November 2009

AEROSPACE AMERICA

Defense acquisitions
A change in direction

Defining a subsidy

Choosing the pathway to space

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AEROSPACE AMERICA

November 2009

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BULLETIN

COVER

The Obama administration has moved to restructure not just the direction and nature of DOD's future acquisitions, but also the processes under which those acquisitions will be made. See the story beginning on page 25.

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Commentary

Nuclear propulsion–The affordable alternative

Planning for human solar system exploration has stubbed its toe, badly, on a simple bit of reality: The performance of chemical rocket propulsion is inadequate. The mass ratio required to deliver something to Mars is over 20 times greater than with nuclear propulsion. The added costs of necessary ferry flights and on-orbit integration are fatal.

The debate on human space exploration, mired in overruns, highlights two seminal drivers: long development time and high cost. Nuclear propulsion, proven nearly to the point of flight qualification in the 1960s, offers the unique combination of high specific impulse and large energy density that can drastically cut Mars mission costs. Propulsion technology change is therefore warranted, and also a different financial policy—one that rests on sustained national and collaborative international commitment, not shackled to unrealistic delivery dates that are clearly unachievable. The seminal cost driver of the Constellation program is the limited performance of chemical propulsion.

Reactivation of nuclear rocket technology will involve decisions to locate test and production facilities. If facilities at the Nuclear Rocket Development Station near Las Vegas can be refurbished economically, significant savings would accrue. Selection of new facilities might stumble into parochial conflicts and regional policy differences, especially during hard economic times, and higher costs. But several new testing approaches that yield significant cost reductions have been conceived in the Center for Space Nuclear Propulsion at the Idaho National Laboratory.

Public fear of radiation injury is greatly overblown. Health physics authorities note that this fear has caused radiation health hazard to be vastly overstudied, overanalyzed, and oversurveyed. The development and testing of nuclear rockets throughout the 1960s were, in fact, remarkably safe, despite vocal criticisms bred in paranoia. No notable radiation injury occurred at NRDS. Experience with nuclear materials in space and ground fission power systems ensures that nuclear rocket development will not present a public health hazard.

The successful development of nuclear rocket propulsion during the 1960s resulted in a near-flight design, which was abandoned when the Nixon administration terminated the Mars mission. The program has, since then, waited several decades for a restart stimulus. The nuclear rocket has always been the recognized solution for Mars exploration; it is now an opportune time for a serious reevaluation. Billions of dollars could be saved by this approach.

A detailed history of past nuclear rocket development is available on the *Aerospace America* Website [www.aerospaceamerica.org].

To resuscitate this option, major decisions must be made, beginning with recovery of the engineering data and equipment still available from remnants of the extensive Rover/NERVA nuclear rocket testing and development programs in the 1950s and 1960s. These decisions include test facility location, primary and secondary fuel types, and nuclear rocket flight configuration. Historic accomplishments of Rover/NERVA provide a powerful jump start in each area, with composite fuels as the primary approach. Cermets or multi-carbide fuels would be a sound backup. A fast-track program ranging over six or seven years to flight appears feasible.

Stanley V. Gunn, Rocketdyne engineer, Rover/NERVA, ret.
Ernest Y. Robinson, nuclear materials engineer, Lawrence Radiation Lab, ret.

Air freight revival: Real or a mirage?

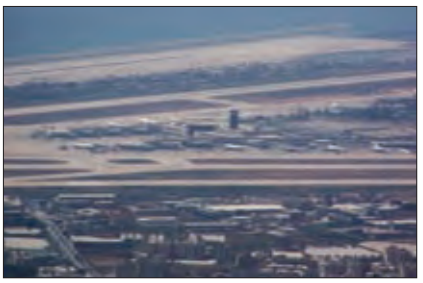
In July of this year the amount of international air cargo handled by Chinese airports rose 1.1% over the same month in 2008—the first increase in a year, according to the Civil Aviation Administration of China.

It is generally agreed across the industry that when the civil aviation recovery comes it will start in the burgeoning economies of the Far East, and the first signs of an upturn will occur in the air freight markets. So is the good news from China evidence of a real recovery in civil aviation, or just another false dawn?

Air cargo growth typically leads economic and passenger traffic growth by three to six months, according to Jim Edgar, Boeing's regional director, cargo marketing, at the Asian Aerospace event in Hong Kong in September. "This year, we're anticipating a deeper decline, and it'll be the first time in history that we'll have two years of decline back to back," he said. "The decline is slowing…things are improving and we're hopeful, but there's a way to go yet."

According to the International Air Transport Association (IATA), there is a fragile recovery in the air freight sector, but only as a result of lower yields and cutbacks in capacity. The rising price of fuel is threatening to choke the recovery before it is fully under way. "Since the low point was hit last December, air freight volumes have risen by 10%," said IATA's September cargo market analysis. "Part of the upswing came at the expense of yields, which fell by nearly 20% in the first half of 2009, as revenues on international air freight markets also plunged by some 40% over levels a year ago."

Rafiq Hariri Beirut International is now the fastest growing aviation hub in the world, with numbers rising for both freight and passengers.



Boom in Asia

Compared to North America and Europe, the economies of the Far East are recovering relatively quickly from the global recession. The domestic market within the Far East is resilient. The Airport Council International (ACI) has reported that domestic passenger travel across the Asia Pacific area rose by 3.9% in the first six months of the year compared to 2008, with June showing a healthy rise of 7.2%.

India is about to transform itself from a relatively small market to a major regional air cargo hub, according to a recent Frost & Sullivan study. International and domestic Indian air cargo turnover was about 1.77 million tonnes in 2007-2008 but will increase at a compound annual growth rate of roughly 8.3% by 2013. "Increasing globalization, integration of the world economy, and the strengthening of India in the IT service provider space has resulted in a booming Indian economy, supporting a thriving global economy," according to Frost & Sullivan analysts Arun Narayanan and Chethan Kambi. "This has increased the aggregate demand and is an important driver for air cargo services."

But it is too early yet to determine whether modest economic growth levels among Far Eastern states will act as a catalyst to a wider recovery in the air transport industry.

Aviation in the Far East

The early indications suggest Far East domestic aviation markets are operating in a distinctly different economic environment to global aviation markets. The Association of European Airlines, for example, reported an overall drop of 16.8% in freight-tonne kilometers for this July compared to July a year ago, mainly as a result of falls in European-Asia traffic, which dropped 23.2% in the same month compared to 2008. Overall, Asia Pacific carriers will post losses of $3.6 billion this year, according to IATA.

"The freight numbers tell an interesting story. The sector is being boosted as companies restock depleted inventories. Once inventories are at desired levels in relation to sales, improvements in demand will level off until business and consumer confidence returns. Given the large amount of debt in all sectors of the economy, instant relief is not in the forecast," said IATA's chief executive officer Giovanni Bisignani in September.

In a September cargo market analysis, IATA said continued excess capacity forced yields down by 21% in the second quarter of this year, leading to a 40% shrink in first-half revenues. One result has been that some freight forwarders were considering air freight, rather than sea freight, for items not of high value.

According to Hong Kong Shippers' Council director Sunny Ho, speaking at the Airfreight Asia 2009 conference in September, Hong Kong garment manufacturers were now turning to air freight for U.S. customers experiencing low inventory levels.

Airbus and Boeing will be watching the fortunes of the Far East air cargo sector with particular interest as they both plan to introduce long-range, high-capacity cargo aircraft—aimed particularly at customers in the Asia Pacific region—in 2010. Airbus' first A330-200F freighter will be delivered soon after certification in the first quarter of the year; delivery of Boeing's first 747-8 freighter is scheduled for the third quarter.

Planning difficulties

While long-term trends point to a growth rate in the air freight market of more than 5% a year, short-term fluctuations in the demand and supply cycle can play havoc with aircraft manufacturers' plans.

The first Airbus A330-200F is expected to be delivered in the first quarter of 2010.

Airbus has had to put on hold the development of an Airbus A380 freighter, despite having orders for 27 of the type at the start of 2005, as program delays and a declining freight market have forced potential customers to develop survival, rather than growth, plans.

The difficult market conditions began in May 2008, according to Boeing, and they led to a contraction in cargo traffic of about 6% for the year, in comparison to 2007 levels. Further declines were recorded early this year. Combined with slowing world industrial production and international trade, this has had a slight downward impact on Boeing's long-term view of the freight market, leading to a 5.4% cargo traffic growth rate, measured in revenue tonne-kilometers, in this year's forecast.

Boeing is still optimistic about the long-term demand for new freighter aircraft and expects global air cargo traffic to return to growth next year amid a broad economic recovery, with the U.S. and China leading the way.

The longer term

The world will need to double the number of freighters over the next 20 years, according to a recent Air Cargo Management Group (ACMG) study, with 3,472 freighters needed for growth and replacement from 2009 through 2028. According to ACMG, 1,100 of these will be "new-build" aircraft and 2,372 will be conversions; the number of widebody freighters as a percentage of the overall market will increase to reflect the growing importance of the Far East customers serving global markets. "If domestic China grows 10% per year as predicted, by 2028 this market will be larger than the domestic U.S. air cargo market is today," says ACMG managing director Robert Dahl. ACMG is predicting transpacific air freight will grow at around 7% a year.

Airbus, too, is confident about the long-term health of the air freight sector. But its latest air freight market forecast, released at the end of 2008, suggested that the rise in price of oil could slow down recovery. "During the summer of 2008, fuel prices rose to unprecedented levels, leading to older aircraft being parked," according to its December 2008 air cargo market forecast. "Indeed, around 400 freighter aircraft were parked during the period September-October 2008 as a direct consequence of the extremely high fuel price and the deteriorating demand."

It also suggested the trend toward more widebody freighters will continue: "Large freighters are the aircraft of choice on the large and fast-growing flows originating in Asia. Today, 69% of large freighter scheduled flights link Asia, China, or Japan to the rest of the world. As a consequence, the large freighter segment is expected to see the highest growth, with a yearly average increase of 5.9% over the forecast period, from 426 aircraft today….more than 50% of the large freighters required are expected to be new deliveries."

(Continued on page 9)


A milestone was reached in the assembly of the Boeing 747-8 freighter as mechanics completed installation of GEnx-2B engines on Airplane 1.

CUSTOMERS AND ORDERS

Customer	Country	Orders	
Airbus A330-200F			
Aircastle	U.S.	Leasing company	12
Guggenheim Aviation Partners	U.S.	Investment fund company	2
Intrepid Aviation Group	U.S.	Investment fund company	20
Avion Aircraft Trading	Iceland	Leasing company	6
Bank of China	China	Leasing company	5
Matlin Patterson Group Advisers	U.S.	Investment fund company	6
Etihad	Abu Dhabi	Operator	3
Flyington Freighters	India	Operator	12
MNG Airlines	Turkey	Operator	2
ACT Airlines	Turkey	Operator	2
Alis Aerolinee Italiane	Italy	Leasing company	5
Boeing 747-8F			
Cargolux	Luxembourg	Operator	10
Nippon Cargo Airlines	Japan	Operator	8
Air Bridge Cargo Airlines	Russia	Operator	5
Atlas Air	U.S.	Operator	12
Cathay Pacific	China	Operator	10
Dubai Aerospace Enterprise	Dubai	Investment fund company	5
Emirates Sky Cargo	Dubai	Operator	10
Guggenheim Aviation Partners	U.S.	Investment fund company	4
Korean Air	Korea	Operator	5

Note – order numbers are subject to sudden change. Table compiled in September 2009.

Controversy and doubts in defense and space

IN A MAJOR POLICY REVERSAL—SAYING THE change was based on advice from Pentagon officers—President Barack Obama personally told the leaders of Poland and the Czech Republic in September that the U.S. will abandon its longstanding plan for a missile defense shield in Eastern Europe.

The change ends Washington's goal of deploying 10 ground-based interceptors in Poland and installing large, fixed-site radar on Czech soil by 2017. The two facilities were expected to work together to counter long-range ballistic missiles launched from Iran. Although the program was defensive, Moscow had adamantly opposed having weaponry so close to its frontiers in a region the former Soviet Union once dominated, and the plan became a thorn in the side of relations between Washington and Russia.

Obama attributed his decision to a changed perception of the threat posed by Iran's missile and nuclear programs. He said Washington now believes that short- and medium-range missiles from Iran pose a more immediate threat, while an Iranian ICBM is many years farther away than once projected. (In late September Iran launched a series of medium-range 'test' missiles of sufficient range to reach parts of Europe and U.S. bases in the gulf.)

Secretary of Defense Robert Gates

Russia welcomed the change. Although Poland and the Czech Republic revel in their newfound role as allies of the U.S., public opinion within both Eastern European nations had been mixed, at best.

As expected, Capitol Hill conservatives expressed displeasure over the decision. Perhaps unexpectedly, they also objected to the suddenness of the announcement. Sen. John McCain (R-Ariz.), who has sometimes crossed the aisle to support Obama on other issues, noted that "a late-night phone call was all it took to tell our friends to take a hike." Obama reportedly reached Polish Prime Minister Donald Tusk by phone at midnight Tusk's time.

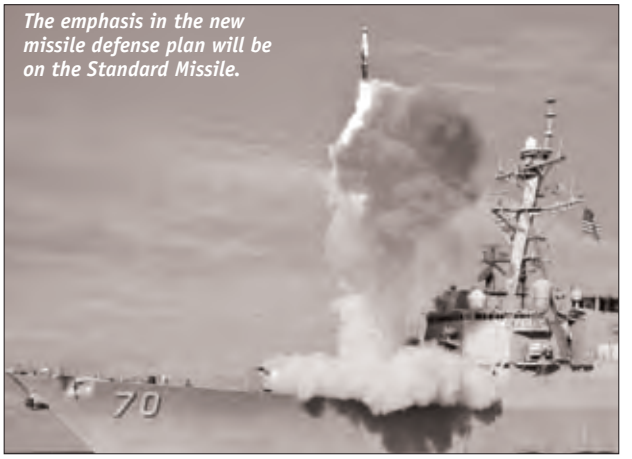
In Capitol Hill testimony, Pentagon policy chief Michele Flournoy apologized to lawmakers for not briefing them in advance. Flournoy said the administration rushed its announcement because details were beginning to leak.

Critics of the decision agreed with *Washington Post* columnist Andrew Nagorski that Washington was "walking away from an agreement with two allies in Central Europe and appearing to bend to pressure from the Kremlin." (Some in Washington place Poland and the Czech Republic in "Central" rather than "Eastern" Europe, pointing out that Prague is west of Vienna).

The Pentagon's civilian boss insists that Washington is not letting its friends down. "Those who say we are scrapping missile defense in Europe are either misinformed or misrepresenting what we are doing," said Secretary of Defense Robert Gates in a press conference. "This shift has even been distorted as some sort of concession to Russia, which fiercely opposed the old plan. Russia's attitude and possible reaction played no part in my recommendation to the president on this issue."

Gates emphasized that "American missile defense on the continent will continue." His proposed new missile defense plan will rely on sensors and interceptor missiles based at sea, on land, and in the air, but the emphasis will be on the RIM-161 SM-3 Block 1-A Standard Missile carried by Navy Aegis-class warships and adaptable to operations from land. Marine Corps Gen. James Cartwright, vice chairman of the Joint

Undersecretary of Defense for Policy Michele Flournoy



The emphasis in the new missile defense plan will be on the Standard Missile.

Chiefs of Staff, said that by 2015, a land-based SM-3 based on the yet-untested block 1-B version could be placed in Poland, the Czech Republic, "and in other NATO countries as well."

Airlifter upgrade doubts

Two famous Air Force cargo haulers, the C-130 Hercules and C-5 Galaxy, are enmeshed in controversy as the Pentagon and Capitol Hill debate the future of the nation's airlift fleet.

Air Force chief of staff Gen. Norton Schwartz wants to kill the C-130H Avionics Modernization Program (AMP). At the same time, Air Force leaders and some in Congress want to save the C-5 modernization program.

The C-130 is the proven, four-engined turboprop craft that performs as a "tactical airlift," bringing supplies and weaponry to crude airstrips close to the front lines. Speaking to reporters about the AMP, Schwartz said in September, "The bottom line is, we can't afford it."

Boeing won the AMP contract in June 2001, defeating the aircraft's manufacturer, Lockheed Martin. Boeing began low-rate initial production and has delivered its first C-130H AMP avionics simulator to Little Rock AFB, Ark.

Intended to modernize and, more important, standardize cockpits of 222 C-130Hs, AMP has experienced cost overruns and delays. A 2008 report by the Government Accountability Office was sharply critical of the program. Schwartz says he wants a less costly upgrade that will enable aging C-130Hs to fly on international air routes. He cautioned that "no decision is final," but since the DOD has succeeded in cutting bigger programs such as the F-22 that were more popular on Capitol Hill, observers expect Schwartz to get his way.

Less clear is what will happen to the C-5 Galaxy fleet. The C-5 and its rival, the C-17 Globemaster III, are the Air Force's outsized "strategic airlift" freighters, carrying large cargoes on transcontinental and transoceanic missions.

The C-5 fleet numbers 111 aircraft, out of 126 built (59 C-5As, 47 C-5Bs, two C-5Cs, and three C-5Ms). A year ago, as an economy move, the Air Force scrapped plans to reengine its first-generation C-5As, which are 15 years older than its second-generation Bs, but both models are still scheduled for an avionics modernization program (also abbreviated AMP). Only C-5Bs will also receive an engine upgrade, replacing 41,000-lb-thrust General Electric TF39-GE-1C turbofan engines with 67,000-lb-thrust GE CF6-80C2 engines. An upgraded Galaxy transport that emerges from both the AMP and reengining program is designated C-5M Super Galaxy.

The AMP is intended to modernize and standardize cockpits of 222 C-130Hs.

