

June 2010

AEROSPACE

A M E R I C A

**Dazzling images
from our nearest star**

**A conversation with Buzz Aldrin
Paradigm shift in U.S. space policy**

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS



Reliable CFD meshing you
trust with a new interface
you'll **love**.

NATIVE
INTERFACES FOR
**FLUENT[®], CFX[®],
STAR-CCM+[®],
OpenFOAM[®]**
AND MORE!

Pointwise, Inc.'s Gridgen has been used for CFD preprocessing for over 20 years. Now we have combined our reliable CFD meshing with modern software techniques to bring you the eponymous Pointwise - a quantum leap in gridding capability. In addition to the high

Toll Free 800-4PTWISE www.pointwise.com

POINTWISE[®]
Reliable CFD Meshing

quality grid techniques we have always had, you will appreciate Pointwise's flat interface, automated grid assembly, and full undo and redo capabilities. Faster, easier, with the same great meshing. You'll love it. You'll trust it. Call us today, and let us show you Pointwise.

DEPARTMENTS

COMMENTARY

U.S. civil space policy: Clearing the fog.

3

INTERNATIONAL BEAT

"Smart" procurement falters in Europe.

4

WASHINGTON WATCH

Disagreements and hard decisions.

8

CONVERSATIONS

With Buzz Aldrin.

12

SPACE UPDATE

U.S. space launch: Growth and stagnation.

16

OUT OF THE PAST

46

CAREER OPPORTUNITIES

48

PHOTO ESSAY

DAZZLING IMAGES FROM OUR NEAREST STAR

20

FEATURES

EARTH-SHAKING SHIFT IN SPACE POLICY

The killing of Constellation is not the only drastic change in the administration's new space policy, which continues to draw both praise and criticism.
by James W. Canan

22

MAKING THE MOST OF GOCE

Favorable on-orbit conditions are bringing major benefits for GOCE's investigations of Earth's gravity field and ocean currents.
by J.R. Wilson

AIRBORNE LASER SHOOTDOWN: DEFYING THE ODDS

Despite its recent success, the Airborne Laser Test Bed program faces an uphill political battle.
by J.R. Wilson

40

BULLETIN

AIAA Meeting Schedule

B2

AIAA Courses and Training Program

B4

AIAA News

B5

Meeting Program

B13

Calls for Papers

B35

COVER

This image of the Sun was taken immediately after the Atmospheric Imaging Assembly CCD camera on the Solar Dynamics Observatory cooled, on March 30, 2010. See the photo essay on page 20.



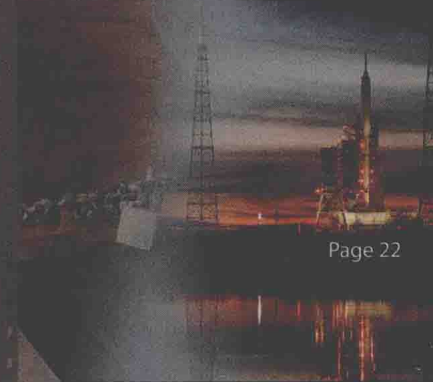
Page 4



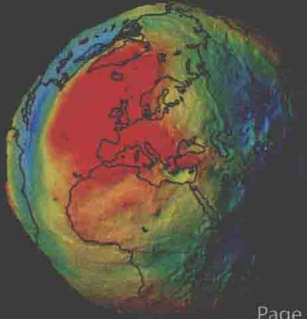
Page 16



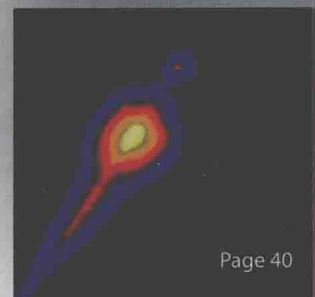
Page 8



Page 22



Page 30



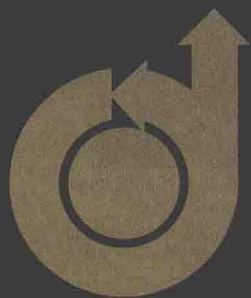
Page 40



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

Elaine J. Camhi

Editor-in-Chief

Patricia Jefferson

Associate Editor

Greg Wilson

Production Editor

Jerry Grey, *Editor-at-Large*

Christine Williams, *Editor AIAA Bulletin*

Correspondents

Robert F. Dorr, *Washington*

Philip Butterworth-Hayes, *Europe*

Michael Westlake, *Hong Kong*

Contributing Writers

Richard Aboulafia, **James W. Canan**,

Marco Cáceres, **Edward Flinn**, **Tom**

Jones, **Théo Pirard**, **David Rockwell**,

Frank Sietzen, **J.R. Wilson**

Fitzgerald Art & Design

Art Direction and Design

Craig Byl, *Manufacturing and Distribution*

Mark Lewis, *President*

Robert S. Dickman, *Publisher*

STEERING COMMITTEE

Michael B. Bragg, *University of Illinois;*

Philip Hattis, *Draper Laboratory;* **Mark S.**

Maurice, *AFOSS;* **Laura McGill**, *Raytheon;*

Merri Sanchez, *National Aeronautics and*
Space Administration; **Mary Snitch**, *Lockheed*

Martin; **Dave Thompson**, *Orbital*

EDITORIAL BOARD

Ned Allen, *Lockheed Martin Aeronautics;*

Jean-Michel Contant, *EADS;* **Eugene**

Covert, *Massachusetts Institute of Technology;*

L.S. "Skip" Fletcher, *Texas A&M University;*

Michael Francis, *United Technologies;* **Christian**

Mari, *Teuchos;* **Cam Martin**, *NASA Dryden;*

Don Richardson, *Donrich Research;* **Douglas**

Yazell, *Honeywell*

ADVERTISING

National Display and Classified:

Robert Silverstein, 240.498.9674

rsilverstein@AdSalesExperts.net

West Coast Display: **Greg Cruse**,

949.361.1870 / gcruse@AdSalesExperts.net

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.

