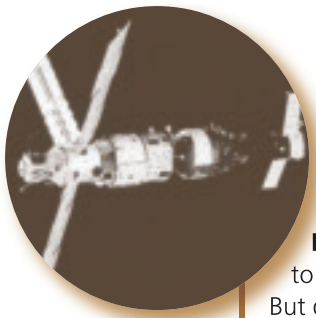
For solar astrophysics, SPP is the equivalent of a Hubble-class mission, so the data gathered are expected to be "really dramatic and revolutionary" in terms of their effects on the field," says solar physicist Jonathan Cirtain of NASA Marshall.

Similar praise comes from Russell Howard of the Naval Research Laboratory. The principal investigator for SPP's wide-field imager, he will be heading one of the mission's five science efforts. His experiment will see the solar wind and provide 3D images of clouds and shocks as they approach and pass the spacecraft.

Says Howard, "We'll be flying through the structures that we've only seen from 100 million miles away," with the imager providing close-up looks at mass ejections, streamers, shocks, comets, and dust. He and his team, he says, feel "like the early voyagers of the Earth: We don't really know what to expect, but we know whatever it is, it is going to be spectacular."

Out of the

25 Years Ago, February 1986



Feb. 20 A Proton launch vehicle boosts the first element of the USSR's Mir space station into orbit. Known as the core module or base block, it enters LEO and is the first of the six modules that eventually will comprise the station, which is to serve as a lab for microgravity and related research. NASA Web site, history.nasa.gov.

50 Years Ago, February 1961

Feb. 1 The all-solid-fuel three-stage Minuteman ICBM makes its first free-flight test from Cape Canaveral, Fla. Although this is mainly a test of the first stage, and the missile with its Avco Mk 5 reentry nosecone impacts 4,300 mi. downrange (2,000 mi. short of its full design range), Air Force Chief of Staff Gen. Thomas D. White hails the flight as "one of the most significant steps this nation has ever taken towards gaining intercontinental missile supremacy in the critical years just ahead." *Flight*, Feb. 10, 1961, p. 171.

Feb. 1 The Space Surveillance System, an experimental research project at the U.S. Naval Weapons Center at Dahlgren, Va., since 1949, becomes fully operational. *U.S. Naval Aviation 1910-1980*, p. 240.

Feb. 1 It is announced that the USAF Strategic Air Command Ballistic Missile Early Warning System (BMEWS) is operational at Thule Air Base in Greenland. This is the first element of the network, which later includes operational sites at Clear, Alaska, and Flyingdales, England. BMEWS stations comprise a network of radars that can detect and track ballistic missiles or nuclear warheads heading toward the U.S. D. Baker, *Flight and Flying: A Chronology*, p. 374.

Feb. 4 Sputnik 7 is launched from the USSR and turns out to be the Soviets' first attempt at a launch toward Venus. But due to a failure in the launcher's third stage, the spacecraft does not leave its parking orbit around Earth. It remains for 22 days in a decaying orbit, then burns up in Earth's atmosphere. On Feb. 12 a similar vehicle, initially designated Sputnik 8, is launched. Also intended to be a Venus probe, it is renamed Venera 1 when it leaves Earth's orbit. Although all contact with it is lost on Feb. 27, it passes within 62,000 mi. of Venus on May 19, becoming the first made-made object to make a planetary flyby. It then enters a heliocentric orbit measuring 67 million mi. by 95 million mi. *The Aeroplane*, March 10, 1961, p. 265; *Flight*, Feb. 24, 1961, p. 232.

Feb. 13 France's Dassault Mirage III interceptor, powered by a British Rolls-Royce Avon RB.146 turbojet, makes its maiden flight at Melun-Villaroche. It is thus considered a Franco-British flight. The plane was recently chosen to equip the Australian Air Force. *The Aeroplane*, Feb. 24, 1961, p. 192.

Feb. 15 A prototype of the giant Rocketdyne F-1 rocket engine achieves a thrust of 1,550,000 lb in a static test at Edwards AFB, Calif. Later, five F-1s power the Saturn V launch vehicle that takes humans to the Moon. *Aerospace Year Book, 1960*, p. 470.

Feb. 16 The four-stage all-solid-fuel Scout launch vehicle makes its first spacecraft launch, boosting Explorer 9, a 15-lb Echo-type balloon satellite. This is also the first satellite launch from NASA's Wallops Island, Va., site. *Flight*, Feb. 24, 1961, p. 232, and March 3, 1961, p. 271.

Feb. 17 The Discoverer XX, launched from Vandenberg AFB, Calif., carries an infrared missile-detection package for use in a test for the Midas program. A day later Discoverer XXI is also sent up, to test the restartable Agena-B upper stage while in orbit. Both the Midas and Samos programs will use the restartable Agena-B for modifying the satellites' orbits during their missions. The Agena-B is successfully restarted by a radio command on Feb. 19. *The Aeroplane*, Feb. 24, 1961, p. 192.

Feb. 21 An unmanned Mercury-Atlas MA-2 is successfully launched into a ballistic flight to an altitude of 107 mi. and a range of 1,425 mi. According to NASA, this is to date "the most severe test of the Mercury program." It replicates the most extreme reentry flight path the capsule could take should there be an emergency abort launch.

Past

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

In this flight, the reentry bearing rate is 30% higher than that planned for normal orbital reentry. *Flight*, March 3, 1961, p. 268.

Feb. 21 Both the Transit 3B and LOFTI (low-frequency transionospheric) satellite are launched as a 'piggyback' pair on a Thor-Able-Star launch vehicle from Cape Canaveral, Fla. However, after the second stage experiences an improper burn, the two spacecraft fail to achieve the correct orbit. But the Transit 3B does stay in orbit for 39 days and provides the first successful demonstration of the navigation satellite system. *U.S. Naval Aviation 1910-1980*, p. 240.

Feb. 24 Radio signals are successfully transmitted from Jodrell Bank in Cheshire, England, reflected from the surface of the Moon, and received at Sydney, Australia. *Flight*, March 3, 1961, p. 267.

75 Years Ago, February 1936

Feb. 1 The initial version of the DC-3, called the DST (Douglas Sleeper Transport), is the highlight of the Los Angeles National Pacific Aircraft and Boat Show, which opens in the city's Pan-Pacific Auditorium. The aircraft made its first flight on Dec. 17, 1935. *The Aeroplane*, March 11, 1936, p. 330; R. Francillon, *McDonnell Douglas Aircraft Since 1920*, p. 232.

Feb. 9 Airmail service between England and Nigeria begins. The weekly transport connects the mail service now handled between Khartoum, Sudan, and Cape Town, South Africa. The carrier is Daedalus Air Lines, a subsidiary of Imperial Airways. *The Aeroplane*, Feb. 5, 1936,p. 153, and Feb. 12, 1936, p. 212.

Feb. 9 Brig. Gen. William 'Billy' Mitchell, an Army Air Corps officer highly controversial for his outspoken views on establishing a separate and strong air force, dies in New York of heart ailments. An organizer of the Army Air Service during WW I, he was also an outstanding flier and combat commander. He commanded the Allied air forces in several battles and, following the war, began openly advocating an air force independent from the Army and Navy, a view opposed by senior officers. In 1925 he was court martialed and suspended from service for five years because he openly criticized the decreasing emphasis on aviation by the War and Navy Depts. Mitchell resigned from the Army in 1926 to devote his time to lecturing about the importance of air power. Although he did not live to see his goals realized, years later his recommendations were incorporated into official U.S. military policy. In 1947 President Truman created an independent air arm, the USAF. *The Aeroplane*, Feb. 26, 1936, p. 251.

Feb. 21 In British defense exercises, RAF planes from an aircraft carrier fly backward and forward over the Rock of Gibraltar trying to dodge Lewis guns and searchlights. *The Aeroplane*, March 4, 1936, p. 283.

Feb. 23 Two mail-carrying, unmanned 'rocketplanes' are launched from frozen Greenwood Lake, N.Y., in an attempt to reach Hewitt, N.J. One of the planes reaches an altitude of about 1,000 ft before its combustion chamber burns and it spins to the ground. The other flies only 15 sec before its wings are torn off. Despite these failures, the attempts generate considerable worldwide publicity for the possibilities of rockets. W. von Braun and F. Ordway III, *History of Rocketry and Space Travel*, p. 82.