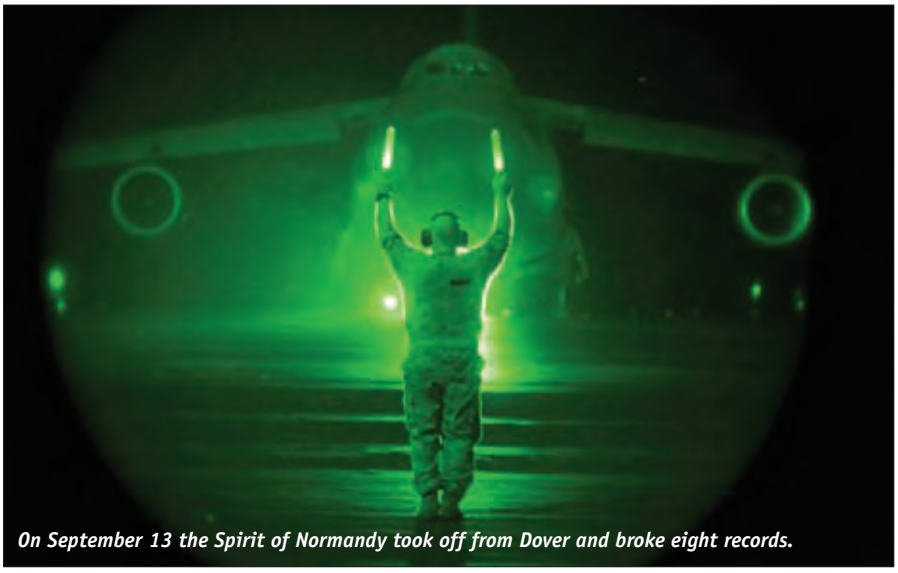
The C-5 is the only aircraft that can carry some cargoes. But some in Congress insist that the C-5M is not needed and that C-5 funding should be diverted to building more C-17s instead, whether the Pentagon requests them or not.

Boeing officials have said that if the Pentagon does not order more C-17s, the production line will shut down in July of 2011.

Sen. Daniel Inouye (D-Hi.) and Rep. John Murtha (D-Pa.) are among C-17 supporters. Inouye, who helped arrange for C-17s to be stationed in Hawaii, said the Globemaster III is a "great aircraft, ideally suited for the vast distances of the Pacific region"—defying the conventional wisdom that the aircraft, although more reliable and economical, is not nearly so long ranged as its rival.

Sen. Tom Carper (D-Del.) and Rep. Mike Castle (R-Del.) oppose this argument. They believe the future of Dover AFB, Del., long a fixture for the nation's transatlantic airlift efforts, relies on continuing to modernize older C-5s to the C-5M. Castle told the Wilmington, Del., *News Journal* that lawmakers regard continued C-17 production "as a jobs program" and that more are not needed.

Amid the C-5 versus C-17 debate, a C-5M Super Galaxy made a record flight on September 13. Carrying a payload of



On September 13 the Spirit of Normandy took off from Dover and broke eight records.

176,610 lb, a C-5M named The Spirit of Normandy took off from Dover and climbed to 41,188 ft in 23 min 53 sec, a new world record for aircraft weighing 551,155-661,386 lb. Altogether, the C-5M broke seven other records. The pilot on the flight was Lt. Col. Scott Erickson, the reservist in charge of C-5M training at Dover.

At the beginning of October Congress appeared poised to appropriate funds for 10 more C-17s in FY10, even though the administration does not want them and the Pentagon did not request them. The White House indirectly gave lawmakers a green light by saying Obama would not veto a bill funding more C-17s. As for the C-130H AMP, observers in Washington did not expect the program to receive more funds.

Tanker program shift

Responsibility for procuring a new air refueling tanker aircraft will go to the Air Force rather than the Office of the Secretary of Defense, Gates has decided. At a September 24 Pentagon news conference, the Air Force announced some details about the latest KC-X program, which will be the third effort to acquire a new tanker since 2001.

Next summer, says Air Force spokesman Col. Michael Curphey, the competition will downselect the winner for 179 aircraft under the KC-X program. The plan is for delivery of 15 tankers a year. The first delivery will take place in 2015, and the service will reach initial operating capability two years later. As the program matures, the Air Force will evaluate its future tanker needs and begin work on a next phase, KC-Y. In similar fashion, a final evaluation of requirements will take place, as will a final phase, KC-Z. Although not explicitly stated, KC-Y and KC-Z will not necessarily end up being the same aircraft as KC-X.

The tanker program will continue to fuel differences on Capitol Hill between supporters of a team headed by Boeing and another led by Northrop Grumman and EADS. Meanwhile, some U.S. airmen continue to maintain and fly tankers that are older than their grandparents: Some of the 415 KC-135R Stratotankers in service today have FY59 serial numbers and will eventually reach 80 years of service before being replaced.

Human spaceflight

At a time when the spaceflight community has been awaiting key policy decisions by the Obama administration, the watchdog GAO on September 25 released a harsh report concluding that NASA is on unsure footing.

The administration was expected to make a decision in the fall on whether or not to proceed with "the Vision" or adopt some other plan to put astronauts into orbit aboard U.S. vehicles. The Vision—now called the Constellation program—would build an Ares I launch rocket and an Orion crew exploration vehicle to replace the three-vehicle space shuttle fleet. There was little good news for the plan in either the GAO report or

Norman Augustine

the findings of a committee headed by former aerospace executive Norman Augustine. (See "Choosing the pathway to space," page 32.)

NASA still lacks a knowledge-based acquisition strategy, a realistic cost estimate, and sufficient funding for the Vision, the GAO stated. It noted that the agency has not properly addressed technical challenges for Ares I and Orion, such as limiting vibration during launch, eliminating the risk of hitting the launch tower during liftoff, and trimming weight from Orion.

The GAO also criticized poorly phased funding that risks monetary shortfalls during every fiscal year through 2012. This means that planned work is not being completed to support schedules and milestones. Also, says the report, "NASA does not know how much Ares I and Orion will ultimately cost, and will not know until technical and design challenges have been addressed."

Rep. Bart Gordon

Rep. Bart Gordon (D-Tenn.), who chairs the House Committee on Science and Technology, requested the GAO findings as part of his committee's oversight of NASA acquisition efforts.

The GAO report amounts to "piling on" findings by the presidentially appointed Augustine blue-ribbon panel. Augustine ran into unexpected anger and frustration from lawmakers when he testified on Capitol Hill that neither NASA's current program, Constellation, nor any of its likely alternatives can get U.S. astronauts out of LEO without a sizable spending increase. His committee's written summary report begins by proclaiming, simply, that the nation's human spaceflight program "appears to be on an unsustainable trajectory."

Critics of the Augustine panel say the group discussed many options but made no clear recommendation. One NASA employee called the panel's report "wishy washy," and summed up the way many feel: "We don't know where we stand," she said. "We don't know whether we'll have a job next week. We don't know whether we'll fly."

At press time, the Ares I rocket was about to undergo a major test, but—as the situation has been with the human spaceflight program for the past several years—no one could say what might happen next.

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(Continued from page 5)

It is perhaps a sign of the times that of the 69 A330-200Fs and 747-8Fs ordered by air cargo airlines, just over half (35) have been bought by Asian carriers, with European airlines ordering 19, Middle Eastern airlines 13, and U.S. operators 12.

Growth in the Middle East

The Middle East is emerging as a key aviation growth area for both passenger and freight services. Between January and June of this year, international air freight grew 3.5% year on year, according to an ACI report in September. This year Middle East airlines will add 114 aircraft to their fleets—equivalent to 8% of total worldwide deliveries, and 122 in 2010 (9% of the total), according to the Center for Asia Pacific Aviation (CAPA). Airlines in the United Arab Emirates are set to more than triple the number of aircraft based in the country over the next two decades, according to CAPA. Dubai's air cargo traffic grew by around 9% in 2008 over 2007, and air freight traffic was up 6.1% for the first seven months of this year. Dubai is now the fourth busiest international air cargo hub in the world—ahead of Tokyo, Shanghai, and Frankfurt.

But it is not just in the oil-rich kingdoms of the gulf where the Middle East is defying the global aviation downturn. The fastest growing aviation hub in the world is now Rafiq Hariri Beirut International, where passenger numbers were up 25% in the first eight months of the year over the same period in 2008, and freight handled rose to 47,221 tonnes, an increase of 9.6%.

Managing new assembly lines

The volatility of demand and supply in the short-term, however, is making it difficult for both Airbus and Boeing to manage the new freighter assembly lines. Airbus has already delayed first deliveries of the A330-200F from the second half of 2009 into 2010. This has been caused by a need to meet an increased demand for passenger versions of the aircraft, according to the company, following a shortage of capacity created by ongoing delays to the Boeing 787 program. Some leasing customers, as a result, have switched their orders from freighters to passenger aircraft.

According to 2008 production schedules, around 10 A330-200F aircraft should be rolling off the Toulouse production line in 2010—a schedule that will probably be revised considerably. It will have to be altered further if there are any more shocks to the global economy, as nearly a third of A330-200F customers are investment funds.

If Airbus' parent company EADS wins the USAF KC-X military refueler contract, EADS would move A330-200F production to Mobile, Ala. EADS has already started work on the $600-million plant, following the award of the initial contract, but that work has now been halted pending a decision on the KC-X contract. EADS estimates it would take 12-18 months to build the plant and hire the 1,000 workers required. The first A330-200Fs could potentially be produced about six months after the first military tanker, according to EADS.

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Despite the volatility in the markets, the order backlog for both the A330-200F and the 747-8F has proved relatively resilient. The large number of investment fund companies that have stuck with the new Airbus and Boeing freighters—despite a lack of clear data on a recovery—suggest that the fundamentals remain strong.

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Events Calendar

NOV. 3-6
NDIA Aircraft Combat Survivability Symposium, Monterey, Calif.
Contact: Meredith Geary, 703/247-9476; mgeary@ndia.org

NOV. 15-20
Twentieth International Congress of Mechanical Engineering, Gramado, Brazil.
Contact: Joao Luis Azevedo, azevedo@iae.cta.br

JAN. 4-7
Forty-eighth AIAA Aerospace Sciences Meeting, including the New Horizons Forum and Aerospace Exposition, Orlando, Fla.
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JAN 20-21
AIAA Strategic and Tactical Missile Systems Conference (Secret/U.S. only), Monterey, Calif.
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JAN. 25-28
Annual Reliability and Maintainability Symposium, San Jose, Calif.
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Thirteenth Annual FAA Commercial Space Transportation Conference, Arlington, Va.
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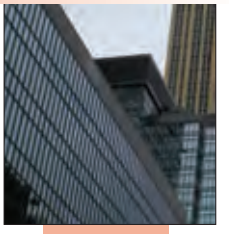
FEB. 14-17
Twentieth AAS/AIAA Space Flight Mechanics Meeting, San Diego, Calif.
Contact: A. Trask, trask@apogeeintegration.com

FEB. 23-26
Space, Propulsion & Energy Sciences International Forum, Laurel, Md.
Contact: Glen Robertson, 256/694-7941; gar@ias-spes.org



Defense giants reshape UAV industry

THE UAV INDUSTRY IS BEING TRANSFORMED as the megadefense companies seek to displace the small firms that have dominated this sector until recently.

Through acquisitions, heavy research spending, and teaming, large corporations are rapidly changing the face of the industry. Smaller companies are being snapped up as their larger competitors seek to establish footholds in one of the key growth markets of the future.

In April, Northrop Grumman purchased the Killer Bee line of UAVs.

Explosive growth

For many years, the UAV sector was treated as a relatively minor market without the budget or large production runs to attract large defense companies. The wars in Iraq and Afghanistan have led to a military transformation in which funding and military adoption rates are making UAVs an increasingly attractive market. The number of such vehicles in DOD inventories exploded from fewer than 50 in 2000 to more than 6,000 last year.

Now UAVs rank with homeland security and cyber security as one of the hot growth areas for defense companies. They have the appeal of being a relatively dependable growth area at a time when the overall defense budget will be under pressure.

The Teal Group forecasts that the market will be worth $62 billion worldwide, with a 7.8% compound annual growth rate over the period from 2009 to 2018. At a time when the overall defense budget will be under pressure, that is a relatively strong growth rate.

Not only is this market large and growing, it is also easily accessible to U.S contractors. The Teal forecast shows that the U.S. will be dominant over the 2009-2018 period. It will account for 72% of R&D and 61% of procurement. Europe will be the second largest market, closely followed by Asia.

Boon for small companies

The explosive growth of the market in recent years has created a unique industrial environment in which small companies have thrived, successfully competing with significantly larger ones.

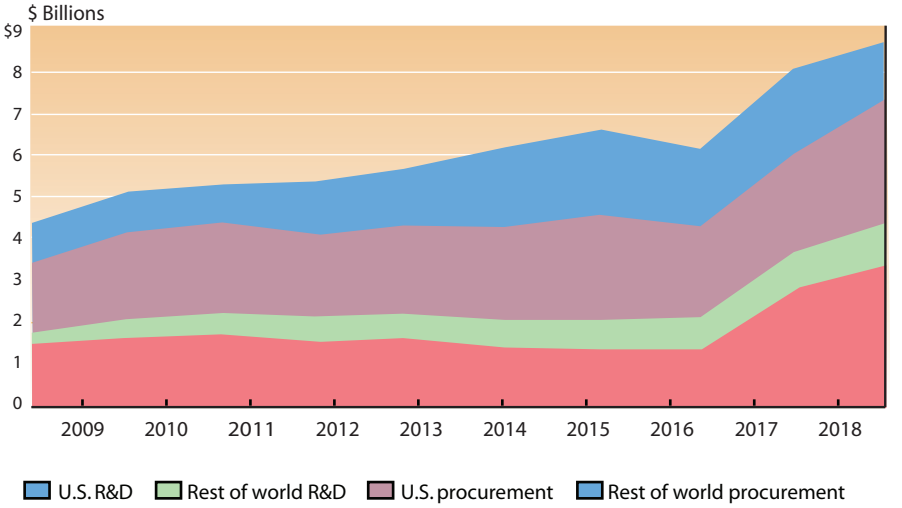
General Atomics Aeronautical Systems grew to dominate the medium-altitude long-endurance market with the Predator drone and its variants. AAI's Shadow became the basic tactical UAV of the Army. Insitu's Scan Eagle became a staple in Navy/Marine Corps services. And AeroVironment became a giant in small UAVs, winning every competition for a U.S. military program of record in this size category.

Not driven by the need to please shareholders on a quarterly basis, these small companies were willing to look at potentially long payoff times. They spent heavily on R&D and were willing to focus on small programs to develop their market presence. The agility that came from being small was critical in building up their market positions.

Large firms follow

Until recently, larger companies possessed relatively modest footholds in the UAV industry, particularly in production programs. Northrop Grumman, through its 1999 acquisition of Teledyne Ryan, was the exception, having the developer of the Global Hawk as its entry into the industry. Northrop Grumman used that acquisition as the seed of an effort that made it the largest UAV company in the

WORLD UAV EXPENDITURES FORECAST
R&D and procurement



world, with $1.3 billion in projected 2009 UAV revenues and two years of UAV backlog.

With the growth of the UAV market, large defense companies have followed Northrop Grumman's early example and made a string of acquisitions of small UAV developers and manufacturers. Acquisitions have tremendous appeal, because there are relatively few new programs available to establish a company's position in the market. That makes a position on an existing program all the more valuable. Smaller companies often have a reputation for innovative UAV solutions that also appeal to their larger competitors.

In an acquisition that kicked off the current wave of purchases, Textron purchased AAI (United Industrial) in December 2007 for $1.1 billion. This made it the main supplier of tactical UAVs to the Army. Boeing followed in September 2008 with its acquisition of Insitu.

In recent months, the pace of acquisitions has continued despite a worldwide economic crisis that has dramatically cut merger activity. Northrop Grumman purchased Swift Engineering's Killer Bee line of UAVs in April. In June, BAE Systems acquired Advanced Ceramics, a manufacturer of three small UAVs.

Even major subcontractors have been making their own acquisitions. Rockwell Collins purchased Athena Technologies, a manufacturer of UAV flight controls and navigation equipment, in April 2008. In May 2009, Goodrich acquired Cloudcap Technology, which develops and manufactures stabilized camera systems.

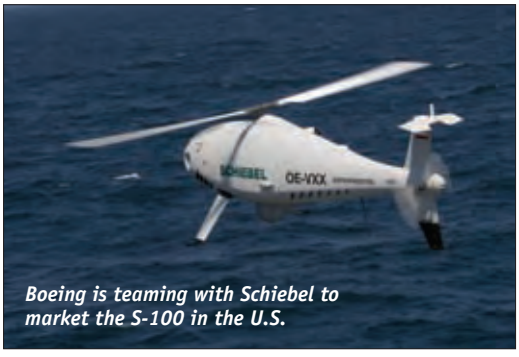
This wave of acquisitions is only part of the strategy shift by larger defense companies to participate in a growth market. Company-funded R&D in UAVs is considerable.

Teaming for success

Teaming arrangements by larger companies to develop relationships with small, innovative UAV developers have become increasingly important. Boeing, for example, teamed with Insitu, a company that initially marketed a UAV for locating schools of tuna. The relationship enabled the smaller firm to build a strong market position in UAVs. Northrop Grumman's relationship with Swift Engineering in research and marketing enabled a company with an expertise in racing vehicles to develop a concept for a family of UAVs. That family, ultimately acquired by Northrop Grumman, was compelling enough that Raytheon developed its own teaming agreement with Swift for the Marine Corps STUAS (small tactical unmanned aerial system) competition.

The Scan Eagle has become a staple of the Marines' weapons portfolio.

While both of those teaming arrangements ultimately ended in the acquisition of the smaller company, new relationships are constantly being unveiled. Boeing announced in August that it would team with Austria's Schiebel to market its S-100 unmanned helicopter in the U.S. Boeing will be offering the S-100 for a U.S. Special Forces Operations Command expeditionary surveillance program. General Dynamics formed a joint venture with Israel's Elbit Systems in May to offer Hermes and Skylark systems in the U.S.



Boeing is teaming with Schiebel to market the S-100 in the U.S.

Larger projects

Major U.S. defense companies are also showing a considerable commitment to spending their own research money on major projects to strengthen their market positions. Boeing is developing the Phantom Ray, a fighter-sized combat UAV, which it plans to flight test in late 2010 with company funding. The move shows Boeing's continued commitment to being a power in unmanned combat aircraft despite its loss of the Navy-led unmanned combat air system program to Northrop Grumman in 2007. The Phantom Ray will continue where the government-

(Continued on page 15)

Transforming human spaceflight

During the past five and a half years, U.S. space policy has been defined by the Vision for Space Exploration announced by President George W. Bush on January 14, 2004. The Vision, as it came to be called, was essentially an effort to revitalize NASA following the loss of the space shuttle Columbia on February 1, 2003, by setting some ambitious goals for human spaceflight designed to rekindle the American public's excitement for space exploration.