Send Letters to the Editor to **Elaine Camhi**

at the same address or elainec@aiaa.org

June 2010, Vol. 48, No. 6



American Institute of
Aeronautics and Astronautics

Commentary

U.S. civil space policy: Clearing the fog

It is time to begin clearing the fog surrounding current U.S. civil space policy. Recent weeks have seen much airing of strong views both attacking and defending President Barack Obama's revised plans for human space exploration and related programs.

The foremost issue, in terms of U.S. international stature, is the half decade or more gap in U.S. capability for human transport to and from the space station. But retiring the shuttle after 30 years is certainly a valid step, both fiscally and in the interests of future crew safety. Shuttle technology is based on what we knew nearly a half-century ago: Imagine using 40- or 50-year-old information technology today! Constellation was also based on aged technology, though it is true that, as with the shuttle, much significant modern technology had been introduced. Besides, Constellation would also leave that gap.

Offering the private sector an opportunity to do what they've been clamoring for over at least the past two decades is also a step forward. If they succeed, it could help space transport emulate the highly successful satellite communications industry; if they fail, their contention will at least finally have been put to rest. The initial investment in commercial cargo transport to the ISS has already been committed, and will begin to show results, positive or negative, very soon. These contracts can then be used as indicators to assess the validity of Obama's planned \$6-billion investment in commercial carriers. And the proven Delta IV and Atlas V are available, too.

Meanwhile the president is carefully hedging his bet. He plans to retain the Orion concept and the heavy-lift option characterized by Ares V. Together with the obvious need in any heavy-lift design for thrust augmentation by solid-propellant rockets, these actions could help ameliorate the economic impact of canceling Constellation, use some of the \$9 billion already spent, and assuage the DOD's concern about loss of industry capability. A valid criticism is that this should start sooner—why wait until 2015?

Most important, the president's intent to invest in new technology initiatives could address the knottiest problem in human space exploration: reducing initial mass (and therefore cost) in LEO, with the corollary benefit of reducing transit times for astronauts' exposure to cosmic radiation. Two technologies that have been developed and could be demonstrated in less than a decade are upper stage nuclear thermal propulsion and orbital assembly. This aspect of the plan also addresses the issue of U.S. leadership in space. Other countries may get humans to the Moon sooner, but the best technology will win in the long term. The British Comet was the first commercial jet transport; the Boeing 707 came later. Which one dominated the skies?

Opponents point to a lack of specific goals and deadlines. But there are goals: extending the ISS to 2020 (and perhaps to 2028, as is now being studied); exploring near-Earth asteroids; building observatories at deep-space locations such as Lagrange libration point L2; returning to the Moon to set up observatories and search for water; and of course going to Mars. Perhaps the wisest element of the plan, however, is *not* setting specific deadlines or total costs of these missions. It is sheer fiscal irresponsibility to do so; we have no idea how much they will cost, nor how long they will take. But we do know that an annual NASA budget of about \$19 billion is acceptable, and that would allow us to make substantial (and measurable) progress toward those goals, without emasculating any of NASA's other important functions.

As the fog clears, a new era of human space exploration will lie before us.

Jerry Grey

Editor-at-Large

"Smart" procurement falters in Europe



IN MARCH OF THIS YEAR EADS AND ITS CUSTOMERS reached an agreement on funding for the Airbus A400M military transport. It entails a €2-billion increase on the original €19-billion contract for development and production of the aircraft, a further €1.5 billion of new funds for the project (in exchange for a share of future export sales), a waiver on current delay penalties and an accelerated rate of payment for aircraft between 2010 and 2014.

and governments have been slowly moving toward a better understanding of how to procure complex military systems. The lessons of the Eurofighter Typhoon, the NH-90 helicopter and, most recently, the A400M programs have resulted in a clear set of basic principles that should underpin the acquisition of any complex, multinational military platform.

In essence, these principles are: Reduce the number of phases that require political authority; identify risk and risk

the second phase encompasses design/development—during which the technological risks are evaluated, and which currently lasts longer than in past programs. This third phase is the production phase. ...In more complex programs sometimes there is a fourth phase between the definition and development phase, essentially the risk reduction phase (for simulations and pre-tests)."

Generally speaking, "smart procurement" means looking at the full life cycle of any new program at the very early stages, so system enhancements and upgrades can be planned and budgeted for many years in advance. It also means the roles of industry and government customers can be managed so technical and financial risks can be shared.

The U.K. strategy

The U.K. introduced its smart procurement initiative in 1988 and redefined it in 2001 as the "smart acquisition program." This became part of a broader new defense industrial strategy in 2005. The U.K. was the first European country to adopt smart procurement and "public/private finance initiative" acquisition policies, which have seen private contractors becoming responsible for military aircraft maintenance, pilot training, air traffic control and, most recently, the management of the RAF's air-to-air re-fueling operation.

A further defense industrial strategy will be launched in the next few years, as well as a new plan for acquisition reform, in which the Ministry of Defence (MOD) will establish procurement frameworks based on 10-year planning horizons.

Meanwhile, the MOD has streamlined its acquisition process for urgent operational requirements (UORs), approving over £3.6 billion of UORs for Iraq and Afghanistan since operations began, mostly related to protecting troops in the field. Recent UOR acquisitions have included General Atomics MQ-9 Reaper unmanned air systems—



Although this was an important breakthrough for both customers and manufacturer, the agreement has again highlighted the difficulties Europe has in procuring complex, multinational military equipment. In 2003 the unit cost of an A400M was around \$80 million, and it was due to enter service in 2009; now, the unit cost is more likely to be between \$120 million and \$130 million, and the entry-into-service date is 2013.

Despite huge efforts to introduce "smart" procurement practices over the past 10 years, the trends are pointing to more cost overruns and further delays to future cooperative ventures.

Principles take shape

For the past 30 years Europe's industry

reduction programs at an early stage (preferably the predefinition phase); and develop integrated teams of industry and customer/government qualified personnel, with real decision-making powers, to jointly manage key aspects of the program. If there are technical problems or delays as a result of budgetary issues—or a change in operational requirements—the expense for these should be allocated fairly between the government customer and industry.