100 Years Ago, February 1911

Feb. 16 The world's first official airmail flights take place in India. Organizing the experiment is Royal Navy Capt. Walter Windham, who obtains permission from the Postmaster General of the United Provinces in India. The letters are flown by French pilot Henri Pequet between the Allahabad Exhibition and the city's post office, where they are canceled with the words "First Aerial Post." They are then forwarded to other destinations by ordinary means. The experiment's great success leads to further flights. *Flight,* March 18, 1911, pp. 223-224.

Feb. 21 U.S. barnstormer James C. "Bud" Mars, who is making an aerial tour of Asia, becomes the first person to fly an airplane in the Philippines, piloting a biplane. E. Santos, *Trails in Philippine Skies*, pp. 10-14.

Feb. 25-March 2 The first Mexican aviation exhibit takes place in Mexico City. President Porfirio Diaz attends. *Aero*, March 18, 1911, p. 203.

TAMU Apophis Study Group (TASG)
http://aeweb.tamu.edu/aemp

Date: April 4-6, 2011

Time: 1PM-11AM (2.5 days)

Stephen Hawking Auditorium
Mitchell Institute
Texas A&M University
College Station, TX 77843

TASG Director:
Dr. David Hyland
+1.979.862.2647
dhland@tamu.edu

Lead Event Manager:
Shen Ge
+1.770.617.4046
shenge86@gmail.com

ISAME brings together an international community of researchers and practitioners to discuss new research results, mitigation and exploration strategies, international collaboration, and public awareness.

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  - **Dr. Simon "Pete" Worden, Director of NASA Ames**
  - **Distinguished Individual from The Planetary Society**

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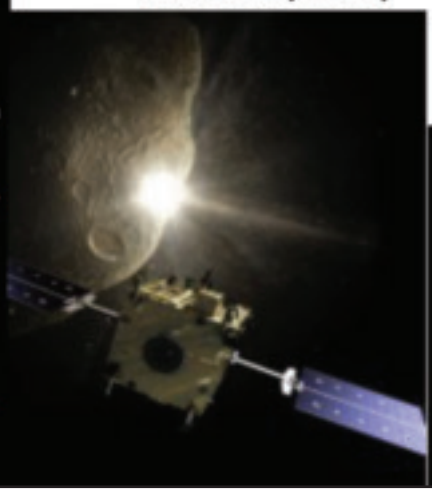
THE PLANETARY SOCIETY



IOWA STATE UNIVERSITY

Department of Aerospace Engineering

TENURE-TRACK FACULTY POSITION: The Department of Aerospace Engineering at Iowa State University invites applicants for a faculty position in the area of autonomous space systems. The appointment will start in August 2011. The search is focused at the Assistant and Associate Professor level, but exceptional candidates who qualify for the rank of Full Professor will also be considered. The primary research interests include robotic and human space exploration, on-board autonomy, and space systems analysis, with background in the disciplines of adaptive guidance and control, navigation, and space flight mechanics. A balanced research program with a strong experimental interest is desirable. An earned Ph.D. or equivalent terminal degree in Aerospace Engineering or closely related field is required at the start date of employment. Underrepresented minorities and women are strongly encouraged to apply. Candidates at the level of Associate or Full Professor must demonstrate a strong record as evidenced by a quality research program, publications, professional recognitions and extramural funding. The successful applicant will be participating in all aspects of the department's mission, including developing a strong externally funded research program, teaching and supervising students at the undergraduate and graduate levels, and participation in service to the university.

The Aerospace Engineering Department currently has 23 faculty. The department is housed in a $50 million state-of-the-art teaching and research complex. Potential applicants are invited to view the department website at http://www.aere.iastate.edu/. Questions regarding the position may be directed to Prof. Ping Lu at plu@iastate.edu.

All offers of employment, oral and written, are contingent upon the university's verification of credentials and other information required by federal and state law, ISU policies/procedures, and may include the completion of a background check. All interested, qualified persons must apply for this position online at:

www.iastatejobs.com
Please refer to vacancy id# 100876

Please be prepared to enter or attach the following:

1) A detailed resume
2) A concise statement of research plans & teaching interests
3) Full contact information for three references

Review of applications will begin March 15, 2011 and will continue until the position is filled.

Iowa State University is an Equal Opportunity/Affirmative Action Employer with NSF ADVANCE funding to broaden the participation of women and underrepresented minorities and enhance the success of all faculty in STEM fields.

EMBRY-RIDDLE
Aeronautical University
DAYTONA BEACH, FLORIDA

http://www.erau.edu/administration/hr_special/dc_aerospace-engineering.html

CHAIR, DEPARTMENT OF AEROSPACE ENGINEERING

The College of Engineering at Embry-Riddle Aeronautical University (ERAU), Daytona Beach, FL
is seeking nominations and applications for a dynamic individual to lead its Department of Aerospace Engineering (AE). The AE Department offers an ABET-accredited undergraduate and Master's degree programs in aerospace engineering. For the past 10 consecutive years, the under-graduate program has been repeatedly ranked by US News & World Report as number one among AE programs offered by non-Ph.D. granting institutions.

MANDATORY QUALIFICATIONS

- Earned doctorate in aerospace engineering, me• Doctorate in aerospace engineering, mechanical engineering or a closely related field.
- Strong record of internationally recognized research, with extensive publication in leading technical journals. Established experience in supervising and graduating doctoral students.
- Demonstrated success in teaching excellence and innovation

PREFERRED QUALIFICATIONS:

- A record of increasing administrative responsibility and the ability to facilitate a positive environment for continuing growth of the AE department and collaboration with other departments.
- Understanding of the aerospace industry's needs in both personnel and technology areas.
- A strong record of research funding, both federal and private.

Please apply through our online application at: **www.erau.edu/jobs, position # IRC35787.** Questions should be directed to Kenny Corbin, Director Recruitment and Compensation at (386) 226-6147 or **kenneth.corbin@erau.edu.** Inquiries and applications will be kept confidential. The anticipated starting date is July 1, 2011.

SAN JOSÉ STATE UNIVERSITY

CHAIR AND PROFESSOR, DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Applications are invited for Chair, MAE Department. Candidates must have an earned doctorate in either Mechanical or Aerospace Engineering with experience and scholarly achievements appropriate for appointment at the rank of professor. We seek a leader who knows and understands both programs and their interfaces, demonstrated ability to develop a vision for and to manage an academic department, the interpersonal skills needed to foster cooperative working relationships among faculty, and a commitment to leading both programs to excellence. Chair's responsibilities are to lead faculty in establishing vision, goals and planning for each of the programs; assist in faculty development ; foster collegial governance; advocate and develop multidisciplinary collaborations; and develop external support for the Department. Our programs are strongly lecture-lab oriented, are well-known for providing excellent hands-on engineering education, and have faculty and students involved in a variety of areas including electronics cooling, alternative energy systems, MEMs design and fabrication, space systems design, CFD, and mechatronics. The College is the leading provider of entry-level engineers to Silicon Valley industry. Salary range commensurate with qualifications and experience. Starting date is August 1, 2011. Employment is contingent upon proof of eligibility to work in the United States. For full job announcement including qualifications and responsibilities, please visit our website at: http://www.sjsu.edu/facultyaffairs/jobs (JOID: 13933). Please send a letter of application, complete curriculum vitae, statement of teaching and research interests and academic leadership experiences, and at least three original letters of reference with contact information by March 15, 2011 for full consideration to: MAE Recruitment Committee, San José State University, One Washington Square, San José, CA 95192- 0087. San Jose State University is an Equal Opportunity/ Affirmative Action employer committed to the core values of inclusion, civility, and respect for each individual.

THE AIAA SUGGESTION PROGRAM

AIAA welcomes suggestions from members on how we can better serve you.
All comments will be acknowledged. We will do our best to address issues that are important to our membership.
Please send your comments to:

Mary Snitch
VP Member Services
AIAA
1801 Alexander Bell Drive
Suite 500
Reston, VA 20191-4344

AIAA

הטכניון – מכון טכנולוגי לישראל
הפקולטה להנדסת אוירונוטיקה וחלל

Technion – Israel Institute of Technology
Faculty of Aerospace Engineering
Meir Hanin International Memorial Prize

The Faculty of Aerospace Engineering at the Technion announces the Meir Hanin International Memorial Prize of **US$10,000** from the Hanin Endowment, in memory of Prof. Meir Hanin, a prominent researcher in theoretical aerodynamics and member of the Faculty of Aerospace Engineering from 1955 to 1999.