The long-term goals of the Vision called for returning astronauts to the Moon by 2020 and an eventual piloted mission to Mars. The short- to medium-term goals were to phase out the shuttle fleet by 2010 and develop a replacement human-rated vehicle by 2014.

From the start, our view of the Vision was that it was poorly conceived. Too many critical questions were left unanswered or answered incompletely, including, "Why are we returning to the Moon?" and "How much will it all cost?" There was a kind of "groupthink" attitude at NASA and within the U.S. space industry that the Vision was a good idea, and that the details of why we were undertaking it and how we were going to pay for it would simply become obvious in time. In other words, that we would cross those bridges when we got there.

Shaping and [under]selling a plan

And so the Bush administration proceeded to sell Congress on the worthiness of the Vision. By the end of 2004, the administration had succeeded in obtaining start-up funding from Congress for the Vision, and in 2005 language was included in the NASA Authorization bill officially endorsing the Vision and laying out the architecture for a return to manned mission to the Moon. The architecture was designated Project Constellation, and it called for the development of the Orion crew capsule and the Ares family of expendable launch vehicles, including the Ares I crew launch vehicle and the larger, more powerful Ares V cargo launch vehicle.

In August 2006, NASA awarded Lockheed Martin Space Systems the prime contract to build Orion. The following August, the agency awarded Alliant Techsystems the contract to develop the first stage of the Ares I rocket, and Boeing a contract for the vehicle's upper stage. Plans are under way for development of the Ares V, which is scheduled to fly in 2018; however, no contractors for that vehicle have yet been named.

A superficial look at the Vision would suggest that the main pieces are slowly coming together. But the truth is that the Vision is in trouble. The Bush administration failed to fulfill its budget obligations to the program, leaving Constellation with a funding shortfall of more than $12 billion.

The target date for the maiden flight of the Ares I/Orion vehicle is now 2015, although we think that 2016-2017 is the more realistic timeframe. Such a delay would mean that the U.S. would not have its own human spaceflight capability for six or seven years following the final mission of the space shuttle in 2010. NASA would be completely dependent on the Russians to transport its astronauts to and from the international space station aboard Soyuz rockets and capsules for an extremely long period.

Initially, it was thought that the gap between the end of the shuttle program and the start of Ares I/Orion operations would be no more than four years. We think that the gap is more likely to be nearly double that, assuming of course that there are no major technical setbacks. The delays we envision only take into account the normal technical prob-

The first launch of the Falcon 9/Dragon is scheduled to be held by the end of this year.

lems and budgetary cutbacks that all NASA programs of this magnitude and complexity usually experience.

Closing the gap

So the question is, "How do you close the gap?" How do you keep from having to rely on the Russians to get access to a station that has cost U.S. taxpayers more than $100 billion to build, launch, and assemble over the past quarter of a century? One way, of course, would be to delay the termination of the shuttle program by two or three years and appropriate over $3 billion more each year for Project Constellation during 2011-2014. The shuttle fleet would fly its final mission sometime in 2012-2013 and Ares I/Orion would come online sometime in 2014-2015.

Rather than having budgets of between $18.5 billion and $19 billion per year during the first half of the next decade, NASA would have to be given at least $22 billion annually, and probably more. But given the extremely tight constraints of the overall budget, we do not believe the Obama administration would seek these levels of funding. At present, the administration's five-year plan for NASA through FY14 calls for yearly budgets of slightly more than $18.6 billion. The only exception is the $18.86 billion planned for FY14.

NASA could realize savings of $3 billion annually after the end of the shuttle program. That money, plus a few hundred million dollars more per year, could be applied to Project Constellation to speed up development of Ares I/Orion and have it ready by 2014-2015. But you would still be left with no U.S. human space system during 2011-2013.

Options

There is the possibility that U.S. commercial spaceflight companies such as SpaceX (Space Exploration Technologies) and Orbital Sciences could have human-rated launch vehicle/capsule systems ready by the end of 2011, but we think this is an overly ambitious target. SpaceX is completing development on its heavy-lift Falcon 9 rocket and Dragon capsule. The first Falcon 9/Dragon is scheduled to be launched by the end of this year. Meanwhile, Orbital Sciences is aiming for a maiden launch of its medium-lift Taurus II and Cygnus capsule in 2010. Both systems are being developed under contracts through NASA's $500-million Commercial Orbital Transportation Services (COTS) program.

Orbital Sciences is aiming for a maiden launch of Taurus II and Cygnus in 2010.

It is entirely possible that both Falcon 9/Dragon and Taurus II/Cygnus will be available for cargo resupply missions to ISS by 2011. However, this does not solve NASA's near-term manned space capability problem. NASA would have to receive a sizable infusion of capital for COTS and quickly issue new contracts to SpaceX and Orbital to push the development of crew-capable systems.

Another option for reducing the gap would be to outright cancel the Ares I and try to launch Orion aboard a crew-rated Boeing Delta IV or Lockheed Martin Atlas V rocket. This is a controversial proposal that has been reviewed for several years. Former NASA administrator Mike Griffin concluded that switching to a Delta IV or Atlas V would not save money because the vehicles are too small for the Orion capsule, which would then have to undergo a costly redesign.

Griffin noted that both rockets could launch downsized capsules to the Moon, but not the type that would allow for carrying the kind of cargo mass needed for building and resupplying a lunar outpost or some other kind of heavy construction that might be envisioned. Also, some industry studies have determined that human-rating the rockets would take five to seven years, saving no time compared to proceeding with Ares I.

Status quo woes

The idea of simply sticking with the current plan to end the shuttle next year and continue the Ares I/Orion program, targeting completion by 2016, is certainly plausible. It is a little risky because it assumes continued goodwill on the part of the Russian government and a continued interest in selling space aboard its Soyuz capsules to NASA at $47 million per seat. There is just something inherently unnerving about having to rely on another country to get access to one's own space facility.

Plus, our sense is that the Ares program is already in danger, mainly be-

cause it is suffering from technical problems and cost overruns. Our understanding is that the design of the Ares I may be problematic, primarily due to the use of a single five-segment stack of solid-fuel boosters as the first stage. There are concerns about computer simulations that show that the vehicle would vibrate excessively during liftoff.

One way to conceivably reduce the cost of the Ares program would be to design one model that would be larger than the Ares I but smaller than the proposed Ares V. The argument against this approach is based on cost. While developing one vehicle, rather than two, would be cheaper, operational costs would be much greater because more launches would be needed to carry the same amount of mass that would have gone up on the larger Ares V.

The commission

All of these options, as well as others we have not explored, have been considered as part of a sweeping space policy review by a 10-member blue-ribbon panel chaired by former chief executive of Lockheed Martin, Norman Augustine. The review was ordered by President Obama in May, and the panel submitted its preliminary report to Congress in September. The primary conclusion of the report is that the current strategy for U.S. human spaceflight is unsustainable given the limited financial resources NASA can realistically count on.

It is unclear yet what impact the Augustine panel will have on the future of Constellation specifically, and on U.S. human spaceflight and exploration in general. The panel's report is under review by Congress.

However, it is hard to imagine that President Bush's Vision will remain intact. Given the more pragmatic nature of President Obama and his preference for working in collaboration with other countries, our assumption would be that ultimately the panel would have to make a more convincing case about why the U.S. should spend over $100 billion to visit the Moon again and then spend tens of billions of dollars more to do something worthwhile there.

The case would have to involve some sort of cooperative arrangement with another country or countries, so that the U.S. would not solely bear the costs and risks of the venture. It would have to be an approach that reflects the Obama administration's tendency to want to do things in partnership with others rather than going it alone.

It would not surprise us at all if the outcome of the final report was a complete scrapping of a return to the Moon and termination of the Ares and Orion programs altogether, and instead focusing on transforming U.S. human spaceflight into a robust commercial industry that could help spur economic growth and fuel the development of other commercial markets such as space tourism.

Any long-term vision for space exploration that does not allow commercial industry to take the lead is extremely limited, given the relatively small size of NASA's budget and the prohibitive relative cost of developing human-rated launch vehicle/capsule systems or reusable spaceplanes.

NASA has been the focal point of U.S. human space exploration for the past half century. It has dominated the industry by being the primary customer for hardware and services. In some ways, though, this has suffocated the potential evolution of the industry to allow it to innovate and discover more practical reasons for sending humans into space other than to simply be the first to get there or for the sake of exploration or scientific discovery—reasons the average person can relate to, such as profit, adventure, and entertainment.

By emphasizing more reliance on the nascent U.S. commercial spaceflight industry, the panel would relieve NASA of a huge responsibility that funding inadequacies prevent it from carrying out efficiently and safely. It would also help facilitate the evolution of human spaceflight by allowing for a more diverse set of reasons why humans should go to Earth orbit or travel to the Moon.

The traditional reasons NASA has promoted are fine, but they are no longer enough to excite the public and keep its attention, particularly for expensive and technically complex engineering programs that require a decade to complete and visions that take even longer to attain.

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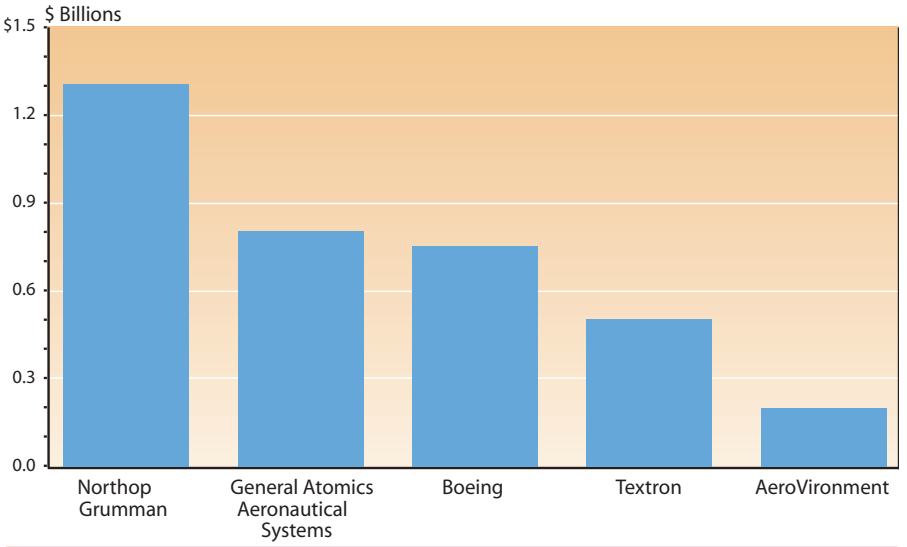
U.S. COMPANIES RANKED BY UAV SALES



funded X-45 program ended with the Northrop Grumman victory.

Lockheed Martin developed and built the $27-million P-175 Polecat with its own funds. The demonstrator, which crashed in 2006, was intended to show the company's strength in rapid prototyping and in developing a stealthy UAV that could potentially compete with Global Hawk. Lockheed has subsequently been developing a fast, stealthy UAV that it may offer in the MQ-X program in approximately 2012.

General Atomics, with an estimated $800 million of UAV revenues, ranks as the second-largest UAV company thanks to its production of Predator drones. The Predator and its variants dominate the U.S. medium-altitude long endurance segment.

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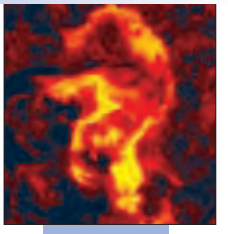


Phantom Torso takes solar blasts for science

THE PHANTOM TORSO IS BACK, AND HAS quite a story to tell.

"He" is an armless, legless, human-shaped torso, a mannequin resembling a mummy wrapped in bandages. Scientists at ESA call him Matroshka, and like his NASA counterpart, Fred, this mannequin is an intrepid space traveler. Now that Matroshka has spent four months on the ISS, scientists are learning about the space radiation he endured there.

Lessons learned from Fred and Matroshka have major implications for NASA's plans to set up a manned outpost on the Moon and, eventually, to send people to Mars. Protecting astronauts from the harmful effects of space radiation will be a critical challenge for these extended missions. In order to design spacesuits, vehicles, and habitats with enough shielding to keep astronauts safe, mission scientists need to know how much radiation—and what kinds—humans actually absorb.

Fred is NASA's version of the Phantom Torso.

Scientists can use computers to estimate the amount, but a computer model and real life can be two wildly different things. Until now, researchers were unsure whether their models accurately predicted the radiation dose astronauts would experience in space.

That is where the Phantom Torso comes in. It has provided the real-world test needed to prove that the models are essentially correct. Francis Cucinotta, chief scientist for NASA's Space Radiation Program, and his colleagues analyzed the measurements from hundreds of radiation sensors embedded throughout Matroshka's body and found that the models are actually quite good—accurate to within 10% of the measured dose. That means it is "all systems go" for using them to plan NASA's return to the Moon or even a trip to Mars.

Gauging the danger

The most dangerous kind of radiation the astronauts encounter is galactic cosmic rays (GCR). These are bare atomic nuclei, some as heavy as iron atoms, accelerated to nearly the speed of light by distant supernovas. Because of their high velocity, high mass, and positive electric charge, GCR particles can cause tremendous damage to a person's cells. Moreover, traditional radiation shielding cannot stop GCR particles.

But understanding the danger is not as simple as merely knowing how much radiation is out there. "What matters most is how much radiation actually hits a person's vital organs," says Cucinotta.

To reach those organs, particles of radiation must first pass through the walls of a spacecraft, an astronaut's spacesuit, and then skin and other body tissues. It is a very complex interaction. Sometimes these barriers will slow down or stop a particle of radiation. Moreover, sometimes the collision between a particle and a barrier will produce a shower of new particles called "secondary" radiation. Computer models must account for all this activity.

Space station astronauts wear sensors on their flight suits to record total radiation exposure, but there is no practical way to measure how much radiation actually reaches their vital organs. Fred has sensors just about everywhere—even on the inside.

The Phantom Torsos are made of a special plastic that closely mimics the density of the human body, sliced horizontally into 35 1-in.-thick layers. Within these layers, researchers have embedded a total of 416 lithium-crystal dosimeters, each of which measures the accumulated radiation dose at one point in the body over the course of the experiment. Fred and Matroshka also contain several "active" dosimeters located where vital organs such as the brain, thyroid, heart, colon, and stomach would be. These active sensors keep a record of how the radiation dose changes moment by moment. Together, these various sensors thoroughly document how radiation propagates through their bodies.

"The geometry and the composition of the torso mimic the human body very well," Cucinotta says. "I think it is a very good test."

Maximizing safety

So now that these computer models have been verified in the real world, what do they say about keeping astronauts safe in a lunar outpost or on Mars?

"Short lunar missions are fine," says Cucinotta, "but living in a lunar habitat for six months starts to be problematic. We are going to have to do a really good job with radiation shielding and perhaps medical countermeasures to have six-month missions."

Mars will be even tougher, these models suggest. Some scenarios call for missions that would last 18 months or more. "Right now there is no design solution to stay within safety limits for such

a Mars mission," says Cucinotta. "Putting enough radiation shielding around a spacecraft would make it far too heavy to launch, so we need to find better lightweight shielding materials. And we probably need to develop medical techniques to counteract damage to cells caused by cosmic rays." One of the biggest obstacles to progress in this area, he notes, is "uncertainty in the types of cell damage deep cosmic ray exposure can cause. We still have a lot to learn."

The solar flare factor

Another key question: How do solar flares affect astronauts? Fred and Matroshka have not experienced any intense solar radiation storms during their time onboard the ISS.

"The energy spectrum of solar events and how the radiation dose changes from organ to organ will be very different from what we have seen so far from cosmic rays," says Cucinotta.

To find the answer, scientists have recreated the intense radiation from giant solar flares right here on Earth. Matroshka has been chosen as the volunteer who will experience the blast.

In 1972, Apollo astronauts narrowly escaped a potential catastrophe. On August 2, a large sunspot appeared and began to erupt repeatedly for more than a week, producing a record-setting fusillade of solar proton radiation. Only pure luck saved the day. The eruptions took place during the gap between Apollo 16 and 17, and astronauts missed the storm.

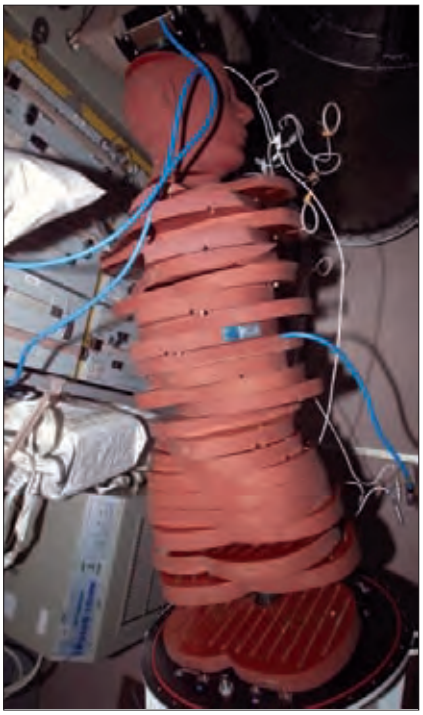
Researchers still wonder what would have happened if the timing had been just a little different. What if astronauts had been caught unprotected on the surface of the Moon?

NASA researchers are working to find an answer to that question. At Brookhaven National Laboratory in Upton, N.Y., scientists are subjecting Matroshka to a beam of protons to learn how astronauts would be affected by the type of radiation generated during the 1972 event.

"We want to know how close it comes to a dangerously acute exposure," says Cucinotta. In the parlance of radiation experts, "acute exposure" is brief but intense—the radiation would strike the body over a relatively short period ranging from minutes to hours, much as a solar flare would. This is different from the "chronic exposure" astronauts normally experience as they travel through space. Cosmic rays hit their bodies in a slow drizzle that is spread out over weeks or months. With chronic exposure, the body has time to repair or replace damaged cells as it goes along, but an acute exposure gives the body little time to cope with the damage.