"There is a tendency to have fewer phases (usually only three) in a program," according to a recent report, *Lessons Learned from European Defence Equipment Programs*, from the EU's Institute for Security Studies. "The first phase now consists of the predefinition phase,

with just 12 months between the original purchase request and the aircraft's use in operations by the RAF in Afghanistan—and airborne defensive aid suites.

Long-term difficulties

Although short-term acquisition processes have improved, many of the ministry's long-term strategic programs are late and over budget. The MOD ordered 21 Nimrod MR4 reconnaissance and surveillance aircraft for operation in 2003; this order has been cut to nine, with an operational date of 2012.

Pressure on defense budgets to reduce spending has also contributed to delays and cost overruns as equipment procurement is slowed down.

An independent audit into MOD acquisition processes commissioned by the U.K. government and released in October 2009 found that a consequence of using delays to manage the funding gap between available resources and acquisition commitments "has meant that programmes take significantly longer than originally estimated, because the Department cannot afford to build them at the originally planned rate.... Across a large range of programmes, this study found that the average programme overruns by 80% or around five years from the time specified at initial approval through to in service dates. The average increase in cost of these programmes is 40% or around £300 million. This study also estimates that the 'frictional costs' to the Department of this systematic delay are

in the range £900 million-£2.2 billion per annum."

This is not good news for the next round of large equipment acquisition programs, such as the purchase of 140 Joint Strike Fighters and two aircraft carriers. According to a recent House of Commons defense select committee report, delaying the carrier program has generated £450 million in savings in the short term but added £674 million in the longer term (over 10 years) of the program.

French twist

In France, acquisition reform has taken a different turn. Responsibility for military purchases lies with the Direction Générale pour l'Armement (DGA), a state organization sitting between the armed forces and the Defense Ministry, staffed by highly qualified technical personnel with both industry and government experience, favoring fixed-price contracting but with flexible contractual renegotiating principles.

In France, as elsewhere, over 50% of all military equipment purchasing con-

Eurofighter Typhoon



tracts are renegotiated at some stage. "In response, the French have introduced a 'responsibility principle' to fixed-price contracting, meaning that those who are actually responsible for failing to meet contractual obligations, whether government or industry, must generally pay the costs," according to a December 2009 U.S. Center for New American Security policy brief.

Although PFI (private finance initiative) government-industry contract deals are commonplace within the U.K., in France they are rare. One of the first was signed in 2007 between the Defense Ministry and the HeliDax company for the supply of up to 22,000 helicopter flight hours to the EA-ALAT (Ecole d'Application de l'Aviation Légère de l'Armée

NH-90



Events Calendar

JUNE 1-4

Fourth International Conference on Research in Air Transportation, Budapest, Hungary.

Contact: *Andres Zellweger, dres.z@comcast.net*

JUNE 7-9

Sixteenth AIAA/CEAS Aeroacoustics Conference, Stockholm, Sweden.

Contact: *Hans Bodén, hansbod@kth.se*

JUNE 8-10

Third International Symposium on Systems and Control in Aeronautics and Astronautics, Harbin, People's Republic of China.

Contact: *Zhenshen Qu, ocicq@126.com*

JUNE 14-18

ASME TurboExpo 2010, Glasgow, Scotland, U.K.

Contact: *www.turboexpo.org*

JUNE 28-JULY 1

Fortieth AIAA Fluid Dynamics Conference and Exhibit; 10th AIAA/ASME Joint Thermophysics and Heat Transfer Conference; 27th AIAA Aerodynamic Measurement Technology and Ground Testing Conference; 28th AIAA Applied Aerodynamics Conference; 41st AIAA Plasmadynamics and Lasers Conference; Fifth AIAA Flow Control Conference. Chicago, Ill.

Contact: *703/264-7500*

JUNE 28-JULY 2

Eighth International LISA Symposium, Palo Alto, Calif.

Contact: *Sasha Buchman, 650/725-4110*

JUNE 30-JULY 3

ICNPAA 2010—Mathematical Problems in Engineering, Aerospace and Sciences, Sao Jose dos Campos, Brazil.

Contact: *Prof. S. Sivasundaram, 386/761-9829, seenithi@aol.com*

JULY 10-15

Twenty-seventh International Symposium on Rarefied Gas Dynamics, Pacific Grove, Calif.

Contact: *Deborah Levin, 814/865-6435, dalevin@psu.edu*

JULY 11-15

Fortieth International Conference on Environmental Systems, Barcelona, Spain.

Contact: *703/264-7500*

JULY 18-25

Twenty-eighth Scientific Assembly of the Committee on Space Research, Bremen, Germany.

Contact: *www.cospar2010.org*

JULY 25-28

Forty-sixth AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Nashville, Tenn.

Contact: *703/264-7500*

JULY 25-28

Eighth International Energy Conversion Engineering Conference and Exhibit, Nashville, Tenn.

Contact: *703/264-7500*

de Terre), a helicopter training school in Dax, southern France.

Currently, according to the DGA, new military equipment procurement programs are running about two months behind schedule, with an increasing demand to meet new UOR purchases. Although a cause for concern, this suggests France is coping with complex military procurement issues somewhat more successfully than is the U.K.

But a recent government audit of all military programs since 2005 costing more than €5 billion—including the Dassault Rafale, NH-90 helicopter, A400M airlifter and Eurocopter Tiger helicopter—has shown that 75% of these major projects are impacted by delays or cost overruns. Among the main reasons for these problems, according to the audit, have been underfunding of programs, underestimation of program costs, international cooperation terms that have driven up costs and the simultaneous launch of several large programs.

Pressures grow

With increasing pressure on the defense budget, it is likely that delays and overruns will escalate in the coming years, in France and elsewhere. The delays and cost overruns to the A400M program will not help the cause of those convinced that private contractors need to be given more responsibility for managing complex new defense equipment programs.

The U.K. and France are not the only major European countries to consider a fresh overhaul of defense equipment procedures. The new German defense minister, Karl-Theodor Freiherr zu Guttenberg, has promised to improve the future German acquisition policy. The A400M delays, coupled with the controversy of the EADS KC-X tanker bid and a naval fleet-support ship contract that is well over budget, have concentrated minds in the German defense ministry on how far smart procurement principles should be taken.