The prize will be awarded once every two years for substantial scientific and/or technological achievements in aerospace sciences. Nominees from any country, regardless of religion, race, sex, or nationality, must have some association with the Technion and can only be nominated by the following: Technion faculty members, previous Hanin Prize winners, members of the Israel Academy of Science, Presidents and Members of the Board of Institutes of Higher Learning, and CEO's of companies specializing in aerospace products.

Nominations, together with all relevant supporting material, should be sent to Prof. Yoram Tambour, Dean of Aerospace Engineering, Technion – IIT, Haifa 32000, Israel (dean@aerodyne.technion.ac.il) by May 1, 2011.

The prize will be awarded in February 2012 at the Israel Annual Conference on Aerospace Sciences, which the winner must personally attend. In addition, he/she will give at least two public lectures at the Technion.

(The Hanin Endowment will cover the winner's accommodation and travel expenses.)

Inspire | Challenge | Enable

The AIAA Foundation is a nonprofit, tax-exempt educational organization founded in 1996. Through scholarships, student conferences, design competitions, and classroom grants, we seek to inspire the next generation with a passion for science and engineering. Aided by donations large and small, we invest in the future.

For more information or
to make a tax-deductable donation
visit www.aiaafoundation.org

AIAA FOUNDATION
Invest In The Future

AIAA Bulletin

NASA Administrator Charles F. Bolden Jr. addressed an overflow crowd of Aerospace Sciences Meeting attendees at the New Horizons Forum in Orlando, FL, on Wednesday, 5 January. (*Copyright © 2011 Choice Photography*)

FEBRUARY 2011

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1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
www.aiaa.org

AIAA Western Office
999 North Sepulveda Blvd., Suite 440
El Segundo, CA 90245
800/683-AIAA or 310/726-5000
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Customer Service: 800/639-AIAA†

Other Important Numbers: ***Aerospace America*** / Greg Wilson, ext. **7596*** • ***AIAA Bulletin*** / Christine Williams, ext. **7575*** • **AIAA Foundation** / Dave Quackenbush, ext. **7514***, Suzanne Musgrave, ext. **7518*** • **Book Sales** / **800/682-AIAA** or **703/661-1595**, Dept. 415 • **Corporate Members** / Merrie Scott, ext. **7530*** • **International Affairs** / Megan Scheidt, ext. **3842***; Emily Springer, ext. **7533*** • **Editorial, Books** / Heather Brennan, ext. **7568*** • **Editorial, Technical Journals /** Amanda Maguire, ext. **7507*** • **Education** / Lisa Bacon, ext. **7527*** • **Exhibits** / Fernanda Swan, ext. **7622*** • **Honors and Awards** / Carol Stewart, ext. **7623*** • **Proceedings** / **800/682-AIAA** or **703/661-1595**, Dept. 415 • **Professional Development** / Patricia Carr, ext. **7523*** • **Public Policy** / Steve Howell, ext. **7625*** • **Section Activities** / Chris Jessee, ext. **3848*** • **Standards, Domestic** / Amy Barrett, ext. **7546*** • **Standards, International** / Nick Tongson, ext. **7515*** • **Student Programs** / Stephen Brock, ext. **7536*** • **Technical Committees** / Betty Guillie, ext. **7573***

* 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				
Feb†	**The "Space Shuttle: An Engineering Milestone" Symposium**	Atlanta, GA (Contact Ms. Cindy Pendley, 404.385.8587, cindy.pendley@aerospace.gatech.edu)		
7–9 Feb	**Airworthiness, CBM, and HUMS Specialists' Meeting**	Huntsville, AL (Contact: Robert King, 256.313.9016; Rob.L.King@us.army.mil)		
7–10 Feb†	**Nuclear and Emerging Technologies for Space 2011 (NETS-2011)**	Albuquerque, NM (Contact: Shannon Bragg-Sitton, sitton@tamu.edu, http://anstd.ans.org/NETS2011.html)		
9–10 Feb	**14th Annual FAA Commercial Space Transportation Conference (Dec)**	Washington, DC		
13–17 Feb	**21st AAS/AIAA Space Flight Mechanics Meeting**	New Orleans, LA Contact: Peter Lai, 310.336.2367, www.space-flight.org/AAS_meetings/2011_winter/2011%20winter.html	*May 10*	**11 Oct 10**
5–12 Mar†	**2011 IEEE Aerospace Conference**	Big Sky, MT Contact: David Woerner, dwoerner@ieee.org, www.aeroconf.org		
28–30 Mar†	**3AF-46th Symposium of Applied Aerodynamics**	Orleans, France (Contact: Anne Venables, secr.exec@aaafasso.fr, http://www.aaafasso.fr)		
29–31 Mar	**Infotech@Aerospace 2011 Conference (Jan)**	St. Louis, MO	*Jul/Aug 10*	**13 Sep 10**
4–7 Apr	**52st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference (Jan)** **19th AIAA/ASME/AHS Adaptive Structures Conference** **13th AIAA Non-Deterministic Approaches Conference** **13th AIAA Dynamics Specialist Conference** **12th AIAA Gossamer Systems Forum** **7th AIAA Multidisciplinary Design Optimization Specialist Conference**	Denver, CO	*Apr 10*	**9 Aug 10**
11–14 Apr	**17th AIAA International Space Planes and Hypersonic Systems and Technologies Conference (Jan)**	San Francisco, CA	*Apr 10*	**1 Sep 10**
13–15 Apr†	**1st CEAS Specialist Conference on Guidance, Navigation & Control**	Munich, Germany Contact: DGLR, +49 228 30 80 5-0, gnc@dglr.de, www.ceas-gnc.eu		
9–12 May†	**2011 IAA Planetary Defense Conference**	Bucharest, Romania Contact: William Ailor, 310.336.1135; william.h.ailor@aero.org; www.pdc2011.org		
11 May	**AIAA Aerospace Spotlight Awards Gala**	Washington, DC		
17–19 May†	**2011 Integrated Communications Navigation and Surveillance Conference**	Washington, DC Contact: Colonel John C. Gonda III, jgonda@mitre.org; www.i-cns.org		
18–20 May†	**Sexto Congreso Argentino de Tecnologia Espacial (Sixth Argentine Congress on Space Technology)**	San Luis, Argentina Contact: Pablo de León, 701.777.2369 (U.S.); deleon@aate.org; www.aate.org		
23–26 May	**21st AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar (Feb)**	Dublin, Ireland	*May 10*	**7 Oct 10**
30 May–1 Jun†	**18th 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		
30 May–1 Jun†	**2nd International IAA Symposium on Private Human Access to Space**	Arcachon, France Contact: Christophe Bonnal, +33.1 60.87.74.89 (Fax); www.avantage-aquitaine.com		
2 Jun	**Aerospace Today ... and Tomorrow: An Executive Symposium**	Williamsburg, VA		
6–8 Jun	**17th AIAA/CEAS Aeroacoustics Conference (31st AIAA Aeroacoustics Conference)**	Portland, OR	*Jun 10*	**9 Nov 10**
9–11 Jun†	**5th International Conference on Recent Advances in Space Technologies**	Istanbul, Turkey		
13–17 Jun†	**International Conference on Aircraft and Engine Icing and Ground Deicing**	Chicago, IL Contact: Frank Bokulich, fbokulich@sae.org		
26–30 Jun†	**International Forum on Aeroelasticity and Structural Dynamics 2011 (IFASD2011)**	Paris, France (Contact: Anne Venables, secr.exec@aaaf.asso.fr, www.ifasd2011.com)		