"The biological effects are very sensitive to the dose rate," Cucinotta explains. "A dose of radiation delivered over a short amount of time is two to three times more damaging than the same dose over a few days."

Matroshka is usually suited up in his white travel poncho.



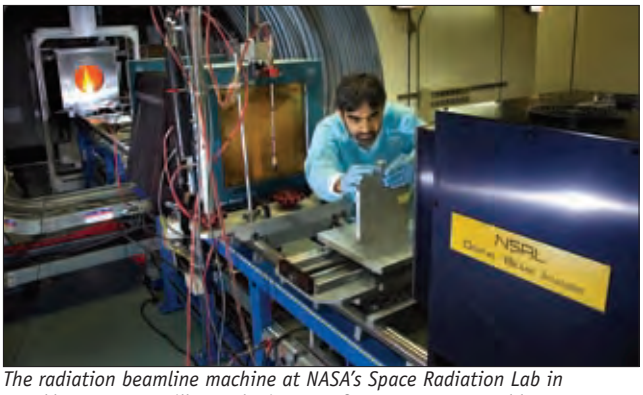
Sensors embedded in 35 different slices of the Phantom Torso measure the impact of radiation.

At first glance, the 1972 event would seem to fall into the acute category. It was, after all, a solar flare. However, there is a complication—it was actually a series of flares producing a radiation storm that was longer and less impulsive than normal. Radiation exposure would have been neither chronic nor clearly acute, but somewhere in between. In this gray area, details about how much of the radiation actually reaches a person's vital organs—vs. how much is blocked by a spacesuit, skin, and muscles—can make all the difference.

True blood

Matroshka is helping scientists understand these details. In addition to its hundreds of radiation sensors, this Phantom Torso even has real human blood cells.

"We put blood cells in small tubes in the stomach and in some places in the bone marrow." Some of these cells are deep within the torso while others are close to the surface where there is less "tissue" to block radiation. Among the questions they are asking is whether the less shielded parts of the bone marrow



The radiation beamline machine at NASA's Space Radiation Lab in Brookhaven, N.Y., will test the impact of protons on Matroshka.

will be much harder hit, raising the risks of leukemia and other cancers.

Using real blood cells lets scientists see how much the radiation damages the cells' DNA. High-speed particles of proton radiation can smash into DNA, breaking the string-like molecules. Cells can usually repair these breaks; however, if several breaks occur within a short period, the damage can be irreparable. At best, the cell will then self-destruct; at worst, it will go haywire and grow out of control, becoming cancerous.

To subject Matroshka to a 1972-style radiation storm, scientists have devised a way to simulate that event using a high-energy proton beam at NASA's Space Radiation Lab in Brookhaven. The beam fans out so that, at the point where Matroshka sits, it is 60 cm across—large enough to engulf the entire torso. By stepping the energy of the beam through a series of energy levels, scientists can mimic the unique energy spectrum of the protons in the 1972 event.

In the upcoming experiment, led by Guenther Reitz of the German Aerospace Center in Cologne, Matroshka's radiation sensors will reveal how much proton radiation reaches various parts of the mannequin's body. "With protons, you might have an order of magnitude difference from one part of the body to another," notes Cucinotta.

The readings will help mission planners figure out how much shielding is necessary to protect real astronauts from a 1972-style storm. The results will also point researchers in the right direction for medical treatments that might help mitigate the effects of such an event.

Unlike a real astronaut, Matroshka can withstand multiple flares with no lasting side effects. A quick transfusion of blood cells and Matroshka is ready for another blast.

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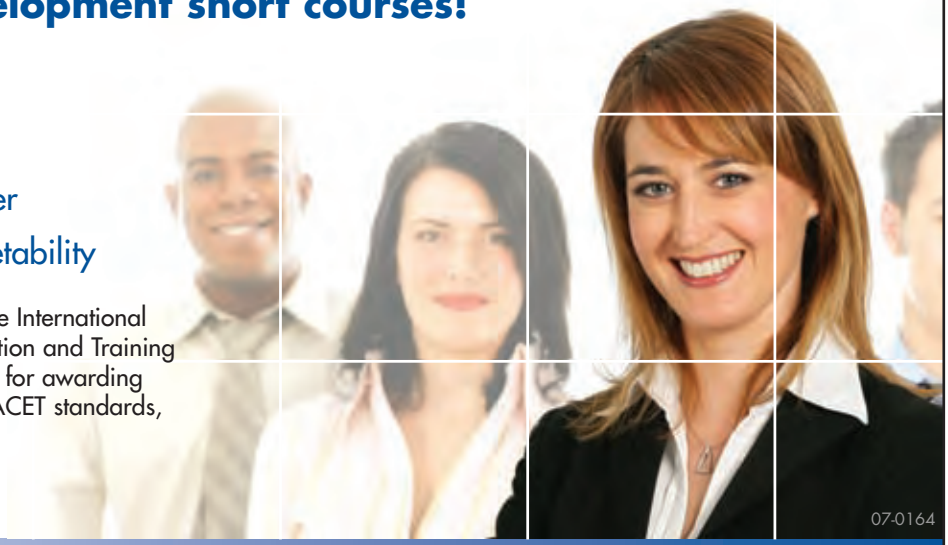

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Cloud computing: Coming full circle

As we move toward the 21st century's second decade, a changing approach to the use of application software is under way. The paradigm is similar to that of the original IBM mainframe days. In the early years of application software, the programs were run on a computer that might not be local to the user, but the data would be stored locally on Hollerith cards. This was not very different from the current trend toward use of application software, now known as cloud computing.

Cloud computing involves the provision of dynamically scalable and often virtualized resources as a service over the Internet. Users do not need knowledge of, expertise in, or control over the technology infrastructure in the "cloud" that supports them.

Cloud computing customers do not generally own the physical infrastructure (large computer servers or data storage servers) that hosts the software platform in question. Instead, they avoid capital expenditure by renting usage from a third-party provider. They consume resources as a service and pay only for the resources they use.

Many cloud computing offerings use the utility computing model, which is similar to the way traditional utility services such as electricity are consumed, while others bill on a subscription basis. A side effect of this approach is that overall computer usage rises dramatically, because customers need not plan for peak load limits. Also, "increased high-speed bandwidth" makes it possible to receive the same response times from centralized infrastructure at other sites. The only performance gate is the broadband Internet bandwidth or speed.

To deliver services to customers, a provider owns and operates live cloud computing systems. Usually this requires significant resources and expertise in building and managing next-generation data centers. Some organizations realize a subset of the benefits of cloud computing by becoming "internal" cloud providers and servicing themselves, although they do not benefit from the same economies of scale, and they must still engineer for peak loads. The barrier to entry is also significantly higher, with capital expenditure required; billing and management also create some overhead.

Aerospace applications

Several cloud computing applications and services are available for use in aerospace-related fields.

•*PowerFLOW On-Demand* is offered by Exa, a leader in the field of CFD. The company supplies fluid flow simulation and analysis software and services primarily to the aerospace industry. Exa PowerFLOW On-Demand provides a complete digital test facility for aerodynamic, thermodynamic, and aeroacoustic testing. Evaluating the interactions of fluid, heat, and noise in one comprehensive simulation can help engineers develop better designs by reducing the time devoted to trial-and-error physical modeling.

•*MSC Software* offers an on-demand enterprise simulation solution in partnership with IBM. Called MD on-Demand, this product is based on MD Nastran, widely considered the world's most-utilized enterprise simulation solution. By combining it with IBM high-performance computing systems, engineers can unleash MD on-Demand's full virtual simulation capabilities. IBM Computing on Demand (COD) Centers enable engineers to tap into virtually unlimited computing power on an as-needed basis. When combined with COD, the software can provide increased business value, cost savings, and flexibility.

•*Google Business Apps* provide email, calendar/schedule management, document editor, a spreadsheet, and a presentation tool, offerings similar to Microsoft Office's. Gmail is a free Webmail, POP3, and IMAP service. Launched as an invitation-only beta release on April 1, 2004, it became available to the general public on February 7, 2007. By July of this year it had 146 million users monthly. The service was upgraded from beta status on July 7. Gmail has a search-oriented interface and a "conversation view" similar to an Internet forum.

•*Google Calendar*, a free time-management Web application, became available on April 13, 2006, and exited the beta stage in July of this year. It lets your colleagues, family, and friends see your calendar and view schedules that others have shared with you. It also allows syncing to your mobile phone's built-in calendar or a mobile version made for the small screen that you access when you are away from your desk. Invitations to events can be based on the Google Calendar, and invitees can RSVP by Calendar or email.

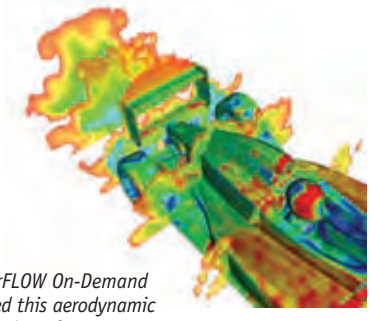
•*Google Docs* is a Web-based word processor, spreadsheet, presentation, and form application. Users can create and edit these items online while collaborating in real time with other users. All such documents can be created within the application itself, imported through the Web interface, or sent via email. They can also be saved to the user's computer in a variety of formats (OpenOffice, HTML, PDF, RTF, Text, Word). By default, they are saved to the Google servers.

Open documents automatically are saved to prevent data loss, and a revision history is kept automatically. Documents can be tagged and archived for organizational purposes. The service is officially supported on recent versions of the Firefox, Internet Explorer, Chrome, and Safari browsers running on Microsoft Windows, Apple OS X, and Linux operating systems.

Google Docs enables editing among users and nonusers in real time. Spreadsheet users, for example, can be notified of changes to any specified regions via email. The application supports the ISO standard OpenDocument format. It also includes support for proprietary formats such as .doc, .xls, .docx, and .xlsx. Google Forms can be used from either the word processor or the spreadsheet applications.

•*Microsoft Office in the Cloud.* Microsoft plans to provide a series of applications in the cloud. Windows Live and Office Live will start with a Web portal that will offer both existing Web-based services for Windows and Office, as well as new services now in development and some currently being offered by Microsoft's MSN portal. In any case, the plan starts with its Hotmail application. Microsoft will eventually transition all its MSN and Hotmail email users to its Windows Live email service, but will continue to evolve the services provided on the MSN portal.

Office Live incorporates the traditional Office products of Word, Excel, and PowerPoint into its software as a service model, thus integrating document sharing and other collaborative services with CRM (customer relationship management) and other business analysis services for small companies.



PowerFLOW On-Demand created this aerodynamic simulation of a Tatuus motorsports racecar. Data are easily visualized with PowerVIZ on the surface of the model as well as slices across the vehicle wake. Image courtesy of Tatuus.

Controversy and control

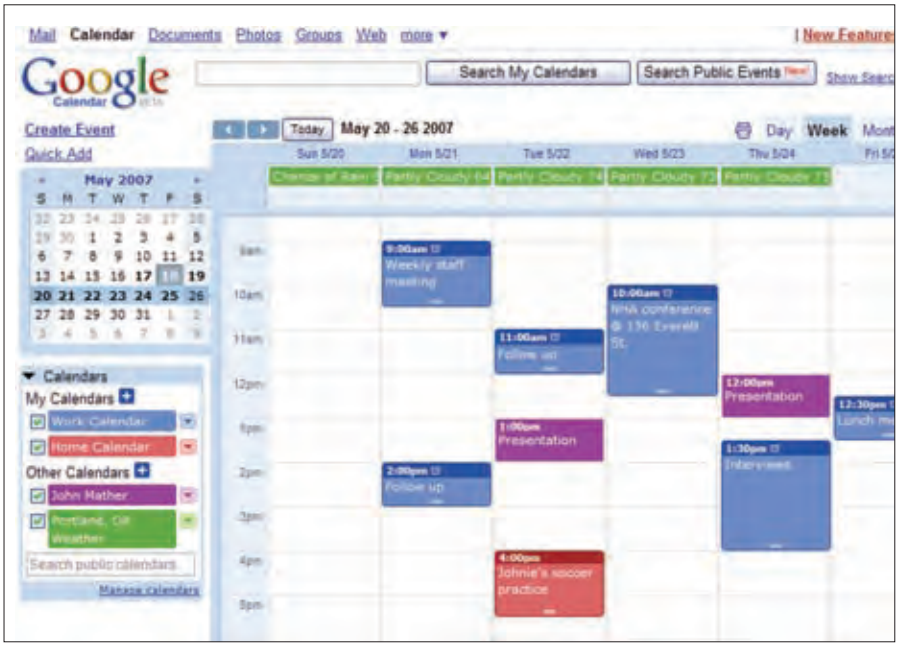
Because cloud computing does not let users physically possess the storage of their data (the exception being the possibility that data can be backed up to a user-owned storage device), responsibility for data storage and control is in the hands of the cloud provider. Responsibility for backup data, disaster recovery, and so on has been a long-standing concern for both cloud and in-house systems. Organizations that rely on these systems and services must now consider the added need to understand what is being offered so they can react to changes that those open services will provide.

In addition, cloud computing has been criticized for limiting the freedom of users and making them dependent on the provider, and some critics have alleged that it is only possible to use applications or services that the provider is willing to offer. In some cloud computing provider cases, users have no freedom to install new applications and need approval from administrators to achieve certain tasks. Overall, it limits both freedom and creativity.

Richard Stallman, founder of the Free Software Foundation, believes cloud computing endangers liberties because users sacrifice their privacy and personal data to a third party. He has stated that cloud computing is simply a trap aimed at forcing more people to buy into locked, proprietary systems that would cost them more and more over time.

And yet cloud computing applications offer the closest paradigm to the traditional beliefs that the Free Software Foundation prescribes: Free software is a matter of the users' freedom to run,

Google Calendar lets others see your calendar and view schedules that others have shared with you.



copy, distribute, study, change, and improve the software. More precisely, it means that the programs' users have the four essential freedoms:

•Freedom to run the program, for any purpose.

•Freedom to study how the program works, and change it to make it do what you wish. Access to the source code is a precondition for this.

•Freedom to redistribute copies so you can help your neighbor.

•Freedom to improve the program, and to release your improvements (and modified versions in general) to the public, so that the whole community benefits. Access to the source code is a precondition for this.

A program is free software if users have all of these freedoms. Thus one should be free to redistribute copies, with or without modifications, either gratis or charging a fee for distribution, to anyone anywhere. Being free to do these things means (among other things) that you do not have to ask or pay for permission.

✈✈✈

In the past four decades, we have come full circle in terms of application software. Forty years ago application software was fee based without ownership. Cloud computing has brought us back to that concept, although today the applications are significantly more sophisticated and extensive. The future of application software is hard to predict. Will it continue to be a purchased software license, will it become software purely sold as a service, or will it become (as the Free Sofware Foundation would like) free to all? Who knows? Much as we would like to maintain the status quo, one thing we do know is that the application software industry will continue to evolve, based on consumer preferences and on the impact of future changes in the computer hardware delivery paradigm.

On a personal note, this will be my last Systems & Software *column. I have enjoyed writing it for the past 15 years and am grateful for having had the opportunity to do so. I have also learned much in the process, and I hope my readers have as well. I will sorely miss the conversations I've had with all of you. As for both systems and the software to run them, they are like entropy, always expanding and ever-changing.*

John Binder
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NOTED IN BRIEF

MathWorks (Natick, Mass.) [http://www.mathworks.com] announced the availablity of **Release 2009b** (R2009b) of its MATLAB and Simulink product families. R2009b, which includes features for faster performance and enhanced handling of large data sets, builds on component-based modeling features in Simulink. It also updates 83 other products, including PolySpace code verification products. Another key highlight for the MATLAB product family is extended support for multicore and multiprocessor systems. MATLAB and Image Processing Toolbox now offer more multithreaded implementations of functions, and Statistics Toolbox adds parallel computing support for several functions. For users with large data sets, MATLAB now offers the ability to perform FFTs on data sets larger than 2 GB. The Image Processing Toolbox also has a function to support processing of arbitrarily large TIFF images, and the Parallel Computing Toolbox includes a new interface for working with large data sets distributed across a cluster.

Autocad (Chicago, Ill.) [http://www.autocad.com] introduced the latest release of the Moldflow software suite for plastics injection molding simulation and optimization. **Autodesk Moldflow 2010**, second release, offers enhanced performance, accuracy, and interoperability with mainstream CAD applications. The software suite is among the first in the CAE market to take advantage of the processing power of high-performance graphics processing unit technology to solve complex computations twice as fast. Sophisticated improvements to 3D mesh analysis quality for parts and assemblies give plastics simulations greater accuracy. Finally, native support for Autodesk Inventor software and a variety of other CAD models improves the integration of Moldflow with the product design and development process.

Autodesk (San Francisco, Calif.) [http://www.autodesk.com] announced the release of the **Autodesk Algor Simulation 2010** products, providing a broad range of mechanical simulation tools to help designers and engineers make critical decisions earlier in the design process. Finite-element modeling tools and built-in material libraries allow users to study initial design intent and simulate the behavior of a digital prototype. In addition, the software supports direct associative data exchange with most CAD tools, so users can collaborate and make iterative design changes without having to redefine simulation data. There are four offerings: Simulation 2010 offers design validation and optimization with a range of engineering simulation tools in a multi-CAD environment; CFD 2010 has the same functionality along with fluid flow analysis, CFD, and mass transfer analysis; MES 2010 also features the full functionality along with nonlinear static and dynamic analysis, rigid-body motion analysis, and combined stress and flexible-body motion analysis; and Professional 2010 has all the functioning of the other three packages plus electrostatic analysis and the ability to combine analysis types for full multiphysics simulations.