Ironically, it was the poor performance, in terms of delays and cost overruns, on the multinational Eurocopter Tiger and the NH-90 military transport helicopter that persuaded the German defense ministry that EADS would have to bear so much of the brunt of costs and



SAR-Lupe constellation

compensation if the aircraft were delayed or if it underperformed, a policy that seems to have backfired.

Like France, Germany has been fairly slow in adopting smart procurement principles, one of the first being the €320-million military SAR-Lupe satellite constellation, a global military surveillance system able to operate night and day, independent of weather condi-

tions, delivering up-to-date, high-resolution images from virtually all regions of the world. Responsibility for managing the system was given to a consortium of companies led by OHB-System AG.

The first satellite was launched on a Russian Cosmos 3M launcher in December 2006, and all five satellites are now in

place. Delivery of the overall system was officially accepted by the customer, the German Federal Office of Defense Technology and Procurement BWB, in September 2008, on time and within budget; OHB is under contract to operate the system for 10 years.

But Germany, like the rest of Europe, now faces some tough choices on major strategic programs such as the

Franco-German-Spanish EADS Talerion ISTAR (intelligence, surveillance, target acquisition and reconnaissance) UAV, where a decision on the future of the program is due to be made this year.

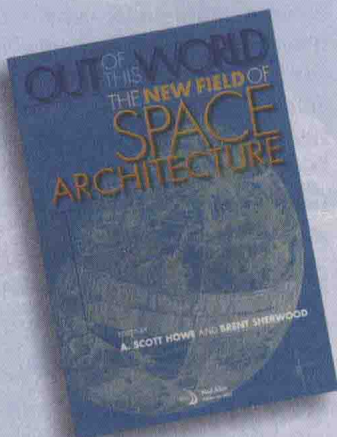


The current economic crisis should mean that governments will look increasingly for private industry partners to take more responsibility for managing and supporting complex new military systems. But there is little evidence that, beyond the U.K., this is happening. Rather, in these straitened times, politicians are coming under increasing pressure to support their domestic industries, delay expensive decisions on major programs for a few more years and concentrate on short-term troop protection acquisitions to support expeditionary operations.

Philip Butterworth-Hayes

Brighton, U.K.

phayes@mistral.co.uk



Out of This World: The New Field of Space Architecture

A. S. Howe
Brent Sherwood
Syd Mead

Library of Flight
2009, 400 pages, Hardback
ISBN: 978-1-56347-982-3

AIAA Member Price: \$89.95

List Price: \$119.95

Out of This World: The New Field of Space Architecture

This collaborative book compiles thirty chapters on the theory and practice of designing and building inhabited environments in outer space. Given the highly visual nature of architecture, the book is rich in graphics including diagrams, design drawings, digital renderings, and photographs of models and of executed and operational designs.

Written by the global network of practicing space architects, the book introduces a wealth of ideas and images explaining how humans live in space now, and how they may do so in the near and distant future. It describes the governing constraints of the hostile space environment, outlines key issues involved in designing orbital and planet-surface architecture, surveys the most advanced space architecture of today, and proposes far-ranging designs for an inspiring future. It also addresses earth-based space architecture: space analogue and mission support facilities, and terrestrial uses of space technology.

In addition to surveying the range of space architecture design, from sleeping quarters to live-in rovers to Moon bases and space cities, the book provides a valuable archival reference for professionals. Space enthusiasts, architects, aerospace engineers, and students will find it a fascinating read.

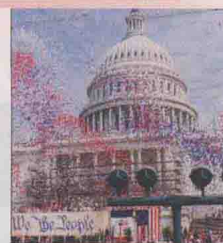
AIAA PUBLICATIONS

09-0554 AC



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

Disagreements and hard decisions



WHEN PRESIDENT BARACK OBAMA APPEARED at the Kennedy Space Center in Florida on April 15 to announce a shift in human spaceflight policy, he drew praise from several advocates of private-sector spacecraft development, including Apollo 11 astronaut Buzz Aldrin (see "Conversations," page 12). He also took lumps from critics who say the White House is grounding U.S. space efforts.

On the Hill, the USAF tanker issue remains unresolved, and "prompt global strike" is on the DOD's radar screens.

Defining the human space effort

The president is seeking to extend funding for the international space station until 2020 and wants NASA to pour \$6 billion into developing commercial space taxi services to give astronauts access to the station in the postshuttle era.

Obama also wants to kill the Constellation program, including the Ares rockets NASA has been developing for six years at a cost of \$9 billion. It does retain a scaled-down version of the program's Orion crew exploration vehicle, which would be launched, unmanned, to the station and be parked there as an emergency rescue vehicle but would not, as previously planned, take astronauts to the Moon and beyond. The president said it would still be possible for U.S. astronauts to reach Mars in the fourth



Sen. Barbara Mikulski

decade of this century, but enunciated no specific plan for achieving this.

Many in Washington believe that designing, developing and flying spacecraft is a strength of the government agency that has done the job for the past half-century and that the private sector—even with federal funding—is not yet ready to take over the building of the only U.S. spacecraft that will carry crews. Others feel, despite White House assurances, that shifting to private-sector spacecraft will cost jobs during a time of economic challenge. One Washington observer says the administration's policy "is not yet a done deal," because it faces robust opposition on Capitol Hill.

Moreover, astronaut Neil Armstrong, the first person to walk on the Moon, joined two other Apollo veterans in expressing "substantial reservations" about the administration's plan. If the policy is implemented, Armstrong, Jim Lovell and Gene Cernan wrote, "It appears we will have wasted our current \$10+ billion investment in Constellation" and that "the United States is far too likely to be on a long downward slide to mediocrity." Public utterances by the almost reclusive Armstrong—in this case, differing with his crewmate Aldrin—are very rare and are taken seriously in the nation's capital.

Following the president's statement and the astronauts' letter, NASA administrator Charles Bolden went to Capitol Hill on April 22 to defend the policy change. Sen. Richard Shelby (R-Ala.) charged that Bolden is an "impediment to moving forward" who lacks credibility among lawmakers. Shelby also accused the administrator of ceding human space exploration to the Russians, the Chinese and the Indians.