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	CALL FOR PAPERS (*Bulletin* in which Call for Papers appears)	ABSTRACT DEADLINE
27–30 Jun	**29th AIAA Applied Aerodynamics Conference** **41st AIAA Fluid Dynamics Conference and Exhibit** **20th AIAA Computational Fluid Dynamics Conference** **42nd AIAA Thermophysics Conference** **6th AIAA Theoretical Fluid Mechanics Conference** **42nd AIAA Plasmadynamics and Lasers Conference** **3rd AIAA Atmospheric and Space Environments Conference**	Honolulu, HI	*Jun 10*	**17 Nov 10**
17–21 Jul	**41st International Conference on Environmental Systems**	Portland, OR	*Oct 10*	**15 Nov 10**
31 Jul–4 Aug†	**2011 AAS/AIAA Astrodynamics Specialist Conference**	Girdwood, AK Contact: William T. Cerven, 571.307.4208, william.t.cerven@aero.org, http://www.space-flight.org/docs/2011_astro/2011_astro.html	*Dec 10*	**5 Apr 11**
1–3 Aug	**9th Annual International Energy Conversion Engineering Conference**	San Diego, CA	*Jul/Aug 10*	**23 Nov 10**
1–3 Aug	**47th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit**	San Diego, CA	*Jul/Aug 10*	**23 Nov 10**
8–11 Aug	**AIAA Guidance, Navigation, and Control Conference** **AIAA Atmospheric Flight Mechanics Conference** **AIAA Modeling and Simulation Technologies Conference**	Portland, OR	*Jul/Aug 10*	**17 Jan 11**
20–22 Sep	**7th AIAA Biennial National Forum on Weapon System Effectiveness (SECRET/U.S. ONLY)**	Virginia Beach, VA	*Sep 10*	**14 Feb 11**
20–22 Sep	**11th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference including Lighter-Than-Air and Balloon Systems**	Virginia Beach, VA	*Sep 10*	**7 Feb 11**
21–22 Sep	**AIAA Centennial of Naval Aviation Forum "100 Years of Achievement and Progress" (Jointly held with ATIO)**	Virginia Beach, VA	*Sep 10*	**7 Feb 11**
26–29 Sep	**AIAA SPACE 2011 Conference & Exposition**	Long Beach, CA	*Sep 10*	**25 Jan 11**
3–7 Oct†	**62nd International Astronautical Congress**	Cape Town, South Africa (www.iac2011.com)		
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**
2012				
9–12 Jan	**50th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition**	Nashville, TN	*Jan 11*	**1 Jun 11**
10–17 Mar†	**2012 IEEE Aerospace Conference**,	Big Sky, Montana Contact: David Woerner, 626.497.8451; dwoerner@ieee.org; www.aeroconf.org		
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		
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		

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			
1 Feb–31 Jul	**Introduction to Spaceflight**	*Distance Learning*	
1 Feb–31 Jul	**Fundamentals of Aircraft Performance & Design**	*Distance Learning*	
27–28 Mar	**Electro-Optical Systems for Aerospace Sensing Applications**	Infotech@Aerospace	St Louis, MO
2–3 Apr	**Design of Aircraft Structures**	Structures Conferences	Denver, CO
2–3 Apr	**The Fundamentals of Composite Structure Design**	Structures Conferences	Denver, CO
2–3 Apr	**Structural Dynamics in Mechanical Design**	Structures Conferences	Denver, CO
2–3 Apr	**Computational Methods in Aeroelasticity**	Structures Conferences	Denver, CO
9–10 Apr	**Fundamentals of Hypersonic Aerodynamics**	Int'l Space Planes & Hypersonics	San Francisco, CA
4–5 Jun	**Computational Aeroacoustics: Methods and Applications**	Aeroacoustics Conference	Portland, OR
25–26 Jun	**Computational Multiphase Flow**	Fluid Dynamics Conferences	Honolulu, HI
25–26 Jun	**Modern Flow I**	Fluid Dynamics Conferences	Honolulu, HI
25–26 Jun	**Turbulence Modeling for Computation Fluid Dynamics**	Fluid Dynamics Conferences	Honolulu, HI
25–26 Jun	**Sensitivity Analysis and Uncertainty Propagation for Computational Models**	Fluid Dynamics Conferences	Honolulu, HI
25–26 Jun	**Microfluidics and Nanofluidics: Fundamentals and Applications**	Fluid Dynamics Conferences	Honolulu, HI
16–17 Jul	**Space Environment and Its Effects on Space Systems**	Int'l Conf. on Environmental Systems	Portland, OR
4–5 Aug	**Liquid Propulsion Systems—Evolution and Advancements**	Joint Propulsion Conf	San Diego, CA
4–5 Aug	**Pressure Vessel Design Requirements and Verification Guidelines**	Joint Propulsion Conf	San Diego, CA
4–5 Aug	**Hybrid Rocket Propulsion**	Joint Propulsion Conf	San Diego, CA
4–5 Aug	**Air Breathing Propulsion Design**	Joint Propulsion Conf	San Diego, CA
4–5 Aug	**Electric Propulsion for Space Systems**	Joint Propulsion Conf	San Diego, CA
6–7 Aug	**Aircraft and Rotorcraft System Identification Engineering Methods and Hands-on Training using CIFER®**	GNC Conferences	Portland, OR
6–7 Aug	**Aircraft Handling Qualities**	GNC Conferences	Portland, OR
6–7 Aug	**Mathematical Introduction to Integrated Navigation Systems with Applications**	GNC Conferences	Portland, OR
6–7 Aug	**Modeling Flight Dynamics with Tensors**	GNC Conferences	Portland, OR
6–7 Aug	**Modern Missile Guidance**	GNC Conferences	Portland, OR
6–7 Aug	**Vision Based Control for Autonomous Vehicles**	GNC Conferences	Portland, OR
17–19 Sep	**Spacecraft Design and System Engineering**	ATIO/LTA/Balloons & Weapons Conf w/Naval Aviation Forum	Virginia Beach, VA
18–19 Sep	**Tactical Missile Design and System Engineering**	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 Validation and Verification**	SPACE Conference	Long Beach, CA
25–26 Sep	**The Space Environment: Implications for Spacecraft Design**	SPACE Conference	Long Beach, CA

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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

WHAT'S THE VALUE OF AIAA?

Klaus Dannenberg, AIAA Deputy Executive Director

"What's the value of AIAA"—that's a question for which we need a better elevator speech. In a recent AIAA leadership effort to get insights into early career professionals' key issues, the question of value and how to communicate it came up over and over again. Although the volunteer leadership of AIAA just completed an update to our Strategic Plan for 2011–2015, we don't have good answers for key issues affecting our growth. The updated Strategic Plan identifies achievable goals and actions for areas of needed improvement, such as improving our currency through use of IT capabilities and social media, gaining efficiencies in operations, and enhancing the relevancy of our products. However, in the collective opinions of both the early career professionals and key AIAA volunteers, the main challenges affecting the Institute's growth seem to fall into three areas:

- Winning the approval of mid-level management for participation in AIAA activities
- Reducing attrition of early career professionals during the first five years after graduation
- Attracting new members from non-legacy AIAA areas of expertise

Overcoming these challenges means that we need to assure that we provide real value in our products and services through their technical content and vision. But it's more than that—we also need to be able to communicate that value to the appropriate constituencies. And that responsibility resides with all of us!

The top reason given why more people don't attend our conferences, short courses, or other events is "I couldn't get approval from my boss. He couldn't afford the overhead." The ironic thing is that senior management clearly does understand the value of AIAA. That's seen by the fact that AIAA's corporate membership has grown by 70% to 97 corporate members over the past 5 years. Since the likelihood of mid-level managers having an aerospace degree is less than 10%, most will not be familiar with AIAA yet. So we need to assure them that we are providing value, both to their employees and also to the careers of the mid-managers themselves. But then we also need to find ways to communicate that value to them.

Similarly, when new grads begin their first job, unless their coworkers are also aerospace engineers and AIAA members, there is no one to communicate the value of AIAA to them. We can address this by having university faculty not only encourage students to become members, but also to assure that they gain early insights into the value of professional networking and maintaining currency with technology trends—both core AIAA benefits.

Finally, when we are reaching out to new constituencies with AIAA products and services, we again need to assure that we communicate their value as well as the value of the professional networking encompassing those communities to which we are reaching out. The technical structure, the visionary looks forward, and the ability to work with a community of peers for the greater good all need to be communicated to be understood.

The theme of all these areas is the same: we need to assure that we are providing value and then we need to communicate that value—concisely, articulately, and in both a justifiable business and technical context. The methods may vary depending on the target audience, but the need and the challenge are identical in all those situations. So, how do we do that? Upon a little examination, I think you'll find that essentially everyone of all generations joined AIAA because some individual, whether a friend or a mentor, convinced them of the value of AIAA membership. Then at a later time, another individual convinced them of the value of participation. Once people are involved, they stay involved! So help us get them involved.