Mercury Computer (Chelmsford, Mass.) [http://www.mc.com] announced the availability of two new software offerings for multicore application development: the **MultiCore Plus** (MCP) **Pro Edition** software environment and the **MultiCore MathPack** library bundle. Based on open standards, the MCP Pro Edition features a scalable, modular architecture that supports a broad range of commercial and rugged multicore and multicomputer systems to meet a variety of size, weight, and power requirements for ISR and industrial inspection applications. With the powerful, easy-to-use Eclipse-based Open Development Suite, application developers can configure, test, debug, and profile from one integrated environment. MathPack is a library bundle that includes the MC SAL (scientific algorithm library) and MC VSIPL (vector signal image processing library). Both libraries can automatically use all available processor cores to ensure peak processor performance without user intervention, enabling high throughput and low latency for demanding processor-intensive applications.

DEFENSE ACQUISITIONS
A CHANGE IN DIRECTION

Like his predecessors, President Obama is moving to reform the military acquisitions process, which DOD, the services, and Congress agree is now cumbersome and outdated. New legislation, organizational restructuring, and different approaches to contracting are among the sweeping changes that will affect nearly every major development and production program in the U.S. military.

by J.R. Wilson
Contributing writer

The U.S. military's approach to contracting and acquisition, especially for big-ticket items such as aerospace, historically has shifted with the political winds in Washington, reflecting more directly than most the policies and ideologies of the president.

Ronald Reagan poured billions of additional dollars into the Pentagon for more warfighters and equipment, with a special emphasis on advancing new technologies. This was a stark repudiation of the lackluster support the services received from both parties in the post-Vietnam 1970s.

George H.W. Bush was the first president to send the "Reaganized" military into a major conflict. However, with the Cold War over and the Soviet Union gone, he also began a policy of reductions in force and spending, often through pushing program milestones to the right. This policy would be greatly accelerated by his successor, Bill Clinton.

Even before the events of September 11 plunged the nation into a multifront global war in 2001, George W. Bush had brought back many members of the Reagan team, and with them another dramatic reversal, pushing forward with a massive, all-services transformation. This would require new equipment and the replacement of aging platforms.

In the years that followed, the military put considerable focus on acquisition reform. This was partly to lower costs and speed delivery of new capabilities to warfighters in active combat, and partly in response to a series of very public meltdowns in bidding, contracting, acquisition, and support. Even so, serious problems continued to develop, especially within the Air Force.

A new direction

First under George W. Bush and now under Barack Obama, Defense Secretary Robert Gates has moved to restructure not just the direction and nature of DOD's future acquisitions, but also the processes under which those acquisitions will be made. Parts of President Obama's approach build on new acquisition commands set up in recent years by the Army, Marine Corps, and Coast Guard.

Much of the initial heat was brought to bear by a report from the Gansler Commission, created by the secretary of the Army in August 2007 to examine that service's ability to provide program and contract management in support of expeditionary operations. In part, it was that report that led to the creation of a two-star Army Contracting Command within the Army Materiel Command.

While the Gansler report specifically addressed the Army, the other services looked at what value it might also have for their processes as they conducted their own internal reviews. For example, both the new Marine Corps Program Executive Office (PEO) Land Systems and the Coast Guard Acquisition Directorate are seeking to correct problems,

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speed processes, enhance end-user input, and generally overcome what the services, DOD, and Congress agree is a cumbersome, outdated approach to acquisitions.

"From a broad acquisitions standpoint, a lot of what the services are doing is complementary to what DOD as a whole is doing. We see that at the Navy's gate process, how the Army is structuring some programs, and how the Air Force and Marines are moving forward," says Ric Sylvester, deputy director for acquisitions management in the office of the under secretary of defense for acquisition, technology and logistics.

"There will be some changes in the way we relate to contractors," he says. "Competitive prototyping will change how they do some things, which should help with some pricing. There will be differences in how they approach some programs, because we will be looking at stabilizing program requirements, which will change what we've done in the past. There will be a greater emphasis on cost control and systems engineering."

"In today's environment, maintaining our technological and conventional edge requires a dramatic change in the way we acquire military equipment."

SECRETARY OF DEFENSE ROBERT GATES

Focus on the warfighter

Sylvester emphasizes that while cutting costs and speeding the progress from development to fielding are key to both recent and future changes, the ultimate focus remains on the warfighter.

"The new Weapons System Acquisitions Reform Act tries to strengthen the combatant commander's role in requirements generation, which is a good thing, although not a new thing. The Joint Staff, through visits with COCOMs [combatant commands] and the primary lists they submit, has always looked at that, although this [act] should strengthen the COCOMs' voice in what we do as we go forward," he says. "The whole acquisitions effort is focused on the warfighters as customers, and their input is important. And getting that done better is of benefit to them and helps us all.

"Assuming we are successful in implementing these reforms, weapons systems should be able to be deployed when the warfighters need them, and, with cost controls, we will be giving them the requirements we said we would give on the time schedule promised without making tradeoffs. We also will have a continuing process to deal with urgent requirements."

The legislation also created a new director of independent cost assessment and reestablished the position of director of developmental test and evaluation. Putting those organizational structures in place "won't be a simple process," nor is it easy to predict how long it will take before everything is in place as directed, Sylvester adds.

The Pentagon's past approach to acquisition problems also came under fire in a recent report from the Defense Science Board (DSB), which said DOD focused too much on tinkering with the mechanics of the acquisitions process and not enough on addressing its root problems at a more basic level.

"Such problems, however, are really only symptoms of the lack of experienced judgment on the part of the department personnel who structure acquisition programs in a way that will almost certainly lead to failure," said the DSB report. It added that the current process takes far too long and produces weapons that are too expensive and often obsolete before they are even fielded.

"An even more important deficiency is the process of determining what to buy. The strategic plan for acquiring military capabilities is only loosely aligned with national security objectives and the military missions to achieve them," the report admonished.

Workforce and other requirements

Aerospace Industries Association president Marion Blakey praised the new law, signed by President Obama in May, as a significant step in a broad effort to "make the acquisition system more accountable and efficient," especially with respect to increasing the acquisitions workforce.

But Sylvester says the workforce problem is larger than numbers alone.

"One of the biggest problems we've had is in our workforce. We don't have all the skill sets we need," he says. The cause is "a combination of factors, including drawing down the workforce in the last several years, people retiring, and some broader global trends. Science and math are not emphasized in the U.S. as much as in other countries, which has resulted in our not having the people we need with the necessary skill sets to keep our eyes on contracts and do the kind of analyses we need to do," he explains.

"We have talked to Congress about that, and about getting a more robust workforce.

We have a shortage of systems engineers, which is not something we have emphasized in the past as much as we should have. We have a shortage of people who put the contracts in place and a shortage of technical people.

"We've seen this before, as the WW II and Korean War generations moved on, causing us to refresh our skills. Now we are running into an emphasis on a smaller workforce during the '90s that did not replenish some skills, and an aging workforce as the Vietnam War generation ages. That is more difficult, because of the leveling of our hiring efforts in the past, and a different dynamic with a different retirement system in which people are more mobile."

Gates' FY10 DOD budget request reflected those criticisms. It included a major increase in the size of the defense acquisition workforce, converting 11,000 contractors and hiring an additional 9,000 government acquisition professionals by 2015—beginning with 4,100 in FY10. Gates also announced sweeping changes in program development and acquisition across the services, saying these would be accomplished through three fundamental steps.

"First, this department must consistently demonstrate the commitment and leadership to stop programs that significantly exceed their budget or that spend limited tax dollars to buy more capability than the nation needs. Our conventional modernization goals should be tied to the actual and prospective capabilities of known future adversaries—not [to] what might be technologically feasible for a potential adversary given unlimited time and resources. I believe the decisions I am proposing accomplish this step," Gates said in announcing his budget recommendations.

"Second, we must ensure that requirements are reasonable and technology is adequately mature to allow the department to successfully execute the programs. Again, my decisions act on this principle by terminating a number of programs where the requirements were truly in the 'exquisite' category and the technologies required were not reasonably available to affordably meet the programs' cost or schedule goals.

"Third, [we must] realistically estimate program costs, provide budget stability for the programs we initiate, adequately staff the government acquisition team, and provide disciplined and constant oversight."

Equally important, he added, is a constant guard against "requirements creep"—adding new capabilities or even missions to a weapon system or platform after it has been approved for development. That has been a frequent complaint with regard to military aircraft programs, especially those designated as joint efforts, often to the point where one service will pull out because additions by one have taken the aircraft out of the weight, payload, range, or speed requirements of the other.

Gates also called for stricter contract terms and conditions—and a solid mechanism for enforcing those.

"I am confident that if we stick to these steps, we will significantly improve the performance of our defense acquisition programs," he predicted. "But it takes more than mere pronouncements or fancy studies or reports. It takes acting on these principles by making tough decisions and sticking to them going forward."

More personnel, but less hardware

In the first six months of the Obama administration, Gates followed his own advice, with major impacts on a number of aircraft and space programs. Some cases could be seen as a plus for the contractor, such as increasing the number and capabilities of manned turboprop


F-35

Gates ordered an end to production of both the F-22 and C-17, but increased the buy for the F-35.


C-17


F-22

"If you named a half dozen things that, if any one fails we won't have an adequate capability in 20 or 30 years, acquisition reform certainly would be one of those."

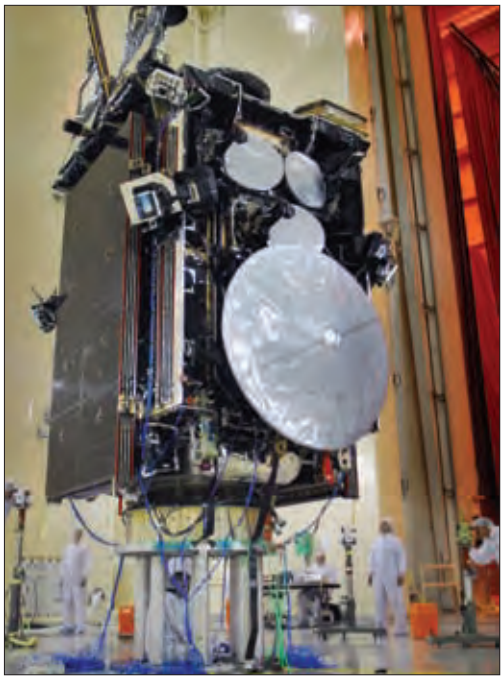
REAR ADM. GARY T. BLORE
ASSISTANT COMMANDANT FOR ACQUISITIONS
U.S. COAST GUARD

aircraft used for ISR (intelligence, surveillance, and reconnaissance) missions in Southwest Asia. Others involve not more platforms but more people, such as recruiting and training more maintenance crews and pilots to support increased helicopter operations in Afghanistan.

With special operations forces growing in both number and use since the events of September 11, 2001, Gates also called for more special-forces-optimized aircraft for transport, mobility, and refueling, along with a 5% increase in personnel.

Two of the biggest and most controversial changes involved the only two new manned aircraft programs currently in production by the U.S.—a good news/bad news decision for Lockheed Martin, prime contractor on both the F-22 Raptor air superiority fighter and the F-35 Lightning II Joint Strike Fighter.

Saying he is "committed to building a fifth-generation tactical fighter capability that can be produced in quantity at sustainable cost," Gates ordered an increase in F-35 funding and buys, from FY09's 14 aircraft and $6.8 billion to 30 aircraft and $11.2 billion in FY10. The overall numbers now stand at 513 F-35s in the current five-year defense plan and an ultimate buy of 2,443 for the Navy, Air Force, and Marines.



The Transformational Satellite program was canceled in favor of this Advanced Extremely High Frequency satellite.

The Air Force was hardest hit in terms of programs that were chopped to help fund the F-35 buildup. Gates ordered an end to production of both the F-22, at only 187 aircraft (including four recommended in the FY09 supplemental budget), and the C-17 Globemaster III airlifter, saying the 205 already fielded or in production are sufficient. In addition, he canceled development work on a proposed next-generation bomber and ordered retirement of the Air Force's 250 oldest tactical fighter aircraft in FY10 and cancellation of a second airborne laser prototype aircraft, shifting the existing aircraft and effort into an ongoing R&D program.

He also announced plans to rebid the KC-X aerial refueling tanker and terminate the Combat Search and Rescue X helicopter. Both programs were at the center of major contract criticisms and were instrumental in the forced resignations of Air Force Chief of Staff Gen. T. Michael Moseley and Secretary Michael W. Wynne in June 2008—the second time in four years top USAF officials had resigned because of contracting blow-ups.

This June, Air Force Chief of Staff Gen. Norton Schwartz told a Heritage Foundation event the service had learned its lessons and was working to correct its internal problems.

"The bottom line is we have taken lessons from that very searing experience and we intend to be very much more rigorous here once the secretary of defense decides, one, what the acquisition strategy will be, and two, who will execute that strategy," he said, adding the Air Force was seeking both a "broader array of talent" internally and a panel of outside experts to raise the level of supervision on the source selection process and increase quality control.

The Air Force also took a hit in space, with its $26-billion Transformational Satellite program canceled in favor of buying two more Advanced Extremely High Frequency satellites as alternatives.

The Marine Corps did not dodge the ax, either, with termination of the planned USMC VH-71 presidential helicopter. Gates said the program had doubled in price to more than $13 billion for 23 aircraft, was six years behind schedule, and might not even deliver the requested capability. However, because the current fleet of VH-3 presidential helicopters is 30-40 years old, he directed the immediate development of options for an FY11 follow-on program.

The Navy fared significantly better, with 31 new Boeing F/A-18E/F Super Hornets ordered for FY10 in addition to the F-35 boost. Gates also announced that the Navy Aircraft Carrier program would be shifted to a five-year build cycle, which he said would put it on a "more fiscally sustainable path" to producing 10 new carriers after 2040.

Orders were also increased for the F-A18E/F.

These actions have impacted not only aviation but virtually every major development and production program in the U.S. military. The speed and scope of the changes left Congress, service brass, contractors, and even some allies—many of whom depend on U.S. programs to advance their own military capabilities—debating the plan's merits, how best to comply, and whether to attempt to thwart some of the proposals, especially the F-22 and C-17 terminations.

Contracting and restructuring

Meanwhile, the individual services continue to grow and modify their new in-house contracting capabilities, significantly bolstered by Gates' plan to increase the defense acquisition workforce. That is seen as a major assist in their efforts to coalesce and better coordinate the process.

"The primary reason was to get as much contracting as possible under one command. By putting them together, we have even more expertise in breadth and power to bring the command and control of those to bear on any contracting problem the Army may have," Jeff Parsons, executive director of the new Army Contracting Command, tells *Aerospace America*. "If you look at our expeditionary contracting capability in the past, there was no true centralized command and control or ownership of resources."

Deployed units now also have a reach-back capability into the contracting structure, to draw on U.S.-based expertise and assistance to support deployed units for a broad range of activities, including helicopters and UAVs, two of the most heavily used military assets in Iraq and Afghanistan.

The Marine Corps traditionally has looked to the Army for acquisition of much of its equipment, but the evolution of corps responsibilities in Southwest Asia led Marine Commandant Gen. James T. Conway to create the corps' first Program Executive Office. PEO Land Systems is strictly focused on acquisition and support, however, leaving the contracting side separate and in the hands of what Acting PEO Daniel Pierson calls an existing "core competency" within the Marine Corps.

"The Navy has 13 PEOs, the Air Force 11, and the Army a bunch, but the Marines only have one," he notes. "In the past, we relied heavily on the Army and, when it comes to airplanes, the Navy. Even as technology advanced and the roles and missions of the individual services evolved, the Marines never strayed away from the concept of taking that beach and not needing a lot of stuff. But now we have had to acquire some unique things the other services could not buy."

PEO Land Systems initially was tasked with eight existing Acquisition Category I and II programs—those designated by the secretary of defense as major programs, most with high-dollar research, development, test, and acquisition budgets. Together, they have a Future Years Defense Program estimated value of $5.6 billion and include the ground/air task-oriented radar (G/ATOR) and the common aviation command and control system.

At the same time, the PEO is moving the corps toward a structure of "competency alignment" similar to that of the Naval Air Systems Command.

"Competency alignment is by functional domain—program management, engineering, logistics, financial management, contracting—each with a functional director who reports to the SYSCOM (Systems Command) commander," Pierson explains. "Aside from a very small core, all the people who work in our programs are assigned to us but aligned with SYSCOM, with each competency director responsible for that domain. We have competency leads for each functional area within the PEO who report back to SYSCOM competency directors. So we don't own all the people, but they are matrixed to us.

"When you look at studies that have been done, you see 80% or more of cost growth on big programs has to do with requirements changes."

TERRY MARLOW
VICE PRESIDENT–ACQUISITION POLICIES
AEROSPACE INDUSTRIES ASSOCIATION

"Being tough-minded on acquisition reform is part of being serious about a strong defense."

DEPUTY SECRETARY OF DEFENSE WILLIAM J. LYNN III

"We're also moving toward progression management, to manage the workforce better. In the past, everyone belonged to the program manager and product group directors, so this is quite a paradigm shift for the command. We're taking it a bite-size at a time with SYSCOM, sorting out a lot of issues."

The new structure has enabled a far greater degree of focus on the programs themselves, rather than on peripheral issues such as staffing. This has made it easier to identify and deal with problems up front, rather than after a program has been running for months or even years, Pierson adds.

The Coast Guard also found itself boxed into some program problems as it sought to upgrade equipment to meet new and shifting demands for homeland security, law enforcement at sea, and combat deployment. What had begun as an effort to move forward quickly and efficiently, under an umbrella structure called Deepwater, quickly became mired in controversy, delays, and criticism. As with the Marines, a new commandant—Adm. Thad W. Allen, who assumed command in May 2006—ordered a sweeping reorganization, putting all Coast Guard programs under a new Acquisition Directorate in July 2007.

"Clearly our acquisition programs were not working as efficiently within Deepwater as they should," Rear Adm. Gary T. Blore, the assistant commandant for acquisitions, acknowledges. "We had a separate acquisition organization running traditional projects—such as the original helicopters—so we knew how to do acquisition, but we had allowed our acquisition and engineering community to downsize perhaps more, in retrospect, than was appropriate."

Allen believes the new directorate will provide a major boost to the Coast Guard—the service upon which most of the world's navies are patterned—as it seeks to replace one of the world's oldest sea and air fleets.

"Our acquisition organization until recently was not properly structured or staffed to acquire the complex systems needed to replace our aging assets. The new directorate is a one-stop shop responsible for managing a $27-billion investment portfolio that includes over 20 major acquisition projects, including the Deepwater program office. With the support of Congress, we'll add 65 more positions to that directorate this next year," Allen says.