Similarly critical if more soft-spoken, Sen. Kay Bailey Hutchison (R-Texas) told Bolden that NASA is "relying too heavily on commercial entrepreneurs who [won't] be ready to send astronauts into space anytime soon." Sen. Barbara Mikulski (D-Md.) was easier on Bolden but questioned the new policy, asking, "How could a commercial vehicle be able to meet a three-year timeframe" for launching astronauts. Apparently not yet decided, Mikulski said she will formulate her position on the administration's budget request for NASA "only after more hearings and further research."

Tanker déjà vu (again)

The Air Force's decade-long effort to acquire a new air-refueling tanker took a new turn April 21 when EADS announced that it will enter the \$35-billion KC-X competition. Previously partnered with Northrop Grumman, which decided in March not to participate, EADS will challenge Boeing for an opportunity to build 179 aircraft to begin replacing 50-year-old KC-135 Stratotankers.

Air Force officers say privately that either of the aircraft likely to be submitted as a KC-X entry would serve their needs. Boeing is expected to press ahead with a version of its 767-200, which is smaller and has less fuel and cargo capacity but is likely to have lower maintenance and operations costs. EADS will propose a version of the Airbus A330-300, which it now calls the KC-45, that is more robust and can offload more fuel, but may be larger than

Sen. Kay Bailey Hutchison



what the Air Force needs. (For a brief period, KC-45 was the official military designation for the next-generation tanker but it is now an industry term.)

Boeing has the advantage of already operating a production line in Everett, Washington, and an outfitting facility in Wichita, Kansas, but has not yet put a prototype of its proposed tanker into the air or tested its proposed advanced air-refueling boom. EADS plans to build an assembly line in Mobile but is still a long way from dipping its first spade into the Alabama earth. EADS has a "production representative" version of its KC-45 and of its advanced refueling boom in the flight test stage. Each company claims that its aircraft can be ready on Air Force ramps sooner than the other.

The KC-X competition evokes powerful feelings at the highest levels in the nation's capital and overseas. French President Nicolas Sarkozy said on March 30 that he trusts Obama's promise that the tanker competition will be "free and fair." Many in Washington heard Sarkozy's words as a plea, if not a demand, rather than an assurance of a high comfort level. Standing beside the French president at a low-key press conference, Obama repeated that the KC-X would be



President Obama and French President Nicolas Sarkozy held a joint press conference on March 30.

a fair competition. He also told reporters that he has no intention of usurping Defense Secretary Robert Gates' control over the competition.

This was the latest of several statements by key figures stressing that the KC-X competition will be as fair as hu-



As the tanker competition ramps up once again, the KC-135 soldiers on.

mans can make it. In fact, that emphasis on fairness means that Gates is recused from the selection process, which will be conducted by acquisitions professionals, to avoid the appearance of unfair command influence.

Pentagon officials extended a deadline for KC-X bids from May 10 to June 9, a move that benefits EADS. Boeing says it was ready to offer its tanker on the earlier date.

This project, more than any other aircraft program—even the behind-schedule, over-budget F-35 Joint Strike Fighter—evokes strong feelings in Congress as well. Sen. Patty Murray (D-Wash.) issued a statement criticizing the inclusion of EADS, pointing to a recent World Trade Organization finding that Airbus's parent company received illegal subsidies from involved European governments.

Sen. Shelby, on the other hand, said the EADS tanker would create more jobs and give the Air Force a better plane. Split on which plane and which planemaker to support, Capitol Hill lawmakers are likely to object to any decision ultimately reached by the KC-X acquisitions team.

Prompt global strike

The Obama administration has asked Congress for \$250 million in FY11 to continue exploring a new weapon that uses an ICBM to boost an unmanned spaceplane into the upper atmosphere. Once called "precision global strike" and now renamed "prompt global strike" to emphasize its potential for rapid response capability, PGS would enable the U.S. to transport a conventional warhead to a high-value target in as little as an hour. Partly in support of PGS, on April 22 the Air Force launched an Atlas V rocket from Cape Canaveral carrying X-37B orbital test vehicle 1, a 29-ft,

Sen. Patty Murray





On April 22 the Air Force launched an Atlas V rocket carrying this X-37B orbital test vehicle.

11,000-lb unmanned space shuttle that can remain in orbit for months and land via remote control.

The Air Force "doesn't know when it's coming back," Gary Payton, deputy undersecretary for USAF space programs, told reporters. Without confirming a link between PGS and the X-37B mission, Payton said of the latter, "I don't know how this could be called weaponization of space. It's just an updated version of the space shuttle-type of activities in space." Others say an LGM-30G Minuteman III ICBM body will eventually replace the Atlas V and be melded with an upgraded X-37B to become an operational PGS system. Funding for a more conventional next-generation bomber is being postponed while the Air Force proceeds with PGS work.

Because PGS is suborbital, it will not violate international agreements or longstanding tradition against putting warheads into orbit. Still, previous administrations led by both parties have resisted using ballistic-missile-style rocket boost-

ers to launch conventional weapons because of the hairtrigger alert status of U.S. and Russian ICBM forces. Almost unnoticed by the public, Washington and Moscow continue to maintain hundreds of ICBMs in "launch on warning" mode, meaning that one superpower would unleash its missiles if it believed it was about to be attacked by the other.

At a high-level meeting in 2006, Russia's then-President Vladimir Putin told President George W. Bush that he opposed a PGS-type weapon because Russia would not know if a newly launched missile carried a conventional or a nuclear warhead. Acknowledging that the idea "really hadn't gone anywhere in the Bush administration," Defense Secretary Robert Gates, who also held the top Pentagon post under Bush, told ABC's "This Week" that the Obama team has "embraced" a conventional weapon that uses a rocket booster.

The appeal of PGS was spelled out by David E. Sanger and Thom Shanker in an April 23 *New York Times* article. The new weapon, they wrote, "is designed to carry out tasks like picking off Osama bin Laden in a cave, if the right cave can be found; taking out a North Korean missile while it is being rolled to the launch pad; or destroying an Iranian nuclear site"—all without the U.S. being forced to resort to nuclear weapons.