We will be emphasizing the communication of AIAA's value as we move forward and seek to grow our Institute. Your Board of Directors and Standing Committees will be identifying and implementing ways to help with this. If you have some ideas that can be applied throughout the Institute, let us know. We especially need to reach students, early career professionals, mid-managers, and new constituencies with this message. So, ask a friend or be a mentor. Bring someone into AIAA and enhance both of your professional careers with establishment of lifelong professional contacts as an integral part of your professional networks. And let me know how we can help by writing me at Klausd@aiaa.org.

INTRODUCING NEW AIAA CORPORATE MEMBERS

AIAA is pleased to welcome the following corporate members.

- ***Altair Engineering (Troy, MI)*** provides innovative technology and services to improve the quality and efficiency of engineering activities in many industries. For aerospace systems, Altair's optimization and simulation modeling technology and expertise are used to reduce weight and improve performance in a highly efficient manner.
- ***Barnhard Associates (Cabin John, MD)*** is a small business with specialized aerospace consulting services.
- ***DFL Space LLC (Bellevue, WA)*** focuses on engineering innovative business strategies for a diverse set of clients, from small businesses to established institutions, in the United States and internationally.
- ***Ohio Aerospace Institute (Cleveland, OH)*** has a mission to build Ohio's aerospace economy through research and technology development, education and training, and collaboration and information exchange.
- ***XCOR Aerospace (Mohave, CA)*** is in the business of developing and producing safe, reliable and reusable rocket-powered vehicles, propulsion systems, advanced non-flammable composites and other enabling technologies.
- ***Virgin Galactic (Mojave, CA)*** is a leader in sub-orbital commercial space tourism with a longer term vision to develop orbital flights for space tourism and other commercial applications.

For more information on the AIAA Corporate Member Program, please contact Merrie Scott at merries@aiaa.org.

BE A PART OF THE 2011 CONGRESSIONAL VISITS DAY

Every year, AIAA members come to Washington, DC, to take part in AIAA's Congressional Visits Day (CVD) program. They meet with national decision makers to discuss critical industry issues in civil aeronautics, civil astronautics, and defense. Through face-to-face meetings with members of Congress, congressional staff, key administration officials, and other decision makers, CVD raises awareness of the long-term value that science, engineering, and technology bring to the United States. Let decision makers hear your voice at this important public policy event on 15–16 March.

With many new faces on Capitol Hill, CVD 2011 is a critical opportunity for AIAA's members to educate congressional decision makers about the value of aerospace to our long-term economic prosperity and national security. For more information on the AIAA CVD program, or to register, go to **www.aiaa.org/cvd**, or contact Duane Hyland at 703.264.7558 or duaneh.aiaa.org.

AIAA ANNOUNCES 2011 FELLOWS AND HONORARY FELLOWS

AIAA is pleased to announce the election of the 2011 AIAA Fellows and Honorary Fellows. Presentation of the new Fellows and Honorary Fellows will take place at the AIAA Aerospace Spotlight Awards Gala on 11 May 2011, at the Ronald Reagan Building and International Trade Center, in Washington, DC.

Honorary Fellow, the highest distinction conferred by AIAA, is granted to preeminent individuals who have had long and highly contributory careers in aerospace, and who embody the highest possible standards in aeronautics and astronautics. The 2011 AIAA Honorary Fellows are:

James F. Albaugh, The Boeing Company
John L. Junkins, Texas A&M University
Elaine S. Oran, Naval Research Laboratory

The distinction of *Fellow* is conferred by AIAA upon outstanding members of the Institute who have made notable and valuable contributions to the arts, sciences, or technology of aeronautics or astronautics. The 2011 AIAA Fellows are:

Iain D. Boyd, University of Michigan
Frank J. Cappuccio, Lockheed Martin Corporation
David Carroll, CU Aerospace
Natalie W. Crawford, The Rand Corporation
John R. Dowdle, Draper Laboratory
Ann P. Dowling, Cambridge University
Stephen P. Engelstad, Lockheed Martin Aeronautics
Walter Eversman, Missouri University of Science and Technology
Michael W. George, NASA Headquarters
Mark N. Glauser, Syracuse University
Dan M. Goebel, Jet Propulsion Laboratory
Kenneth C. Hall, Duke University
Jeffrey Hamstra, Lockheed Martin Aeronautics Company
Ronald A. Hess, University of California at Davis
John C. Hsu, The Boeing Company
Ray O. Johnson, Lockheed Martin Corporation
Mary V. Jones, Aerojet
In Lee, Korea Advanced Institute of Science and Technology
Jack Levine, Crown Consulting Inc.
Mark S. Maurice, Air Force Office of Scientific Research
David K. McGrath, ATK
Ellen Ochoa, NASA Johnson Space Center
Pradeep Raj, Lockheed Martin Aeronautics Company
William F. Readdy, Discovery Partners International LLC
Philip A. Rubin, RKF Engineering Solutions LLC
Christopher L. Rumsey, NASA Langley Research Center
Tom I-P Shih, Purdue University
Trevor C. Sorensen, University of Hawaii at Manoa
Anthony M. Waas, University of Michigan

AIAA President Mark Lewis stated: "Being named a Fellow of AIAA is among the highest honors that can be bestowed upon an aerospace professional, and represents recognition from colleagues and peers for great contributions to our field and technical community. I congratulate each member of this year's class of Fellows and Honorary Fellows."

In 1933, Orville Wright became AIAA's first Honorary Fellow. Today, AIAA Honorary Fellows and AIAA Fellows are the most respected names in the aerospace industry. For more information about AIAA's Honors and Awards Program, please contact Carol Stewart at carols@aiaa.org or 703.264.7623.

CALL FOR NOMINATIONS

Recognize the achievements of your colleagues by nominating them for an award. Nominations are now being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 July 2011**.
AIAA members may submit nominations online by logging into **www.aiaa.org**, "MY AIAA" or downloading the nomination form from **www.aiaa.org**.

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

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

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

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

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

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

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

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

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

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

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

Summerfield Book Award is presented to the author of the best book recently published by AIAA. Criteria for the selection include quality and professional acceptance as evidenced by impact on the field, citations, classroom adoptions, and sales.

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

If you need further information, please contact Carol Stewart, Manager, AIAA Honors & Awards Program, at carols@aiaa.org or at 703.264.7623.

Important Announcement
New Editor-in-Chief Sought for the *Journal of Aircraft*

Thomas Weeks, current Editor-in-Chief of AIAA's *Journal of Aircraft*, will step down from his position after 32 years of service at the end of 2011. We are seeking an outstanding candidate with an international reputation for this position. This is an open process, and the final selection will be made only on the basis of the applicants' merits.

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

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

Rodger Williams
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344
703/264-7551 FAX
E-mail: rodgerw@aiaa.org

A minimum of two letters of recommendation also are required. The recommendations should be sent by the parties writing the letters directly to Mr. Williams at the above address, fax number, or e-mail. To receive full consideration, applications and all required materials must be received at AIAA Headquarters by **1 March 2011**, but applications will be accepted until the position is filled.

A selection committee appointed by the AIAA Vice President–Publications Michael B. Bragg will seek candidates and review all applications received. The search committee will recommend qualified candidates to the AIAA Vice President–Publications, who in turn will present a recommendation to the AIAA Board of Directors for approval. All candidates will be notified of the final decision.

New and Forthcoming Titles

Hot Off the Press!
2011 AIAA Products and Services Catalog

The 2011 AIAA Products and Services Catalog is now online! Discover all there is to AIAA—membership, public policy, journals, magazines, standards, books, ebooks, conferences, AIAA Foundation, professional development courses … and more. View the Catalog today! Visit *www.aiaa.org/2011catalog*.