"But a real commitment to change lies in an organizational culture, core values, and structure. And real modernization is committing to make a series of future investments over time to meet the changing and growing demands we face. In the world in which we live and operate, we must create a change-centric service that is capable of continual adaptation."

A strategic focus

In December 2008, the Professional Services Council (PSC) released a survey of its member firms on "Acquisition in Transition: Workforce, Oversight and Mission." PSC officials say the results clearly show President Obama will face a growing and high-priority acquisitions environment as he contends with annual government procurements of some $450 billion.

"This report is unique, because it represents the voices of the acquisition community in their own words," project lead Diane Denholm says. "Now, more than ever, it is imperative that acquisition leaders have a seat at the table if the critical issues facing the federal government are to be addressed."

The concerns raised by the survey respondents echo some of those voiced by Gates and some that the services have sought to address through their new acquisition commands. An example is the need for hands-on oversight by well-trained professionals, from the very beginning of a program rather than after a problem arises.

"There are a lot of things we put in place the last few years that we need to continue to emphasize and execute, such as competitive prototyping and configuration steering boards to make sure we have stable requirements," Sylvester concludes. "The issue now is execution. The thrust the secretary has given us now is to move a lot of our thinking up front, to concentrate on how much we want to spend and on what kinds of systems.

"We need to get that strategic focus on procurement, what kinds of systems we want, what they are supporting, where we can make some adjustments in implementing the changes in the legislation—which are important to supporting where we want to go with a lot of these processes. The secretary has said we need to look at the kinds of things we will be engaged in from a strategic view, and let those drive where we go. That is a change from what we've done in the past."

Choosing the pathway to space

It may have been obvious to many in the civil space community, but it took a presidentially commissioned panel to make it unambiguous: The path to space that NASA has been following since January 2004—once termed the Vision for Space Exploration and subsequently emerging as Project Constellation—is unsustainable. The commission, chaired by Norm Augustine and populated by a host of experienced space engineers and former astronauts, laid out a series of scenarios in a September 8 summary report that called into question the viability of that policy if not its technical merits.

The missing element is money. The program, said the report, "appears to be on an unsustainable trajectory. It is perpetuating the perilous practice of pursuing goals that do not match allocated resources. Space operations are among the most complex and unforgiving pursuits ever undertaken by humans. It really *is* rocket science. Space operations become all the more difficult when means do not match aspirations. Such is the case today."

Originally tasked with keeping its review within the budget established last May by the Obama administration—a budget billions of dollars smaller than what the Bush administration initially proposed—the Review of U.S. Human Spaceflight Plans Committee was forced to ask the White House to let them roam a bit more freely in budget alternatives.

What followed became a stark picture of a space program that was locked in LEO with little chance of achieving the grandiose exploration goals set by the previous president to return to the Moon and then continue on to Mars. The committee concluded that the ultimate goal of space exploration is to chart a path for human expansion into the solar system. Mars, it said, was the ultimate destination of U.S. astronauts in space, but should not be the first such destination beyond LEO. And while the Moon could be within reach by the late 2020s, given sufficient funds, the committee laid out other scenarios that, for the same funds, could include other deep space manned missions, too.

The group developed five alternatives for NASA's human spaceflight program. It found that human exploration beyond LEO is not viable under the FY10 budget guideline, but is possible under a less constrained budget that ramps up to approximately $3 billion a year above the FY10 numbers and continues that extra funding until 2014, after which it would grow only 2.4% annually for inflation. Funding at that higher level would allow either an exploration program to explore the Moon first, or a program that follows a "flexible path" of exploration. Either could produce results in a reasonable timeframe, starting in the middle of the 2020s. The committee weighed in on the merits of developing a heavy-lift booster, commercial alternatives for crew de-

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A presidentially appointed panel finds NASA's human spaceflight program has too little money and too few options.

livery to the ISS, and the inclusion of international partners in future exploration missions. It also assessed the status of the shuttle and station programs. While the industry is awash with reactions to the summary, as of this writing the White House has not commented.

Reality check on current programs

The panel first looked at options regarding the space shuttle and international space station. Currently, NASA plans to retire the shuttle fleet after six more flights, the last scheduled for September 2010, with no funds in the FY11 budget for continuing operations much beyond that date. The group noted that the projected flight rate is nearly twice that of the actual flight rate since shuttle operations resumed in July 2005.

The panel suggested that a more realistic schedule be adopted and urged the administration to find the funds to fly out the remaining missions into 2011. They soberly predicted that, after the shuttle's retirement, the gap in U.S. access to space by astronauts will be at least seven years long. One option presented was to continue to fly the shuttle at a minimum annual flight rate until it is replaced by a new vehicle or vehicles. Should that option be pursued, the panel noted, NASA should conduct a thorough review of shuttle recertification and reliability to ensure that the risk associated with that extension would be acceptable. With many shuttle suppliers now exiting their manufacturing and production capabilities, this option would be increasingly expensive if selected.

The group was concerned that the ISS could be vulnerable once the shuttle is retired. After shuttle retirement, the ISS would rely on a combination of international and new and unproven commercial vehicles for cargo transport. Because this planned commercial resupply capability will be crucial to both ISS operations and use, it may be "prudent to strengthen the incentives to the commercial providers to meet the schedule milestones."

The report strongly suggested that the station's return on investment to both the U.S. and its international partners would be "significantly enhanced" by a life extension to 2020, saying that it seemed foolish to deorbit the station after 25 years of assembly and only five years of operational life. Not to do so, the panel said, would significantly impair U.S. ability to develop and lead future international space missions.

The only problem with this recommendation: The current budget funds station operations until only 2015.

Constellation status

The committee then compiled all of the status reports obtained during its site visits to NASA facilities and assessed the status of the emerging Constellation program and vehicles. The panel found that the original budget

"I want to go to Mars, but let's go the right way!"
Jeff Greason

Background

On May 7 John Holdren, director of the White House Office of Science and Technology Policy, sent a letter to NASA Acting Administrator Chris Scolese requesting that he assemble "an independent review of ongoing U.S. human spaceflight plans and programs" and alternatives, to ensure that the nation "is pursuing the best trajectory for the future of human spaceflight."

Holdren tasked NASA with identifying and characterizing a range of options that would span the reasonable possibilities for continuation of U.S. human spaceflight activities beyond retirement of the shuttle fleet. Those options should explore a new U.S. capability for supporting use of the ISS; supporting missions to the Moon and other destinations beyond LEO; and stimulating commercial spaceflight capabilities, all fitting within the current budget.

On June 1, Scolese responded by establishing the charter of the Review of U.S. Human Spaceflight Plans Committee. Ten members, appointed by NASA, would comprise the panel, chaired by retired Lockheed Martin executive Norm Augustine. They would include engineers, academic experts, former astronauts, and commercial space entrepreneurs.

The charter tracked the charge given NASA in Holdren's May 7 letter: Conduct an independent review of U.S. manned spaceflight programs from the shuttle and station to beyond Earth orbit, and examine the appropriate amount of research and complementary robotic activities needed to make human spaceflight more productive and affordable over the long term. It asked that the panel specifically evaluate "options for extending ISS operations beyond 2016."

Augustine divided the panel into four subgroups, with each member assigned to two. Sally Ride chaired the ISS-Shuttle subgroup, Edward Crawley headed the Exploration Beyond LEO subgroup, Gen. Lester Lyles chaired the Integration subgroup, and Bohdan Bejmuk headed up the LEO Access group. The subgroup reports would be folded into the full panel's final document.

Chair: *Norman Augustine*

Dr. Wanda Austin	*Dr. Christopher Chyba*	*Dr. Charles F. Kennel*
Mr. Bohdan Bejmuk	*Dr. Edward Crawley*	*Gen. (ret.) Lester Lyles*
Dr. Leroy Chiao	*Mr. Jeff Greason*	*Dr. Sally Ride*

estimates made in January 2004, along with the vehicle designs established in the 2005 Exploration Systems Architecture Study, were a reasonable plan for human exploration. But many of those estimates were based on funding being made available by shuttle retirement in 2010 and the decommissioning of ISS in early 2016.

Since those early projections, the development schedules of the Ares I crew launch vehicle and the Orion crew exploration vehicle have slipped, and work on the Ares V heavy lifter and Altair lunar lander has been postponed. The group said the emerging technical problems facing Ares I could be solved but would add to the vehicle's development cost.

The 2005 schedule showed Ares I and Orion available to support the ISS in 2012, only two years after shuttle retirement. But the current schedule now shows that date as 2015, and an independent assessment of the technical, budgetary, and schedule risk to the Constellation program performed for the committee by the Aerospace Corporation indicated a further delay of at least two years. This means those vehicles, designed specifically to support the ISS post-shuttle, will not be available before the station's currently planned demise. And the manned spaceflight gap will be seven years, not two.

The committee endorsed the designs of the CLV and CEV. But it had concerns about Orion's recurring costs, noting the design was considerably larger than previous Apollo craft. It hinted that a smaller and lighter four-person Orion could reduce operational costs, but that such a late-stage redesign would likely result in over a year of additional development delay and a significant increase in cost.

The future of the ISS is dependent on which option goes forward.

Where to go beyond LEO

The panel considered a series of possible targets for U.S. manned spaceflight beyond Earth orbit. Three paths were identified:

•Mars First, with a Mars landing, perhaps after a brief test of equipment and procedures on the Moon.

•Moon First, with lunar surface exploration focused on developing the capability to explore Mars.

•A Flexible Path to inner solar system locations, such as lunar orbit, Lagrange points, near-Earth objects, and the moons of Mars, followed by surface exploration of the Moon and/or Mars.

Humans to Mars followed by colonization was highlighted as the ultimate goal of U.S. manned spaceflight. "Mars is unquestionably the most scientifically interesting destination in the inner solar system," the report said. But the planet is not an easy place to visit with existing technology and without a substantial investment of resources, and the panel stated flatly that it is not the best first destination beyond Earth orbit.

By exploring the Moon first, the panel found, NASA could develop the operational

experience and technology for landing on, living on, and launching from another planetary surface. Astronauts could acquire an understanding of human adaptation to another world and apply this to Mars missions.

The report listed two main strategies for exploring the Moon. Both begin with a few short sorties to various lunar locations to scout the region and test landing and ascent systems. The next step would be to build a Moon base. Over many missions, a small colony of habitats would be assembled, and explorers would stay for extended periods, conducting scientific studies and prospecting for resources. In the second strategy, these sorties would continue on to different sites, with astronauts spending weeks and eventually months at each. Additional equipment would have to be brought on each trip, but explorations would cover more diverse sites and do so in greater detail.

In the third, or "flexible" path, the crews would visit sites for the first time and deepen the operational knowledge of space missions, all while traveling to destinations farther and farther from Earth. Potential missions would include lunar orbit, the Lagrange points, near-Earth objects, and entering orbit around Mars. Manned spacecraft such as Orion could rendezvous with a Martian moon, then coordinate with or control robotic landers on the planet's surface, without the complication of the time delay between the Earth and the vicinity of Mars.

The Flexible Path represents a new exploration strategy for NASA. It would provide a series of scientifically valid missions to keep the public engaged and political leaders supportive. Its flexibility would allow different options as exploration progresses, including a return to the Moon's surface, or a continuation to the surface of Mars.

The committee found that both the Moon First and the Flexible Path are viable exploration strategies and not necessarily mutually exclusive. And all paths share one other element: Each would require a further $3 billion a year every year until 2014.

Option families

Within these paths, five option families were identified for consideration. They include one based on the program of record, Constellation, but with sufficient funds to meet the original Bush goals, and four possible alternatives.

Augustine said he was asked to provide two options that fit within the existing FY10 budget profile: a NASA budget that is flat or decreases through 2014, then increases only at 1.4% a year thereafter, less than the 2.4% a year used to estimate inflation. The first two options are constrained to that budget.

"If Santa Claus brought us this system tomorrow, fully developed, and the budget doesn't change, our first action would be to cancel it."
Jeff Greason

•Option 1: Program of record as assessed by the committee, constrained to the FY10 budget. This is Project Constellation, with only two changes the committee deemed necessary: Providing funding for the shuttle into FY11, and including sufficient money to deorbit the ISS in 2016.

Although this is the current plan, the group found no money in the budget for actually doing it. When constrained to this budget profile, Ares I and Orion are not available until after the ISS has been destructively deorbited. Worse, the heavy-lift Ares V is not available until the late 2020s, and there is no money to develop the Altair lunar lander and lunar surface systems until well into the 2030s, if ever.

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AUGUSTINE MEETS THE HILL

Norm Augustine took his summary report on the future of the U.S. human spaceflight program to Capitol Hill September 15-16 in back-to-back hearings in the House and Senate. At the September 15 House Committee on Science and Technology hearing, a lukewarm reception turned hostile when several members defended the existing Constellation program and questioned why Augustine's panel proposed so many alternatives. "I have to say that I am extremely frustrated—in fact, I am angry," said Rep. Gabrielle Giffords (D-Ariz.), who chairs the subcommittee on space and aeronautics. "With all due respect to Mr. Augustine and his panel, I have to say that I think we are no further ahead in our understanding of what it will take to ensure a robust and meaningful human spaceflight program than we were before they started their review," she stated.

"At this point, my focus is on the future and finding the best path forward," said Rep. Bart Gordon (D-Tenn.), chairman of the full committee. Gordon expressed skepticism regarding any need for change. "NASA has been working for more than four years on the Constellation program, a development program in support of which Congress has invested billions of dollars over that same period. I think that good public policy argues for setting the bar pretty high against making significant changes in direction at this point."

Giffords ridiculed Augustine's assertion that the need for more NASA funding was uncovered by his panel. "But we didn't need an independent commission to tell us that. That's been painfully obvious for some time now," she told Augustine.

The panel received a warmer reception the next day at a hearing before the Senate subcommittee on science and space. "Now the president needs to provide the visionary leadership required to continue American leadership in space exploration. That means not just the necessary funding to take us beyond low Earth orbit, but a plan to keep our workforce and industrial base engaged and productive," said the subcommittee's chairman, Sen. Bill Nelson (D-Fla.).

Defining a subsidy

Aircraft manufacturers *face worsening economic conditions, new competition from abroad, and major budgetary shortfalls just when research for the next generation of airliners urgently needs increased government funding. Yet even the World Trade Organization has not been clear about what constitutes fair and unfair state support for civil aircraft research.*

On September 4 the World Trade Organization (WTO) issued an interim ruling on a 2004 complaint by the U.S. over alleged unfair launch aid loans to Airbus by European governments. However, the ruling is likely to make the issue of what constitutes fair, or unfair, state support to civil aircraft programs more, rather than less, complex.

There are major transatlantic differences of interpretation on what the confidential ruling says and what the implications are for future state support measures. Some U.S. news reports have suggested that WTO has ruled the $23 billion in European government loans to Airbus over the past 40 years were unfair subsidies and, in some cases, violated a ban on export aid. Other reports, from Europe, denied there had been a clear-cut result at all.

Meanwhile an EU counterclaim against the U.S., alleging that Boeing received unfair state support in the form of tax breaks and a defense grant, is still being considered by the WTO and is understood to be about six months behind the U.S. case against Airbus.

But with the governments of Germany, France, the U.K., and Spain considering a plan to provide €3.3 billion of new launch-aid loans to support development work on the Airbus A350 XWB, this issue is likely to become more heated over the coming months. Moreover, the European Union has indicated that Europe's governments will continue to support the A350 program regardless of the WTO ruling.

by Philip Butterworth-Hayes
Contributing writer

CRITICAL FUNDING NEEDS

Both Boeing and Airbus face a funding crisis. They will need billions of dollars of R&D money to build new single-aisle aircraft to replace their Boeing 737 and Airbus A320 families sometime toward the end of the next decade. Yet they face a major shortfall in funding over the next five years as airlines cancel or defer orders for new aircraft—at a time when the first serious research funds are required. What is worse, they have new competition in the form of the COMAC 919, from CACC (Commercial Aircraft Corporation of China). This 150-seat airliner could be in production by 2014, some years before the new Boeing and Airbus single-aisle replacements, and will likely be very heavily supported by the Chinese government.

Another potential new competitor is Russia's Irkut MC-21, an aircraft family with passenger capacity of 150, 181, and 212 seats, scheduled for introduction in 2016.

So it is not surprising that the issue of

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Europe's governments will continue to support the A350 program regardless of the WTO ruling.

what constitutes fair and unfair state funding for new civil aircraft programs has once again become an issue of major concern on both sides of the Atlantic. After all, both Boeing's and Airbus' single-aisle aircraft are their essential revenue-generating programs, with more than 6,000 of both types ordered.

In recent new programs, Airbus has received around a third of the required development funds from governments in the form of repayable launch-aid loans, which European industry and government officials say do not breach international trade agreements.

But the U.S. has said it will act if European governments go ahead with their plan to inject funds into the A350 program. "If they do move forward, we will respond quickly and swiftly and file another action within the WTO," according to U.S. WTO representative Ron Kirk, speaking in Paris in June 2009.

Given the speed with which the WTO process is currently operating, it may be 2013 before the committee assessing this next potential dispute makes its final ruling on the issue—just in time for the A350 to roll out of the hangar. This aircraft would require around €11 billion in production investment, according to many industry estimates.

There are at least eight ways in which manufacturers can access government funds to research, build, and sell airliners, and all may constitute fair or unfair subsidies, depending on the viewpoint.

Many of these instruments are used in varying degrees by Boeing and Airbus. But in Europe there is growing acknowledgment that the current dire economic situation means manufacturers will need access to large amounts of state aid—though not in the form of direct government grants, which would breach international trade agreements—if they are to retain their current strong position in the civil aerospace sector.

According to Allan Cook, president of the Aerospace and Defense Industries Association of Europe, speaking in June, "Our sector is not asking for any government bailout….we do need EU institutions and national governments across Europe to increase investment in our industry, and in particular to increase their level of financial support for research and development activities."

In terms of supporting small- and medium-sized enterprises (SMEs) down the supply chain as they struggle to cope with the liquidity crisis, "a loan program for aerospace SMEs would be particularly welcome," he said.