The U.S. will soon have a slower response version of the same capability using the B-2 Spirit stealth bomber and the Air Force's massive ordnance penetrator (MOP), a 30,000-lb bunker-busting bomb

scheduled to join the B-2's arsenal after a flight program is concluded later this year. Development of the MOP is widely understood to be a direct response to Iran's nuclear development program, which includes extensive underground construction.

All 20 operational B-2s belong to the 509th Bomb Wing at Whiteman AFB, Mo. Brig. Gen. Robert Wheeler, 509th commander, told Angus Batey of the *London Daily Mail*: "The MOP can hold any target at risk. It's a psychological deterrence weapon as well as a capability. There's no leadership that can hide from that particular weapon."

A source told *Aerospace America* that the Pentagon wants to be able to act quickly on short-notice intelligence and to attack a high-value target "within minutes rather than over a period of hours." The advantage of a Minuteman/X-37B PGS weapon over the B-2/MOPS combination lies only in the timing: Launched from Whiteman, a B-2 would take 10 hr to reach a target along the Afghanistan-Pakistan border; a missile-boosted spaceplane might reach the target in an hour.

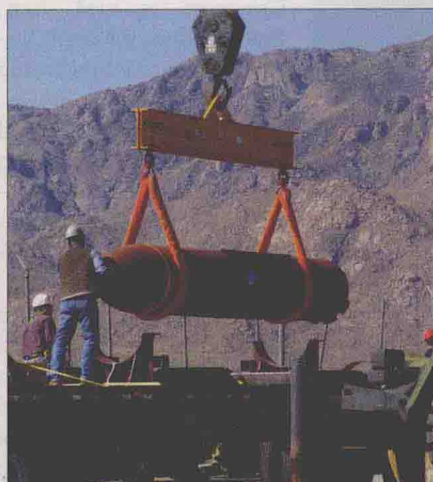
While the April 22 X-37B launch—about which, apart from Payton's comments, nothing has been said publicly—is part of the PGS effort, other pieces of the program are in the DOD's "black" budget and apparently include vehicles that have not been revealed in public. A senior source told this column that a part of the program is located at the Air Force's Groom Lake, Nev., facility.

The issue that must be resolved in Washington: Given the very high (but as yet unknowable) cost of a PGS system, does the nation really want to give up a next-generation bomber for it? A skeptic pointed out that bin Laden is probably living in a house, not a cave, and that the U.S. would have blown down the roof long ago using existing technology if leaders possessed accurate intelligence on the al-Qaeda figure's whereabouts.

The nation's leaders must also determine whether the U.S. can field a PGS capability without violating at least the spirit and possibly the letter of existing arms treaties, including a pact signed by Obama and Russian President Dmitri A. Medvedev in Prague on April 8.

Robert F. Dorr

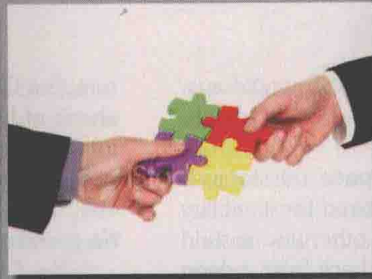
robert.f.dorr@cox.net



The flight program for the massive ordnance penetrator should be concluded later this year.

Going to the Joint Propulsion Conference in Nashville, TN
or the GNC Conference in Toronto, Canada?

Sizzling Summer Savings on Short Courses



**SAVE up to
\$300 by registering
by 15 June,
PLUS conference
registration
waived!**

Courses at the Joint Propulsion Conference

29–30 July 2010, Nashville, TN

- Advanced Solid Rocket Technologies
- Air Breathing Pulse Detonation Engine Technology
- Liquid Propulsion Systems—Evolution and Advancements
- Hydrogen Safety Course*
- Numerical Propulsion System Simulation (NPSS): A Practical Introduction*
- Tactical Missile Design—Integration

Courses at the Guidance, Navigation, and Control Conference

31 July–1 August 2010, Toronto, Canada

- Advanced Space Vehicle Control and Dynamics
- Automated Modeling and Simulation of Dynamic and Control Systems Using the Bond Graph Method in Aerospace Applications*
- Emerging Principles in Fast Trajectory Optimization
- Mathematical Introduction to Integrated Navigation Systems with Applications
- Robust and Adaptive Control Theory
- System Identification Applied to Aircraft—Theory and Practice

* New Course

www.aiaa.org

www.aiaa.org/courses

Buzz Aldrin

The whole world saw you walking up the stairs to Air Force One last April arm in arm with President Obama. You were headed to the space conference in Florida. What were you talking about?

He thanked me for my help in supporting his space plan.

That's it?

He's a very smart guy.

Much of the program you've advocated for years is included in the new plan. Do you feel vindicated?

No, because there is a lot of work to be done. We didn't get everything we sought.

What, for example?

There is still a need to develop a runway lander type vehicle for the space taxi, not a space capsule. And I urged the shuttle be extended so as to speed the development of a shuttle-derived heavy-lift vehicle. That doesn't seem to be likely now.

So you have no use for capsules?

No, I didn't say that. Making the space taxi that flies to and from the international space station a capsule is a

coming home from the ISS would sustain a more benign environment aboard a glider.

Now, for deep space missions, a capsule would be preferred for its ability to aerocapture and to otherwise sustain reentry speeds coming back from a deep space or planetary entry. There, wings and a lifting shape become problems for the heat shield and the higher heating loads and g forces. So I think an Orion-like vehicle would be preferred for use with a deep space vehicle, and a lifting body preferred for returning taxi missions from ISS. Each has a place.

For years, policymakers have ignored many of your ideas. Now they're being codified into policy. Why now? What has changed?

Things are really bad, and that's when change becomes possible. Government bureaucracies aren't known for their ability to make substantial changes; they're not very agile. NASA faces difficult times in transitioning from the shuttle era to an agency more focused on research and deep space manned flight.

This opens up the possibility of hearing new approaches. Under Constellation, the program of record was falling so far behind schedule that there

tors. But Charlie Bolden has a tough job ahead of him as he wrestles his agency into a new focus. The forces that support the status quo are very entrenched.