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

Principles of Flight Simulation
David Allerton, University of Sheffield
AIAA Education Series
2010, 417 pages, Hardback
ISBN: 978-1-60086-703-3
AIAA Member Price: $74.95
List Price: $94.95

Fundamentals of Aircraft and Airship Design Volume I—Aircraft Design
Leland Nicolai and Grant Carichner
AIAA Education Series
2010, 926 pages, Hardback
ISBN: 978-1-60086-751-4
AIAA Member Price: $89.95
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
List Price: $3,750
See AIAA Web site for special member discount

Unmanned Aircraft Systems: UAVS Design, Development and Deployment
Reg Austin
AIAA Education Series
2010, 360 pages, Hardback
ISBN: 978-1-60086-759-6
AIAA Member Price: $94.95
List Price: $124.95

Cooperative Path Planning of Unmanned Aerial Vehicles
Antonios Tsourdos, Brian White, & Madhavan Shanmugavel
Progress in Astronautics and Aeronautics, Vol. 235
2010, 216 pages, Hardback
ISBN-13:978-1-60086-779-8
AIAA Member Price: $94.95
List Price: $124.95

Multiple Scales Theory and Aerospace Applications
Rudrapatna Ramnath
AIAA Education Series
2010, 613 pages, Hardback
ISBN: 978-1-60086-762-0
AIAA Member Price: $74.95
List Price: $99.95

Optimal Control Theory with Aerospace Applications
Joseph Ben-Asher, Technion—Israel Institute of Technology
AIAA Education Series
2010, 264 pages, Hardback
ISBN: 978-1-60086-732-3
AIAA Member Price: $69.95
List Price: $89.95

Advances in Collaborative Civil Aeronautical Multidisciplinary Design Optimization
Ernst Kesseler and Marin Guenov, Cranfield University
Progress in Astronautics and Aeronautics, Vol. 233
2010, 438, Hardback
ISBN: 978-1-60086-725-5
AIAA Member Price: $79.95
List Price: $109.95

The Engines of Pratt & Whitney: A Technical History
Jack Connors
Library of Flight
2010, 529 pages, Hardback
ISBN: 978-1-60086-711-8
AIAA Member Price: $39.95
List Price: $49.95

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

21st AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar

23–26 May 2011
Trinity College
Dublin, Ireland

Synopsis

The AIAA Aerodynamic Decelerator Systems (ADS) Technical Committee is pleased to announce the 21st AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar will be held 24–26 May 2011, at Trinity College in Dublin, Ireland. The ADS Seminar will be held Monday, 23 May 2011, with the conference taking place the following three days. This conference provides the world's leading scientists, engineers, and promising students within the field of parachute and aerodynamic decelerator systems with an opportunity to present recent advances before a knowledgeable international audience. The underlying goals of the conference are to promote sharing of technical information, to serve as an educational tool for industry customers and providers, to facilitate technical exchange and interaction, to engage new contacts and refresh old ones, and to recognize significant achievements from within the community. As with every ADS Conference, there will be the opportunity to extract lessons learned from decelerator system applications and programs, which can have the result of increased technical success, cost savings, and schedule savings for current or ensuing projects or programs.

ADS Seminar

On Monday, 23 May 2011, the day before the conference begins, the ADS Technical Committee will host a one-day ADS Seminar on "Systems Engineering in the Real World: ADS Case Studies" presented by a panel of subject-matter experts sharing perspectives from government agencies, industry, and academia, as well as distinctive personal experiences. The morning session will be dedicated to case studies from the Apollo Crew Capsule and the Space Shuttle's Solid Rocket Booster Recovery System, and the afternoon session will focus on the F-111 Crew Escape System and the IRDT hypersonic inflatable decelerator. Following the case study overviews, an open forum will allow audience members to query the presenters in further detail. Registration is required. Tickets for the seminar may be purchased upon registration.

Special Events

Industry Reception

On Tuesday, 24 May 2011, there will be an industry-sponsored reception at O'Neill's Pub. Located in the historic heart of Dublin, just minutes from Trinity College and Grafton Street, it's the perfect place for a pint, and for the lively welcome Dublin is famous for. O'Neill's has existed as a licensed premises for 300 years and is renowned for its ageless character, numerous alcoves, snugs, nooks, and crannies. Conference delegates and their guests will be treated to an expansive buffet and drinks in this classic Dublin pub. Stay and enjoy the whole evening with fellow delegates or stop for a short while before heading off to one of the many fine restaurants in the local area.

Awards Reception and Banquet

The awards reception and banquet will be held on Thursday evening, 26 May 2011, at the historic dining hall at Trinity College. The cost of the banquet is included in the conference registration fee where indicated. Additional tickets for guests may be purchased upon registration or on site.

Best Student Paper Competition

The AIAA Aerodynamic Decelerator Systems Technical Committee (ADS TC) is sponsoring a Best Student Paper Competition at the conference. Five finalists have been selected from student submissions on all research topics related to aerodynamic decelerators. The finalists will present their papers once at the conference. This presentation will be used simultaneously for judging purposes and to fill a regular Technical Session. Finalists will receive a complimentary ticket to the awards banquet. All finalists will also receive complimentary lodging at Trinity College, and a $1250 award (for travel expenses) after attending and presenting their papers. An overall best paper and presentation will be selected from the Best Student Paper Competition finalists, and this winner will be presented with an additional $1250 prize and recognized at the awards banquet. All prizes are provided by the AIAA ADS TC.

Pre-Conference Book Sale—15% Off for Conference Attendees

Conference attendees can save an extra 15% off of any books* prior to the conference. Details about how to participate are posted on the conference Web site under Publications Sale, located to the right of the page. **(Exclusions Apply)*

Conference Proceedings

Proceedings for this conference will be available in an online proceedings format. The cost is included in the registration fee where indicated. The online proceedings will be available on **16 May 2011**. Attendees who register in advance for the online proceedings will be provided with instructions on how to access the conference technical papers. Those registering on site will be provided with instructions upon registration.

Bound Conference Proceedings Available for Purchase

AIAA and the ADS TC are pleased to offer individual copies of library-quality bound proceedings from this year's conference. This offer is made available for persons who also purchase the online proceedings and will be offered as an extra ticket price of $121 (includes 21% VAT). The cost includes shipping (domestic and international). Bound proceedings may be purchased upon registration or on site, and cannot be ordered after the conference. Copies will be delivered approximately three months after the conference.

Accompanying Persons Program

AIAA has arranged for a tour of "Wild Wicklow" on Wednesday, 25 May 2011. Accompanying persons should stop

General Chair
Rob Sinclair
Airborne Systems North America

Technical Program Co-Chairs
Storm Dunker
Airborne Systems North America

Oleg Yakimenko
Naval Postgraduate School

Keith Bergeron
U.S. Army Natick Soldier RD&E Center

Administrative Chair
Shane Glynn
Vorticity Systems

Seminar Chair
Glen Brown
HDT Engineered Technologies

by the AIAA registration desk to sign up for a tour of beautiful Wicklow County, located just 30 minutes outside of Dublin. The tour includes Avoca Handweavers, Glendalough, and Sally Gap. The tour will depart from The Shelbourne Hotel, St. Stephens Green, at 0850 hrs. This is a full-day tour. Tour will stop for lunch at a local pub. Lunch is on your own. Space is limited; sign-up at the AIAA registration desk is required.

Registration Information

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

All participants are urged to register on the AIAA Web site at **www.aiaa.org/events/ads**. Registering in advance saves conference attendees more than $200. A check made payable to AIAA or credit card information must be included with your registration form. A PDF registration form is also available on the AIAA Web site. Print, complete, and mail or fax the form with payment to AIAA. Address information is provided.

Early-bird registration forms must be received by **25 April 2011**, and standard registration forms will be accepted until **17 May 2011**. Preregistrants may pick up their materials at the advance registration desk at the conference. All those not registered by 17 May 2011 may do so at the on-site registration desk.

Cancellations must be received no later than **6 May 2011**. There is a $100 cancellation fee. Registrants who cancel beyond this date or fail to attend the conference will forfeit the entire fee.

Please note: The Irish government requires AIAA to register for and to assess a Value Added Tax for goods and services sold in Ireland. The registration prices for the conference include a 21% Value Added Tax assessment. The Irish government also provides a refund mechanism for Value Added Taxes paid by individuals or corporations who are eligible to claim exemption from the tax with valid documentation. The documentation and claims must be submitted to the Irish VAT authority.