Russia's Irkut MC-21 is a potential competitor in the single-aisle market.

Thus there is a new urgency to ensure that government-funded research programs produce key competitive technologies in time for the next generation of airliners. In this, the Clean Sky Joint Undertaking will be critical.

CLEAN SKY'S SMART AIRCRAFT

Clean Sky is a €1.6-billion research effort, funded half by the European Commission and half by industry, involving 54 aerospace companies, 15 research centers, and 17 universities. Although most of the results of the effort will arrive too late for the A350 if the tight deadlines are met, they might be available for the A320 replacement.

The aim of Clean Sky's smart fixed wing aircraft (SFWA) research team is to reduce fuel burn and emissions by around 10-20% and noise by 5-10 dB. Unlike previous EC-funded research programs, Clean Sky has a very ambitious target for moving from theoretical research into flight tests. The idea is to accelerate the development of current research rather than work on entirely new concepts, and to select the key technologies at the start of 2011, conduct flight testing in 2013, and analyze the data from these tests in 2014.

According to the commission, "The objective of the SFWA ITD [integrated technology demonstrator] is not to start up new research, but to take existing research much further. Technologies that have been developed through research partly funded by the EC over the last 20 years will be matured and enhanced to a technology readiness level that can be implemented on the next generation of civil aircraft."

Among the technologies to be advanced is a new "smart wing" design that makes use of passive and active flow and load control technologies to reduce the drag of the wing in cruise. SFWA will also examine the impact on aircraft architecture—such as a modification to the rear empennage—of new geared turbofan or open-rotor engine concepts. These should be available within the current timescale of the A320 and 737 replacement.

European industry leaders have been keen to ensure the tight deadlines are not going to be missed.

"Clean Sky has been struggling to get off the ground," said Cook, speaking in July. "The program has been mired in administrative difficulties, with industry partners finding it hard to deal with severe constraints imposed by internal commission regulations….I am glad to say that this message has been heard by the European Commission. We have now received reassurance that commission services are exploring solutions to meet industry's requests, and we noted with satisfaction that an ad-hoc group had been set up within the commission to facilitate and speed up decision-making on Clean Sky-related issues."

Clean Sky research areas

*•The **SMART Fixed Wing Aircraft** program will deliver active wing technologies and new aircraft configurations to support open-rotor and geared turbofan engine designs.*

*•The **Green Regional Aircraft** program will deliver a low-weight aircraft design using "smart" structures. It will also research low external noise configurations and the integration of technology developed in other EC-backed research programs, in areas such as engines, energy management, and new system architectures.*

*•The **Green Rotorcraft** program will deliver innovative rotor blades and engine installation for noise reduction, lower airframe drag, integration of diesel engine technology, and advanced electrical systems for elimination of noxious hydraulic fluids and fuel consumption reduction.*

*•The **Sustainable and Green Engines** program will design and build five engine demonstrators to integrate technologies for low-noise and lightweight low-pressure systems, high efficiency, low NO_x and low weight cores, and novel configurations such as open rotors and intercoolers.*

*•**Systems for Green Operations** will focus on all-electrical aircraft equipment and systems architectures, thermal management, capabilities for "green" trajectories and missions, and improved ground operations to give any aircraft the capability to fully exploit the benefits of Single European Sky.*

*•The **Eco-Design** program will focus on green design and production, withdrawal, and recycling of aircraft, by optimal use of raw materials and energies, thus improving the environmental impact of the whole product's life cycle.*

U.K. FACTORIES FACE COMPETITION

Another area where more European state aid will be required is in building factories and providing new equipment for A350 work.

One result of the economic crisis has been increased competition among key suppliers to retain long-term contracts. While Airbus partners have now developed an established network of manufacturing sites for the A350, which could also serve as a basis for A320 replacement work, there is growing competition for major new production contracts outside the consortium members.

Probably the largest, and potentially the most profitable, is the contract to supply wings. This has traditionally been centered on the U.K. sites in Filton (now owned by GKN) and Broughton—owned by Airbus UK. The U.K. government provided £530 million in launch investment aid to develop the West Factory in Broughton, where A380 wings are assembled. More funds will be needed to provide facilities for the A350 XWB wing—although at this writing it was unclear how

Airbus consortium partner workshares on the A350 XWB

Supplier	Plant/company location	Work package	Comment
Airbus UK	Broughton, U.K.	Wings	The Broughton site is responsible for assembling wings for all Airbus aircraft.
Airbus France	Toulouse, France Nantes, France	Structures and final assembly	Airbus started construction work on the final assembly line for the A350 XWB in January. The 74,000-m^2 factory will house the first stages of final assembly for the A350 XWB: the joining up of the fuselage and wings. Toulouse is responsible for the customer definition of cabins, design, and painting. Nantes produces the center wing box for all Airbus aircraft.
Airbus Spain	Getafe, Spain Puerto Real, Spain Illescas, Spain	Structures, components, and surfaces	The Getafe plant specializes in the assembly and equipping of the horizontal tail plane for all Airbus aircraft, and the design, development, and manufacture of composite materials.
Airbus Deutschland	Hamburg, Germany Bremen, Germany Stade, Germany Buxtehude, Germany	Structures and final assembly	Bremen houses the process chain for the high-lift elements of Airbus wings and builds forward and aft fuselages, where it manufactures sheet-metal parts like clips and thrust crests for all Airbus aircraft. The tails for all Airbus aircraft are produced at Stade. Stade also produces other components from CFRP. The Airbus site at Buxtehude houses cabin and cargo customization.
Premium Aerotec	Nordenham, Germany Varel, Germany Augsburg, Germany	Structures	A former Airbus concern, now sold to the private sector. The company is providing the fuselage structure for the A350 XWB. The structures are for the floor and aft pressure bulkhead, adding to existing work it has to build forward section elements and aft side shells (see below). The aft press bulkhead will be made from CFRP and will be the third aircraft structural component developed and manufactured by the company using the vacuum-assisted process—an infusion process it has developed in-house and patented.
Premium Aerotec	Nordenham, Germany Varel, Germany Augsburg, Germany	Structures	A former Airbus concern, now sold to the private sector. The Nordenham facility—which manufactures forward and aft fuselages—is the central facility for manufacturing fuselage shells for all Airbus aircraft. Varel supplies complex machined aircraft structural components to all seven Airbus sites in Germany.
Aerolia	Saint-Nazaire, France Méaulte, France	Structures	A former Airbus concern, now sold to the private sector. The site at Méaulte, near Paris, is responsible for assembling the nose sections of all Airbus aircraft.

Eight ways to access government money for new airliner projects

•Obtain competitive technologies from high-level, quasi-academic research programs pioneered by government-funded bodies such as NASA or the European Commission.

•Obtain support from regional government bodies to build new facilities or invest in technology upgrades to existing manufacturing centers.

•Access increasing amounts of work from small and medium-sized enterprises down the supply chain that have their own discrete sources of government financial support.

•Obtain direct government launch aid to support new programs, on the basis that retaining strategic technologies and skills is in the national interest.

•Borrow from banks that have received money from governments specifically to help finance aerospace companies.

•Rely increasingly on export credit guarantees and other government financing methods that support aircraft sales campaigns.

•Use strategic partners in third-party countries who have access to large government grants.

•Use technologies that have been developed for military use—financed by defense departments—for civil applications.

much the U.K. government would make available to Airbus UK to develop new facilities, and whether this would take the form of a straight loan or reimbursable launch aid.

In June the Welsh assembly agreed a £28.6-million investment in new composite manufacturing facilities at Broughton.

But with BAE Systems no longer a member of the core Airbus consortium, there are possibilities for companies outside the U.K. to take over this lucrative work. Airbus and the U.K. government may have invested heavily in wing manufacturing plants over the past few years, but many in the U.K. are now worried that without a substantial government commitment to provide new facilities, this work will move elsewhere.

China unveiled the COMAC C-919 at the Asian Aerospace 2009 air show in Hong Kong.

"To sustain our future contribution to a balanced British economy, further action is now required from industry and the government in partnership," says Ian Godden, chief executive of the Society of British Aerospace Companies. "With the global market for the new single-aisle replacement for the Airbus A320 and Boeing 737 alone worth an estimated $1 trillion over the next 20 years, with the total market at over $2.6 trillion, this is an opportunity that the U.K. literally cannot afford to miss."

Godden is concerned that if the U.K. does not recommit to buying the A400M military transport, "the probability that in 15 years' time the U.K. is a fully fledged composite wing manufacturer will reduce substantially….If the U.K. government does not fund [the work], then Germany and Spain will pick it up."

The political pressure on the U.K. government to find funds for new civil aircraft manufacturing has never been more intense.

FUNDING COMMITMENTS

In France, government commitments to civil aircraft manufacturing are much clearer. Of the approximately €3.3 billion pledged, in principal, by France, Germany, Spain, and the U.K. to the A350, Germany is to contribute €1.1 billion and France €1.4 billion, reflecting France's slightly larger workshare. This early and strong commitment will also mean German industry's contribution to the A320 replacement will probably be greater than the workshare allocated to current Airbus programs, according to German officials.

In January of this year the French press reported that the government planned to inject €5 billion into banks to finance aircraft purchases. *Les Echos* reported that the French government would inject the money into banks that have a history of lending to the aviation sector—Calyon, Societe Generale, and BNP Paribas are examples.

Meanwhile, Airbus sales have also received a boost from extra support given by European export credit agencies. These will back about half of Airbus deliveries in 2010, up from 40% for this year, Airbus COO John Leahy has said. The use of government-backed export credit guarantees is becoming increasingly important on both sides of the Atlantic. The U.S. Export-Import Bank may boost guarantees on bank loans for Boeing aircraft this year by more than 70%.

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With Europe's large aircraft manufacturing sector coming under increasing pressure from new competitors in Canada, Brazil, and China, the importance of obtaining research and infrastructure funds from governments to maintain a competitive edge has never been greater, especially given the exceptionally difficult economic climate. But defining what is fair and unfair state support has proved elusive. With new manufacturers entering the market, it is likely to become even more murky in the future than at present.

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•Option 2: ISS and lunar exploration, constrained to the FY10 budget. This option extends the ISS to 2020, and conducts a program of lunar exploration using a smaller version of Ares V. It assumes a shuttle flyout in FY11, and includes a technology development program, a program to develop commercial crew services to LEO, and money for enhanced utilization of ISS. This option does not deliver heavy-lift capability until the late 2020s and does not have funds to develop the systems for lunar landing or exploration.

The remaining three alternatives are sized to a larger budget profile—one the panel judged more appropriate for a program designed to carry humans beyond LEO. It adds $3 billion above the FY10 guidance each year to FY14, then slows to a 2.4% inflation adjustment a year.

•Option 3: Baseline case—implementable program of record. This is an executable version of Constellation. It consists of the content and sequence of the existing program—deorbiting the ISS in 2016, developing Orion, Ares I, and Ares V, and beginning lunar exploration. The committee made only two additions—budgeting for the flyout of the shuttle in 2011, and ISS deorbit. The assessment is, under this funding profile, that the option delivers Ares I/Orion in FY17, with human lunar return in the mid-2020s.

•Option 4: Moon first. This keeps the Moon as the first destination. It extends ISS life to 2020 using commercial crew-carrying vehicles and funds technology advancement. There are two variants to this option: Variant 4A retires the shuttle in FY11 and develops the Ares V Lite heavy-lift booster for lunar missions. Variant 4B includes the only foreseeable way to eliminate the gap in U.S. human-launch capability: It extends the shuttle to 2015 at a minimum safe-flight rate. It also develops a heavy-lift booster that is more directly shuttle-derived. Both variants of Option 4 permit human lunar return by the mid-2020s.

•Option 5: Flexible Path. This option follows the Flexible Path as exploration policy. It flies the shuttle into FY11, extends the ISS until 2020, funds technology development, and develops commercial crew services to LEO. There are three variants within this option (they differ only in the heavy-lift booster design selected). Variant 5A develops Ares Lite, the most capable of the heavy-lift vehicles in this option. Variant 5B employs an EELV-heritage commercial heavy-lift rocket and assumes a significantly smaller role for NASA. It has lower operational costs but requires major restructuring of NASA. Variant 5C uses a shuttle-derived heavy-lift vehicle, taking maximum advantage of existing infrastructure, facilities, and production capabilities.

All variants of Option 5 begin exploration along the Flexible Path in the early 2020s, with lunar flybys, visits to Lagrange points and near-Earth objects, and Mars flybys occurring at a rate of about one mission a year, and a possible rendezvous with Martian moons or human lunar return by the mid-to-late 2020s.

All paths lead to funding

The committee found that no strategy compatible with the FY10 budget profile allows manned spaceflight to continue in any meaningful way. But with a budget increasing by $3 billion annually above the FY10 budget levels, both the Moon First and Flexible Path strategies begin human exploration on a reasonable, though not aggressive, timetable. The panel believed an exploration program that will be a "source of pride for the nation" requires more money annually for NASA.

Regardless of the pathways selected, the group strongly urged the design and development of some form of heavy-lift booster to support manned spaceflight.

"I think it would be fair to say that our view is that it would be difficult with the current budget to do anything that's terribly inspiring in the human spaceflight area."
Norm Augustine

It also suggested that the U.S. make greater use of international cooperation and partnerships beyond any missions from LEO. And it found attractive the prospect that selection of a commercial crew spacecraft development effort to lower costs for access to the station would help to develop a new commercial space industry for the nation.

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As was the case following the 2003 Columbia disaster, NASA and the U.S. civil space program again face the prospect of a new direction. Whatever option the Obama administration chooses, neither a blue-ribbon panel, nor NASA, nor the White House will have the final say as to what the nation does in space. "Whatever space program is ultimately selected, it must be matched with the resources needed for its execution," said the report.

And that choice remains, as it should, with the public at large.

"So you have a heavy-lift vehicle in 2028, but absolutely nothing to put in it to send to the Moon."
Sally Ride

Out of the

25 Years Ago, November 1984

Nov. 8-16 The space shuttle Discovery is launched from the Kennedy Space-flight Center on STS 51A with commander Frederick H. Hauck, pilot David M. Walker, and three mission specialists. Crewmembers retrieve two satellites from orbit, Palapa B2 and Westar VI, for return to Earth. They also launch Canada's Telesat-H and the Hughes Synsom-IV-1 communication satellites. NASA, *Astronautics and Aeronautics, 1979-84*, pp. 516-517.

Nov. 10 The Spacenet 2 communications satellite, owned by GTE, is placed into orbit by Ariane V11. The same booster also carries the Marecs B-2 maritime communications satellite into orbit for ESA. NASA, *Astronautics and Aeronautics, 1979-84*, p. 517.

Nov. 27 Miss Baker, the South American squirrel monkey that flew with U.S.-born rhesus monkey Able in a test spaceflight on a Jupiter rocket on May 28, 1959, up to 300 mi., dies of kidney failure. She is buried at the Space and Rocket Center in Huntsville, Ala. *Astronautics and Aeronautics, 1979-84*, p. 519; E. Emme, ed., *Aeronautics and Astronautics 1915-60*, pp. 109-110.

50 Years Ago, November 1959

Nov. 4 NASA launches a second Little Joe II all-solid-fuel test launch vehicle at its Wallops Island, Va., facility. The purpose is to test the Project Mercury escape system mounted on a tower on a 2,000-lb boilerplate model of the capsule. *Flight*, Nov. 20, 1959, p. 569.

Nov. 5 The North American X-15 rocket-powered research aircraft (No. 2) achieves its third powered flight, with Scott Crossfield at the controls. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 114; D. Jenkins, *X-15,* p. 609.

Nov. 5 The Air Force successfully launches Atlas, Jupiter, and Thor missiles from Cape Canaveral, Fla. All three reach the full design ranges down the Atlantic. *Flight*, Nov. 13, 1959, p. 538.

Nov. 7 The Air Force's Discoverer VII satellite is boosted into polar orbit, although the capsule is not recovered. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 114.

Nov. 8 A British Avro Vulcan B-1 bomber returns to England after a 30,424-mi. round-the-world flight. During the trip the plane took part in the opening ceremony of the new airport in Wellington, N.Z. *The Aeroplane*, Nov. 20, 1959, p. 498.

Nov. 10 A five-stage sounding rocket called Strongarm, with a 150-lb scientific payload, is launched from NASA's Wallops Island, Va., facility to an altitude of 1,050 mi. and gathers data on electron density in the upper atmosphere. Strongarm uses an Honest John motor as the first stage, two Nike boosters as the second and third stages, a modified Recruit rocket as the fourth, and a scale Sergeant as the fifth stage. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 114; D. Baker, *Spaceflight and Rocketry*, p. 96.

Nov. 11 The president of England's Royal Aeronautical Society receives a letter announcing that Henry Kramer, chairman and managing director of Microcell, is offering a £5,000 prize for the first successful flight of a man-powered aircraft. The rules are posted by the society in 1960. The Kramer Prize's monetary award grows considerably, is opened to persons beyond Britain, and is finally won years later by the U.S. amateur cyclist and hang-glider pilot Bryan Allen. He pilots the plane, designed by Paul McCready and named the Gossamer Condor, on Aug. 27, 1977. *Flight*, Nov. 20, 1959, p. 500; R. Reed, *Wingless Flight*, p. 13: M. Grosser, *Gossamer Odyssey*, passim.

Nov. 11 It is announced that radio signals are successfully reflected back to Earth from Venus with a 250-ft-diam radio telescope at Jodrell Bank of the University of Manchester, England. *The Aeroplane*, Nov. 13, 1959, p. 459.

Nov. 16 Air Force Capt. Joseph W. Kittinger Jr. makes a parachute jump of 76,400 ft from the Excelsior I open balloon gondola, setting a world record. *The Aerospace Year Book*, *1960*, p. 26; *Flight*, Dec. 4, 1959, p. 658.

Nov. 20 The Discoverer VIII reconnaissance satellite is placed into polar orbit, but its capsule is not recovered. E. Emme, ed., *Aeronautics*

Past

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

and Astronautics 1915-60, p. 115.

Nov. 23 The Boeing 720 four-engine medium-range jet transport aircraft

makes its first flight, though it does not enter scheduled service with United Airlines until July 5, 1960. *FAA Historical Chronology*, p. 64.