So you'd abandon the Moon entirely?

No, I believe we should go back to the Moon, only this time as part of an international partnership that establishes a lunar development authority. We are a great power and have the experience to help the other nations that want to develop the Moon. Same for the station. Our role today is to express our leadership by facilitating the space programs of our partners.

"Things are really bad, and that's when change becomes possible."

China, India, South Korea, Brazil all are seeking to develop advanced space programs, some of which include manned space programs. We can help make that a reality. And when we do, our stature increases, which strengthens our strategic interests.

Why the focus on Mars for all these years?

Our survival requires us to become a true multiplanet species. We need to identify places we can go in the solar system that could be candidates for habitation and colonization. Mars offers us tremendous scientific benefits, in understanding global climate change, possible life—and even, during the period when it was wet, advanced life. It is the best candidate we know of to support a human colony. So that's why Mars should be our focus, not the Moon.

What's the relationship between Mars and heavy lift?

A heavy-lift system is a better way to launch an interplanetary deep space vehicle into low Earth orbit than two vehicles. Using today's EELVs would require half a dozen launches of small

"Making the space taxi that flies to and from the international space station a capsule is a pretty dumb idea."

pretty dumb idea. But a space capsule would work in a deep space mission.

What difference does it make?

A space taxi, by definition, should be able to return crew and ISS experiments to a runway to speed their processing and to carry the larger payloads that a lifting body runway lander can deliver. A space capsule shape strongly limits the down mass and increases the g forces sustained during reentry. I have flown reentry profiles aboard capsules, and I can tell you that delicate samples

was no funding to build the Ares V or the Altair lander. It needed all of the funding just for "Apollo on steroids." That's because under [former NASA Administrator] Mike Griffin the focus became returning to the Moon, rerunning the Moon race we won 40 years ago.

I have had a unified strategic vision for space that is appropriate for the 21st-century world we face. The Cold War is over. Today, to demonstrate global space leadership requires that you collaborate and build coalitions with other nations, not see them as competi-

packages; that would not be desirable. To go anywhere beyond Earth orbit requires greater lift than we have today.

So you endorse the president's proposal to speed up a heavy-lift vehicle?

It won't take us five years to design.

How long would it take?

If we used the existing space shuttle infrastructure we could start now. That's why shuttle extension was so critical. But that doesn't seem to be in the planning, so we may have to change course and try a "clean sheet" approach.

You no longer favor a shuttle-derived heavy-lift design?

That's my preferred approach, but without shuttle extension you lose the workforce and the shuttle systems. So an entirely new approach may be needed.

And you didn't support the Ares I and Ares V vehicles?

The Ares I used five-segment motors that were unproven and underpowered for the weight of the Orion. And Ares V was too big. So it was clear to me that we needed a different approach to heavy lift.

How can NASA develop a deep space vehicle under their budget pressure?

If we utilize the spare parts left over from the ISS construction, or inflatable technology, we can get at least to the prototype stage fairly quickly without a huge expenditure of funds. There is always the tendency to go for the most expensive approach, the Cadillac, when something cheaper is available. The idea is to get us out into deep space as soon as we can start.

What is the most difficult thing about a manned Mars mission?

We don't have the technology to sustain a Mars crew for the long trip required by chemical rocket propulsion systems. That's why we need to develop

capabilities like the VASIMR plasma rocket and other designs, to shrink the transit times to Mars or asteroid rendezvous. We also need more research in radiation shielding. And a heavy-lift booster and possible advanced upper stages. We should be working on these areas now, and I think the new R&D budget supports this. In-space refueling of upper stages is a technology we should develop.

Buzz Aldrin was educated at the U.S. Military Academy at West Point, graduating third in his class with a B.S. in mechanical engineering. He then joined the Air Force, where he flew F-86 Sabre Jets in 66 combat missions in Korea, shot down two MiG-15s and was decorated with the Distinguished Flying Cross. After a tour of duty in Germany flying F-100s, he earned his doctorate of science in astronautics at MIT and wrote his thesis on manned orbital rendezvous.

Selected by NASA in 1963 into the third group of astronauts, Aldrin was the first with a doctorate and became known as "Dr. Rendezvous." The docking and rendezvous techniques he devised for spacecraft in Earth and lunar orbits became critical to the success of the Gemini and Apollo programs and are still used. He also pioneered underwater training techniques, as a substitute for 0-g flights, to simulate spacewalking.

In November 1966 during the Gemini 12 mission, he performed the world's first successful spacewalk, overcoming prior difficulties experienced by Americans and Russians during extravehicular activity and setting a new EVA record of 5 hr 30 min.

On July 16, 1969, Aldrin, Neil Armstrong and Michael Collins were launched aboard the Apollo 11 mission. On July 20 Aldrin and Armstrong landed their lunar module, Eagle, on the Moon's surface, spending 21 hr on the Sea of Tranquility. Apollo 11 returned 46 lb of Moon rocks,

Recently the LCROSS [Lunar Crater Observation and Sensing Satellite] mission detected substantial amounts of water on the Moon. Would you take advantage of this in your Mars scenario?

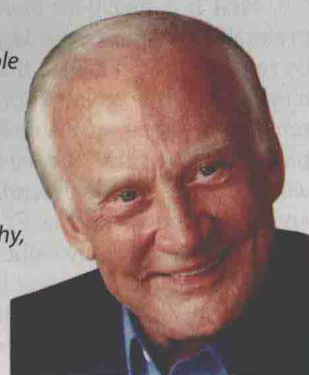
Robots can mine the water on the Moon, and we could teleoperate those robots from a deep space vehicle on a lunar flyby test flight—or by students back here on Earth. You don't need a

the first lunar samples to be returned by an Apollo crew.

Upon returning from the Moon, Aldrin was decorated with the Presidential Medal of Freedom, the highest U.S. peacetime award. A 45-day international goodwill tour by Aldrin and the crew followed, with 23 other countries bestowing numerous distinguished awards and medals. Asteroid 6470 Aldrin is named for him, as is the Aldrin Crater on the Moon.