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

Registration fees are as follows:

	Early Bird By 25 April	**Standard** 26 April–17 May	**On Site** On-Site
Option 1: Full Conference with Online Proceedings			
AIAA Member	$1113 ($920 + 21% VAT)	$1234 ($1020 + 21% VAT)	$1355 ($1120 + 21% VAT)
Nonmember	$1301 ($1075 + 21% VAT)	$1422 ($1175 + 21% VAT)	$1543 ($1275 + 21% VAT)
Includes sessions, awards banquet, and single-user access to online proceedings.			
Option 2: Seminar			
AIAA Member	$333 ($275 + 21% VAT)	$333 ($275 + 21% VAT)	$333 ($275 + 21% VAT)
Nonmember	$333 ($275 + 21% VAT)	$333 ($275 + 21% VAT)	$333 ($275 + 21% VAT)
Includes seminar only. Registration required to attend seminar.			
Option 3: Full-Time Undergraduate Student			
AIAA Member	$24 ($20 + 21% VAT)	$36 ($30 + 21% VAT)	$48 ($40 + 21% VAT)
Nonmember	$61 ($50 + 21% VAT)	$73 ($60 + 21% VAT)	$85 ($70 + 21% VAT)
Includes sessions only. Students may purchase food function tickets separately or select the Student Ticket Package when registering online.			
Option 4: Full-Time Graduate or Ph.D. Student			
AIAA Member	$73 ($60 + 21% VAT)	$85 ($70 + 21% VAT)	$97 ($80 + 21% VAT)
Nonmember	$109 ($90 + 21% VAT)	$121 ($100 + 21% VAT)	$133 ($110 + 21% VAT)
Includes sessions only. Students may purchase food function tickets separately or select the Student Ticket Package when registering online.			
Option 5: Full-Time Retired Member (AIAA Member Only)	$48 ($40 + 21% VAT)	$61 ($50 + 21% VAT)	$73 ($60 + 21% VAT)
Includes sessions and awards banquet.			
Option 6: Discounted Group Rate	$1002 ($828 + 21% VAT)	$1002 ($828 + 21% VAT)	N/A

10% discount off AIAA member rate for 10 or more persons from the same organization who register and pay at the same time with a single form of payment. Includes sessions, all catered events, and single-user access to online proceedings. A complete typed list of registrants, along with completed individual registration forms and a single payment, must be received by the preregistration deadline of **17 May 2011**.

Extra Tickets

Awards Reception and Banquet	$150 (includes 21% VAT)
Extra Online Proceedings	$97 (includes 21% VAT)
Book of Conference Proceedings	$121 (includes 21% VAT)

AIAA Programs

On-Site Registration Hours

On-site registration will be held in the Hamilton Conference Center at Trinity College as follows:

Monday, 23 May 2011	0700–1700 hrs
Tuesday, 24 May 2011	0700–1700 hrs
Wednesday, 25 May 2011	0700–1700 hrs
Thursday, 26 May 2011	0700–1600 hrs

Hotel Reservations

AIAA has arranged for a block of rooms at Trinity College. There is a range of accommodation available as follows:

- Single rooms in two- or three- bedroom apartments (Wifi enabled)—68.50 Euro per night
- Twin ensuite rooms (Wifi enabled)—90.00 Euro per night

All bedrooms are centrally located on the historic campus, and continental breakfast is included in rates. Rooms are serviced daily. The college particularly recommends the recently renovated two- and three-bedroom apartments on campus. They are self contained with two or three single bedrooms (bedrooms have individual locks), a large kitchen and living room, and one bathroom. These apartments are very suitable for individuals or small groups of colleagues.

Information and online reservation for these accommodations is available under the "Travel & Accommodations" link on the conference Web site at **www.aiaa.org/events/ads**. Additionally, hotel reservations at Trinity College can be made by visiting: **https://accomodation.tcd.ie/kxHotel**. For best rates, please use the promotion code "AIAA" when using the online reservation page. For questions and concerns about booking rooms at Trinity College, e-mail: reservations@tcd.ie.

Help Keep Our Expenses Down (And Yours Too!)

AIAA group rates for hotel accommodations are negotiated as part of an overall contract that also includes meeting rooms and other conference needs. Our total event costs are based in part on meeting or exceeding our guaranteed minimum of group-rate hotel rooms booked by conference participants. If we fall short, our other event costs go up. Please help us keep the costs of presenting this conference as low as possible—reserve your room at the designated hotel listed in this Preliminary Program and on our Web site, and be sure to mention that you're with the AIAA conference. Meeting our guaranteed minimum helps us hold the line on costs, and that helps us keep registration fees as low as possible. All of us at AIAA thank you for your help!

"No Paper, No Podium" & "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. Also, if the paper is not presented at the conference, it will be withdrawn from the conference proceedings. 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. These policies are intended to improve the quality of the conference for attendees.

Certificate of Attendance

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

Professional Development Short Courses

Registration is now open for the following courses co-located with the **AIAA InfoTech@ Aerospace Conference** in St. Louis, Missouri; the **AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference** (and **co-located conferences**) in Denver, Colorado; and the **AIAA International Space Planes and Hypersonic Systems and Technologies Conference** in San Francisco, California.

27–28 March 2011 • St. Louis, MO
Electro-Optical Systems for Aerospace Sensing Applications

2–3 April 2011 • Denver, CO
Computational Methods in Aeroelasticity
Design of Aircraft Structures
Fundamentals of Composite Structure Design
Structural Dynamics in Mechanical Design

9–10 April 2011 • San Francisco, CA
Fundamentals of Hypersonic Aerodynamics

Register for a Course Today and Receive **FREE Conference Registration** (sessions only) to the conference where your course is scheduled!

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11-0081

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.

Sessions-At-A-Glance

The 2011 Conference currently has 137 paper presentations organized into 34 sessions. Sessions scheduled at this time are shown below. For the full conference program, including paper titles and authors, please visit **www.aiaa.org/events/ads**.

ADS Seminar
Airdrop
Best Student Paper Competition Finalists
De-Orbit Concepts
Design and Development
Fluid Structure Interaction I
Fluid Structure Interaction II
Guidance, Navigation, and Control
High-Fidelity Simulations
Inflatable Aerodynamic Decelerator Modeling
Inflatable Aerodynamic Decelerators I
Inflatable Aerodynamic Decelerators II
Mars
Materials and Manufacturing
Measurement Techniques
Meteorology Studies
Modeling and Simulation I
Modeling and Simulation II
Modeling and Simulation III
Orion
Plenary
Precision Aerial Delivery I
Precision Aerial Delivery II
Precision Aerial Delivery III
Ram Air I
Ram Air II
Recovery Systems I
Recovery Systems II
Recovery Systems III
Recovery Systems IV
Sensors and Instrumentation
Software
Space I
Space II
Stability and Control
Testing I
Testing II
Trajectory Analysis

17th AIAA International Space Planes and Hypersonic Systems and Technologies Conference

Grand Hyatt San Francisco
Union Square
San Francisco, CA
11–14 April 2011

Early Bird
Registration Deadline:
14 March 2011

"In AIAA, we've been able to get together and meet people who have the same ambitions, the same dreams... the same area and field, and discuss our careers and accomplishments. [AIAA] is a good network to meet people."
–AIAA Conference Attendee

AIAA

6th International Conference "Supply on the Wings"

2–4 November 2011
Exhibition Center Frankfurt
Frankfurt, Germany

Abstract Deadline: 31 March 2011

Aim of the Conference

AIRTEC, taking place 2–4 November 2011, in Frankfurt, Germany, is the world's specialized trade fair for the entire international aerospace supply chain from design and engineering to materials, production, components and systems and lifecycle support. With its special focus on the whole aerospace supply chain and its unique combination of exhibition, back-to-back meetings, and conferences, AIRTEC provides a focused and international business and technology meeting point for the dialogue between first-, second-, and third-tier suppliers and to OEMs. AIRTEC is also a platform for participants to gain and extend their knowledge of the latest trends, technologies, and developments in the aerospace industry.

Along with AIRTEC, there will be a dedicated conference, "Supply on the Wings," bringing together participants from industry, government institutions, and academia. Under this year's motto "Aerospace—The Global Innovation Driver," the conference is seeking to attract professionals in the fields of development, engineering, project management, research and technology, production and manufacturing, supply chain management, and related areas. Experts from all areas related to aerospace are welcome to contribute to the conference program with their latest developments, new products, projects, and experiences.

In 2010, the program combined 85 presentations with keynotes from Airbus, Boeing, Embraer, BIAM (China), Lufthansa Technik, NLR, European Commission, Bombardier, and NASA. In 2011, again, top high-level keynote speakers from all over the world will be invited.

Conference Topics

The topics addressed in the conference cover all aspects of current and future aerospace products. The head topics of the sessions are: aerospace supply chain management, processing, operations and lifecycle support, composite structures, metallic structures, manufacturing/production, improved simulation, non-destructive inspection and structural-health-monitoring, engines, systems and components, automation process, whole aircraft design, alternative fuels, and energy technologies.

Call for Abstracts

Prospective authors are requested to submit an abstract of up to one page by **31 March 2011**. The abstract should contain sections addressing the objective of the work presented, the methods employed, and conclusions.

Conference Details

You will find the conference details (e.g., abstract submission, registration, hotels, etc.) and the 2010 conference program at **www.airtec.aero**. For more information, contact:

Prof. Dr. Richard Degenhardt
German Aerospace Center (DLR)
Institute of Composite Structures and Adaptive Systems, Braunschweig
E-mail: richard.degenhardt@dlr.de

Upcoming AIAA Professional Development Courses

Distance Learning Courses
1 February–31 July 2011

Introduction to Spaceflight (Instructor: Francis J. Hale)
The emphasis throughout the course will be on fundamental concepts and analytical expressions rather than on "cookbook" and detailed numerical solutions. Upon conclusion of the course, participants will be able to plan a geocentric or interplanetary mission to include the determination of suitable trajectories, the approximate velocity budget (the energy required), the approximate weight (mass) and number of stages of the booster, and the problems and options associated with the terminal phase(s) of the mission.

Fundamentals of Aircraft Performance and Design (Instructor: Francis J. Hale)
This course will give participants an introduction to the major performance and design characteristics of conventional, primarily subsonic, aircraft. At the end of the course, participants will be able to use the physical characteristics of an existing aircraft to determine both its performance for specified flight conditions and the flight conditions for best performance. Participants will also be able to take a set of operational requirements and constraints and perform a feasibility design of an aircraft that should satisfy both the requirements and constraints. This course is ideal for anyone who is interested in or has any involvement with aircraft (and uninhabited aerial vehicles [UAVs]) to include such people as pilots, flight planners, operations personnel, air traffic controllers and supervisors, aircraft designers, fixed base operators, maintenance people, and other aviation aficionados.

27–28 March 2011
Free Conference Registration to the AIAA Infotech@Aerospace Conference, in St. Louis, Missouri, when you sign up for this Course!
http://www.aiaa.org/content.cfm?pageid=161&lumeetingid=2325

Electro-Optical Systems For Aerospace Sensing Applications (Instructor: Tim Howard)
This course will provide an introduction to electro-optical systems for practicing aerospace engineers. It is oriented toward non-specialists in electro-optics (EO), such as systems engineers, specialists in related disciplines (such as computer/software, electrical, and mission planning), as well as others who must integrate and interact with EO payloads. It will cover basic EO design principles, methods for predicting and assessing performance, current topics in airborne, ground-based, and space-based EO systems, and applications to unmanned and networked systems including unmanned sensor networks. Systems engineers, program managers, payload specialists, mission planners, and subsystem design engineers who must work with and interface to EO systems will benefit from this course. The course assumes that attendees will have a basic undergraduate degree in a technical field but does not require specialization in any optics-related field.

2-3 April 2011
Free Conference Registration to the 52st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference; 19th AIAA/ASME/AHS Adaptive Structures Conference; 13th AIAA Non-Deterministic Approaches Conference; 12th AIAA Gossamer Systems Forum; 7th AIAA Multidisciplinary Design Optimization Specialist Conference; Including AIAA Dynamics Specialists Conference in Denver, Colorado, when you sign up for one of these Courses!

Design of Aircraft Structures (Instructor: Michael Mohaghegh)
An examination into the latest concepts and lessons learned in design of aircraft metal and composite structures, including evolution of design criteria, structural design concepts, evolution of advanced materials, static strength, buckling, durability and damage tolerance, practical design considerations, validation, and certification. Design and analysis exercises are included to involve students in the learning process.

Fundamentals of Composite Structure Design (Instructor: Rikard Benton Heslehurst)
Receive a fundamental understanding the structural design requirements for composites. Key Topics discussed in this course include structural design requirements; laminate configuration sizing and distribution; structural performance estimation and understanding; other structural considerations—holes, joints, ply termination; and operational environment issues.

Computational Methods in Aeroelasticity (Instructors: Gautam SenGupta and J. Castro)
This course provides an introduction to numerical methods used in aeroelasticity. Topics include introduction of basic concepts; interpolating structural modes to an aerodynamic mesh; linear unsteady aerodynamic tools: Strip Theory, Vortex Lattice, and Doublet Lattice methods; application of CFD for transonic nonlinear flow; model reduction methods used in aeroelastic formulation; and nonlinearity and uncertainty analysis in aeroelasticity.

Structural Dynamics in Mechanical Design (Instructor: Dennis Philpot)
This course is designed to provide the student with a good theoretical—as well as practical—knowledge of the methodologies for performing dynamic analysis on a wide range of structural and mechanical systems. Throughout the course, equal attention will be given to both the methods of classical analysis techniques and the theories on which the methods are based. Key topics include dynamic loads and boundary conditions; foundational topics in energy methods; Newtonian Dynamics: first- and second-order systems; Multiple-Degree-of-Freedom (MDOF) Systems; dynamic response of MDOF Systems; and dynamics in the mechanical design process.

AIAA Courses and Training Program Registration Form

The World's Forum for Aerospace Leadership

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

B0211

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

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.

5

☐ 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 ☐ American Express
☐ Check ☐ VISA
☐ Travelers Check ☐ MasterCard
☐ Wire Transfer ☐ 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.

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—

DISTANCE LEARNING COURSES (1 FEB–31 JUL)

Early Bird by 1 Jan 2011 From 2 Jan–1 Feb 2011

	AIAA Member	Non-Member	AIAA Member	Non-Member	AIAA Member	Non-Member
Introduction to Spaceflight	☐$1075	☐$1195	☐$1180	☐$1300		
Fundamentals of Aircraft Performance and Design	☐$1075	☐$1195	☐$1180	☐$1300		

COURSE OFFERED AT INFOTECH@AEROSPACE CONFERENCE

Attend any professional development course and receive "free" registration to the conference sessions only

Early Bird by 18 Feb 2011 Advance (19 Feb–18 Mar) After 18 Mar 2011

Electro-Optical Systems for Aerospace Sensing Applications	☐$900	☐$1050	☐$1100	☐$1250	☐$1200	☐$1350

COURSES OFFERED AT SDM CONFERENCES

Attend any professional development course and receive "free" registration to the conference sessions only

Early Bird by 25 Feb 2011 Advance (26 Feb–25 Mar) After 25 Mar 2011

Design of Aircraft Structures	☐$895	☐$1045	☐$1095	☐$1245	☐$1250	☐$1395
Fundamentals of Composite Structure Design	☐$895	☐$1045	☐$1095	☐$1245	☐$1250	☐$1395
Computational Methods of Aeroelasticity	☐$895	☐$1045	☐$1095	☐$1245	☐$1250	☐$1395
Structural Dynamics in Mechanical Design	☐$895	☐$1045	☐$1095	☐$1245	☐$1250	☐$1395

Please indicate if you qualify for the:

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

TOTAL DUE: $ _____

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*. The transition from WriteTrack to ScholarOne Manuscripts (Thomson Reuters) will be completed in 2010. Information about the transition is available on the WriteTrack home page.

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.

STRATEGY FOR SUCCESS

In today's dynamic business environment, effective outreach and customer interface are vital to successfully capturing new partnership opportunities.

If your company is looking for a mechanism to heighten visibility, expand networking capabilities among industry leaders, and demonstrate your unique value to thousands of aerospace professionals, AIAA can help to achieve your objectives.

With over 75 years' experience, and a distinguished roster of legendary aerospace policymakers and pioneers, AIAA's Sponsorship Program can provide access to key industry, government, and academia contacts all in one location.

Whether you are looking to build new relationships within the aerospace community, or strengthen your brand image as a major industry contender, an AIAA sponsorship will provide global marketing to the individuals and companies that matter most to your organization.

For more information on sponsorship opportunities with AIAA, contact **Cecilia Capece**, AIAA Sponsorship Program Manager, at **703.264.7570** or **ceciliac@aiaa.org.**

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