Since retiring from NASA and the Air Force, Aldrin has devised a master plan for missions to Mars known as the Aldrin Mars Cycler—a spacecraft system with perpetual cycling orbits between Earth and Mars. He has received three U.S. patents for his schematics of a modular space station, Starbooster reusable rockets and multicrew modules for spaceflight. Aldrin founded Starcraft Boosters, a rocket design company, and the ShareSpace Foundation, a nonprofit devoted to advancing space education, exploration and affordable spaceflight experiences.

Aldrin published an autobiography, Magnificent Desolation, in 2009.



Moon base to do that. And when we do return to the Moon, the lunar development corporation will set out extraction plans and those nations that wish to will participate.

"There is always the tendency to go for the most expensive approach, the Cadillac, when something cheaper is available."

If you compare your Apollo 11 flight to an asteroid rendezvous mission today, which would you say is the more difficult to accomplish?

The asteroid mission will be very challenging, but it's a good precursor to missions to Phobos and Mars settlement.

Why Phobos? Why not just go straight on to a Mars landing?

Because the gravity on Phobos is substantially less than Mars, meaning that missions to Phobos can build a sustainable base, and building our first settlement off-world would be less complicated on Phobos.

Why is an asteroid mission a good precursor to a Mars mission?

It tests many of the same technologies, plus planetary defense. Unless we want to go the way of the dinosaurs, we need to understand these NEOs [near-Earth objects] and develop ways to deflect any that may threaten the Earth in the future. Under the Constellation program there just wasn't any funding available for any of this.

What are the technologies needed for the asteroid mission?

First is a heavy-lift launch system, preferably with an upper stage that can be refueled. You'd launch the stage, and after it performs its [injection] mission it remains in space, available for the next payload. The HLV [heavy-lift vehicle] would use the new hydrocarbon booster engines called for in the FY11 budget, new stronger but lightweight stage structures and bulkheads, a new launch facility in Florida that incorporates shuttle experience along with the experiences of other launch systems. Perhaps horizon-

tal vehicle processing. The trajectory for the asteroid intercept would be highly optimized for minimal transit times.

Then the design of the spacecraft. The habitat would have to be sized to ac-

commodate both the crew and optical instruments and telescopes, the ability to catalog data from observations. Some means to possibly either land on an asteroid or extract a sample and bring it back into the ship. A capsule like Orion docked to one end that can become a lifeboat in an emergency, but also perform an aerocapture maneuver at the end of the flight. The capsule could dock with a runway lander lifting body for the return trip back to Earth, or land itself.

Above all, the technology to allow the crew to survive the high-radiation environment. New in-space propulsion systems to maneuver around the asteroid once the capsule/habitat is in orbit, and the propulsion to break out of orbit to the return trajectory.

None of these capabilities exists today. Ideally, I would like to see that HLV be fully reusable at some point, which would require flyback boosters.

Why not just build new Saturn Vs?

The technology is dated, as are the engines, structures and guidance. Plus the tooling and construction facilities are gone. The best approach is either an interim step, which would be an all-cargo shuttle-derived solution using the shuttle facilities, workforce, engines, tank and boosters, followed by the new design. You may have to get there in incremental steps. But an advanced reusable vehicle should be our technological objective.

There has been concern over the shift in space taxi services from Orion CEV/Ares I to commercial entrepreneurs. You've supported this change. Why?

Private contractors are well within the capability to carry both crews and cargoes to the station. NASA can over-

see that while shifting to a focus on exploration missions. Routine space transportation can be performed by commercial industry. Gives us more options and a greater number of systems that can be developed.

Isn't there a risk in trusting the lives of astronauts to unproven vehicles?

They won't be unproven by the time astronauts fly on them. They will have to follow man-rating requirements and submit to NASA regulation.

Your former colleagues, like Neil Armstrong, Jim Lovell and Gene Cernan, don't agree—they call this shift the end of American human spaceflight.

A commercial industry that will have multiple crew vehicles flying in space, NASA developing Orion for deep space missions, a manned, heavy-lift launch vehicle, a budget that increases \$6 billion over five years—how is that the end of human spaceflight?

You call your ideas a unified vision. How is it unified?

It combines exploration, commercial development, science and security. Furthermore, all of the elements support each other—shuttle extension to speed the development of heavy lift, runway landers for ISS taxi services, a capsule and habitat for deep space missions, partnering with other nations to advance use of the ISS and the lunar surface, missions to Phobos that establish the technology for colonization of Mars. It's a strategic approach.

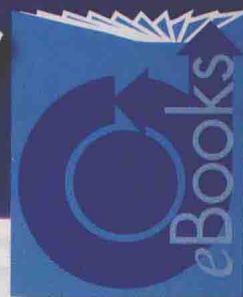
Okay, I have to ask about [your TV appearance on] Dancing with the Stars. Why did you do that?

To call attention to the successes of the Apollo program and get people to think about the future, support our military personnel, those who also supported our space program, and old geezers like me.

So you admit to being an old geezer?

I wanted to show people of my age that you can go out and get up and try to do new things. Be active. I'm 80 years old, so if I can do it so can you.

New!



Personal • Flexible • Portable • Trusted

AIAA eBooks

Gain the portability, flexibility, and personalization that AIAA eBooks provide. Now available from AIAA—your trusted source for aerospace research for more than 75 years.

- **More than 200 titles** from the *AIAA Education Series* and the *Progress in Astronautics and Aeronautics* series—including formerly out-of-print volumes from the 1960s and beyond.
- Read it **online** or **download** it to your computer.
- **PDF format**—easily read through the **free Adobe software**.
- Available at the **chapter level** in addition to the **entire book**.
- **Print, copy, cut, paste!** (some restrictions apply)
- AIAA Members receive a **25% discount** off of list price.
- Make notes, search, and export citations.
- Receive e-mail alerts and RSS feeds.

Start reading today at

<http://ebooks.aiaa.org>

Institutions wishing to purchase access should contact Adrian Fair at **adrianf@aiaa.org**, **888.854.6853**, or **703.264.7505**. Collections are available for all titles, by series, or by subject.