Nov. 26 The attempted launch of the Pioneer V lunar probe fails when the plastic shroud of the Atlas-Able 4B launch vehicle separates 45 sec after liftoff. The vehicle breaks up 25 seconds later. *The Aeroplane*, Dec. 4, 1959, p. 566; D. Baker, *Spaceflight and Rocketry*, p. 96.

Nov. 27 The Hiller X-18 tilt-wing VTOL research transport aircraft makes its

first flight, at Edwards AFB, Calif. *The Aerospace Year Book, 1960*, p. 457.

Nov. 28-29 Optical observations and photos of Venus are taken from an altitude of 81,000 ft through a special mechanism on a 16-in. telescope carried on the Office of Naval Research Strato-Lab High IV balloon. Conducting the experiments aboard the 172-ft-diam helium-filled balloon are scientists Charles B. Moore Jr. and Cmdr.Malcolm Ross. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 115; *Flight*, Dec. 11, 1959, p. 706.

75 Years Ago, November 1934

Nov. 4 Congress gives belated recognition to Emory Bronte's achievement in navigating the first civilian aircraft across the Pacific from California to Hawaii in 1927, presenting him with the Distinguished Flying Cross. Pilot Ernest Smith received a similar award five years ago. *Aviation*, December 1934.

Nov. 16 President Albert Lebrun of France opens the 14th Paris Air Show, which features greater than usual shows of nationalism by participating countries. Dominating Germany's exhibit is a gigantic swastika on the fin and rudder of a larger Junkers trimotor float plane, with more swastikas displayed on other planes. Across the exhibit hall is the symbol of the USSR, a 10-ft-high red star sitting atop a model of the Maxim Gorki, the eight-engined Soviet flying propaganda machine. The French display an unusual number of fighter-bombers, which seem to be a symbolic answer to the German bombers allegedly in development from Junkers passenger planes. The propagandistic tendency of the Soviets is especially apparent, notes one reviewer, considering the USSR does not sell airplanes or engines to other nations at these shows. *The Aeroplane*, Nov. 21, 1934, pp. 607-632.

Nov. 17 Capt. Fred Nelson wins the Mitchell Trophy Race, averaging 216.8 mph over the four circuits of the 20-mi. course at Selfridge Field, Mich. All contestants in this military event, last held three years ago, use low-wing Boeing P-26 pursuit planes powered with supercharged Wasp engines. The Curtiss Trophy is awarded for the first time this year and goes to Lt. Thomas Gaughan Jr. for circling the 20-mi. course three times at an average speed of 191.4 mph. *Aviation*, December 1934, p. 404.

Nov. 18 The Navy issues a contract to Northrop for the XBT-1, a two-seat scout plane and 1,000-lb dive bomber. The initial prototype leads to the Douglas SBD Dauntless series of dive bombers, introduced to the U.S. fleet in 1938 and used throughout WW II. E. Emme, ed., *Aeronautics and Astronautics 1915-60*, p. 32.

Nov. 30 The USSR announces it will establish its first dirigible line between Moscow and Sverdlovsk, a distance of 1,000 mi. It will use a semirigid dirigible with three motors of 250 hp each. The airship will carry 18 passengers, with mail, and is expected to cover the route in 16 hr. *Flight*, Nov. 8, 1934, p. 1168.

And During November 1934

—According to a German press report, 32 American officers will be engaged as instructors to the Russian air force. *Flight*, Nov. 8, 1934, p. 1178.

100 Years Ago, November 1909

Nov. 29 The Etrich Taube ("Dove"), designed and built by Igo Etrich, completes its first flight. The Taube monoplane is the first Austrian aircraft to fly in that country. Its graceful bird-like design inspires many imitators and is widely produced in Germany.
A. van Hoorebeeck, *La Conquete de L'Air*, p. 81.

Mechanical Engineering Faculty Search

THE DEPARTMENT OF MECHANICAL ENGINEERING at Florida State University and Florida A&M University's jointly administered College of Engineering invites applications for tenure track faculty positions in the general areas of Aeropropulsion, Thermal and Energy Systems, and Robotics/Mechatronics. The openings are at the Assistant Professor level; however, exceptional candidates at higher levels will also be considered. Special consideration will be given to candidates who have a strong background in research areas that are presently very active within the Department. These include: active flow and noise control, including sensor, actuator and control design; advanced flow diagnostics; micro-fluidics, bio-inspired and micro-air vehicles; and multi-scale, multi-physics computations.

Successful candidates will be expected to teach and develop mechanical engineering courses at the undergraduate and graduate levels, and conduct high quality, externally sponsored research. Our faculty have established a number of nationally recognized, inter-disciplinary research programs and the Department is home to several state-of-the art research facilities and Centers of Excellence that offer excellent opportunities for collaboration and growth. These include: the Florida Center for Advanced Aero-Propulsion (a multi-university Center of Excellence led by Florida State University), the National High Magnetic Field Laboratory, and the Institute for Energy Systems, Economics, and Sustainability, along with a number of facilities within the Department (see www.eng.fsu.edu/me).

The positions are tenure track academic faculty lines within Florida State University or Florida A&M University. A Ph.D. in Engineering or a related field is required. Applications from minorities and women are strongly encouraged.

Applicants are encouraged to apply by December 15, 2009 for full consideration, although the application process will remain open until suitable candidates have been found. Candidates interested in being considered should send a send a cover letter which includes a brief discussion of their research and teaching philosophy and plans and a curriculum vita, with three references to:

Professor Farrukh Alvi
Chair, Faculty Search Committee
Department of Mechanical Engineering
FAMU-FSU College of Engineering
2525 Pottsdamer Street, Room A229
Tallahassee, FL 32310
mefacsearch@eng.fsu.edu
Florida State and Florida A&M Universities are equal opportunity/access, affirmative action employers.

Search for Aerospace Engineering Department Chair

The Department of Aerospace Engineering at Iowa State University (www.aere.iastate.edu) invites nominations and applications for the position of Department Chair. We are seeking a visionary leader with demonstrated aerospace engineering experience in an academic, industrial, and/or national laboratory setting. Candidates are expected to maintain the tradition of a strong Aerospace Engineering program, strengthen and broaden the department's research programs and resource base, and be an advocate for the department.

The candidate must possess a PhD, or equivalent terminal degree, in aerospace engineering or related area, have an exemplary record of scholarship, have an international reputation for research accomplishment, and have demonstrated university and/or professional leadership. Preferred qualifications include prior budget management and team-building accomplishments and ability to function successfully in an academic setting. The successful candidate will have a strong commitment to undergraduate and graduate education, promoting diversity, and long-term advancement of the department. The qualifications must match with those expected for an appointment at a tenured Full Professor level.

The Department of Aerospace Engineering is among the oldest nationally recognized programs, offers an undergraduate degree in aerospace engineering, and graduate programs in aerospace engineering and engineering mechanics. The department has strong research focus in multidisciplinary areas such as internationally recognized non-destructive evaluation, computational fluid dynamics, wind engineering and experimental aerodynamics; guidance, control, and astrodynamics; mechanics and materials; and turbulence and transition. The department is centrally located in a newly constructed modern engineering research and teaching complex (ETRC). The unique research facilities include a large Aero/ABL Wind Tunnel and a Tornado/Microburst Simulator. The faculty and graduates of the department have been well-recognized for excellence and the department has a strong alumni base. The department faculty includes two NAE members and seven fellows of professional societies.

Iowa State University of Science and Technology is a comprehensive, land grant, Carnegie Doctoral/Research Extensive University with an enrollment of over 27,000 students. The College of Engineering includes eight departments, with over 200 faculty members and annual research expenditures exceeding $60 million and a U.S. News and World Ranking of 37 in the nation. Unique entities at Iowa State that enable cross-campus collaboration include the Ames Laboratory of the United States Department of Energy. Iowa State's nearly 2000-acre park-like campus is located in Ames, Iowa, ranked as the second most livable small city in the nation.

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/applicants/Central?quickFind=77820. Please be prepared to enter or attach the following:

1) A letter of application/cover letter
2) A curriculum vitae
3) A statement describing education, research, diversity, and leadership philosophy and vision, and
4) Full contact information for at least four professional references.

If you have questions regarding this process or would like to submit a nomination, please email Professor Arun K. Somani (arun@iastate.edu) or call 515-294-0442. Review of applications will begin immediately and continue until position is filled. We anticipate having a successful candidate in place on July 1, 2010.

Iowa State University is an Affirmative Action employer and will take action to ensure that employment practices are free of discrimination. Iowa State University is committed to achieving excellence through a diverse workforce. Iowa State University does not discriminate on the basis of race, color, age, religion, national origin, sexual orientation, gender identity, sex, marital status, disability, or status as a U.S. veteran. Women and minorities are highly encouraged to apply for all employment opportunities. Inquiries or questions regarding our non-discrimination policy can be directed to Carla R. Espinoza, Director of Equal Opportunity and Diversity and ADA Coordinator, 3750 Beardshear Hall, Ames, IA 50011 or by phone at (515) 294-6458.

UF | UNIVERSITY of FLORIDA

Department of Mechanical and Aerospace Engineering

The Department of Mechanical and Aerospace Engineering (MAE) at the University of Florida is seeking to hire multiple tenured/tenure-track faculty. Outstanding candidates at all levels will be entertained in the following focus areas: energy, nanoengineering, biomechanical engineering, and dynamics and controls. Candidates must possess an earned Ph.D. in Mechanical or Aerospace Engineering or a closely related discipline and demonstrate ability to create and sustain internationally recognized research programs in their fields of expertise.

The MAE Department currently has approximately 52 faculty, 375 graduate students, and annual expenditures in excess of $20 million. Persons joining the Department will find outstanding facilities, a collaborative and collegial work environment, and a strong dedication to diversity and excellence in research and education. Potential applicants seeking more information are encouraged to visit our website at **http://www.mae.ufl.edu**.

Candidates should submit applications electronically to the Search Committee Chair at **maesearch@mae.ufl.edu**.

Applications should include: 1) formal letter of interest, 2) complete resume/curriculum vitae, 3) statement of research and teaching plans, and 4) names and contact information for at least three references. Applications should be submitted by October 1, 2009 when the search committee will begin reviewing applications. Acceptance and review of applications will continue until a qualified applicant pool is identified.

As part of the application process, applicants are invited to complete an online confidential and voluntary self-disclosure card referencing one of the following position numbers 00009192, 00007430 or 00007432. This information is used as a means of recording or tracking candidate applications and is accessible to the university's Faculty Development Office when needed to fulfill reporting obligations. A self-disclosure card can be found at **http://www.hr.ufl.edu/job/datacard.htm**.

The University of Florida is an Equal Opportunity Employer dedicated to building a culturally diverse faculty and staff. We strongly encourage minorities, women, and members of other under-represented groups to apply.

MIT Massachusetts Institute of Technology

Come work with us!

Faculty Search

Department of Aeronautics and Astronautics

The Department of Aeronautics and Astronautics is seeking applicants for tenure-track faculty positions with potential starts in September 2010. Department programs encompass aircraft, spacecraft, transportation, information, and communication systems. The search will be broad, encompassing all areas of Aeronautics and Astronautics. Our goal is to hire candidates who have deep expertise in one or more core disciplines, and who have the potential and intellectual flexibility to become world leaders through integration of these disciplines to define and address new opportunities. Areas of interest include, but are not limited to, real-time, safety-critical systems; autonomous systems; humans-in-the-loop systems; structures and materials; combustion/reacting flows; aero-acoustics; aircraft or engine design; air transportation; human and robotic exploration of space; aerospace communications; environmental impact modeling; and computational engineering. Faculty duties include teaching at the graduate and undergraduate levels, research, and supervision of student research. Further information on this search and the Department may be found at http://web.mit.edu/aeroastro/about/jobs.html.

Candidates should hold a Ph.D. in Aeronautics and Astronautics or a related field by the beginning of the appointment period. The search is for the Assistant Professor level, but qualified candidates at all levels will be considered.

Applications must be submitted in PDF format online at https://facsearch.mit.edu. Applicants must submit a cover letter, a curriculum vitae, a 2-3 page statement of research and teaching interests and goals, and the names and contact information of at least three individuals who will provide letters of recommendation. Applicants should request that letters of recommendation be submitted online at https://facsearch.mit.edu by the recommenders. Applications should be addressed to: Professor David W. Miller, Chair, Faculty Search Committee, MIT Department of Aeronautics and Astronautics. Applications will be considered complete when both the applicant materials and at least three letters of recommendation are received. Applicants are encouraged to apply by January 1, 2010.

MIT is an equal opportunity/affirmative action employer, and we encourage applications from women and underrepresented minorities.

http://web.mit.edu

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

Florida Institute of Technology
College of Engineering
Allen S. Henry Professor of Engineering

The College of Engineering at the Florida Institute of Technology invites outstanding candidates for the Allen S. Henry Chaired Professorship beginning fall 2010.

Applicants with experience and achievement commensurate with full professor rank in Aerospace or Mechanical Engineering will be considered. Special consideration will be given to candidates with a background in thermal systems, including combustion or renewable energy. The successful candidate will be expected to develop an externally funded research program as well as to teach courses in their areas of expertise.

Qualified applicants are expected to have: a Ph.D. degree in aerospace or mechanical engineering or a related field, the ability to acquire substantial research funding, proven teaching skills, dedication to education, and a record of professional activities in accordance with full professor rank. Applicants should send: a letter of interest, a detailed curriculum vitae, and four references via email to henrychair@fit.edu. Review of applications will begin Nov. 1st 2009 and will continue until the position is filled.

Florida Tech (www.fit.edu) is an independent technological university and is ranked as a High Research Activity Institute by the Carnegie Foundation. The technology focused university is located in Melbourne, Florida near NASA's Kennedy Space Center. Florida Tech is an Equal Opportunity Employer committed to excellence through diversity.

UNIVERSITY OF CAMBRIDGE
Department of Engineering

UNIVERSITY LECTURESHIP IN AEROACOUSTICS

Candidates should have a proven record of research in the area of aeroacoustics and will be expected to establish their own research portfolio as well as collaborate with other faculty. This tenure-track post will be held within the Division of Energy, Fluid Mechanics and Turbomachinery which enjoys an international reputation for high-quality, innovative and industry-relevant research. In addition to research the post will involve contributing to the teaching of acoustics and fluid mechanics in the engineering undergraduate course and supervising research students.

The successful candidate will take up the appointment on 1st March 2010 or as soon as possible thereafter. The current pensionable scale of stipends is in the range of £36,532 - £46,278 per annum.

Informal enquiries may be made to Professor Ann Dowling, e-mail: apd1@eng.cam.ac.uk. Further details and Information on how to apply can be found at: http://www.eng.cam.ac.uk/admin/jobs.shtml. Closing date: 4 December 2009.

The University values diversity and is committed to equality of opportunity. The University has a responsibility to ensure that all employees are eligible to live and work in the UK.

KU THE UNIVERSITY OF KANSAS
School of Engineering

Aerospace Engineering

The University of Kansas Aerospace Engineering Department invites applications for a ***faculty position*** and at least two ***doctoral candidates.*** The Aerospace Engineering research team is currently engaged in research sponsored by the NSF, NASA, various aerospace corporations, and the KU Transportation Research Institute.

Applications for the ***faculty position*** are encouraged at the Assistant or Associate Professor level, although exceptional candidates at a higher rank will be considered. Successful applicants will demonstrate a promising externally-funded research program in ***aerodynamics,*** especially ***computational fluid dynamics*** and/or ***experimental aerodynamics.*** Experience in the aerospace industry, especially with ***uninhabited vehicles***, is a plus. Research productivity at KU is evaluated with respect to publications in respected academic journals and success in supporting and mentoring PhD and MS students. Faculty members are expected to teach both undergraduate and graduate courses in an effective manner, and to be active in service to the University and the engineering profession. An earned doctorate in Aerospace Engineering or a closely-related field is required. The successful candidate for the position should be eligible to work in the U.S. prior to the start of the appointment. Salary is commensurate with experience.

Doctoral candidates are sought in the fields of: precision orbital mechanics; autonomous and intelligent flight control; and, adaptive structures for flight vehicles. Yearly support ranges from $25,000-30,000, depending on academic preparation and experience. Candidates will find application instructions at www.ae.engr.ku.edu/graduate/admissions.html.

The faculty position will be available between May 15, 2010 and August 18, 2010. Apply online at www.ku.edu/employment, attaching the following documents to the applicant data form: a letter stating your teaching and research interests, a resume, and contact information for three references. Any attachments exceeding 5MB may be emailed to aerohawk@ku.edu. Review of complete applications will begin on January 15, 2010 and continues until the position is filled. On-campus interviews are anticipated to begin February 15, 2010.

The University of Kansas is an affirmative action/equal-opportunity employer and encourages applicants from under-represented segments of the population.

Faculty Positions
Mechanical Engineering Department
Vanderbilt University

The Department of Mechanical Engineering at Vanderbilt University invites applications for one or more faculty positions to begin Fall 2010. Applications will be considered for positions at all ranks commensurate with qualifications. Applicants must possess a Ph.D. in Mechanical Engineering or closely related discipline and have expertise and research interests that are synergistic with existing research areas in the department including energy conversion, combustion, microfluidics, bioMEMS, nanotechnology, mechatronics, portable power, and robotics. Successful candidates will be expected to build a strong, externally-funded research program and make a significant contribution to the department's research activities. The candidate should also have a marked interest in and talent for teaching in both the undergraduate (B.E.) and graduate (M.S. and Ph.D.) programs. Vanderbilt University is ranked among the top 20 universities in the nation. The Department of Mechanical Engineering offers B.E., M.E., M.S. and Ph.D. degrees and has a student body of about 265 undergraduates and 40 Ph.D. students. Applications consisting of a cover letter, a complete curriculum vitae, statements of teaching and research interests, and the addresses of four references (include email address) should be sent to Professor Robert W. Pitz, Chair, Search Committee, Department of Mechanical Engineering, Vanderbilt University, Box 1592, Station B, Nashville, TN 37235-1592, or sent electronically to: robert.w.pitz@vanderbilt.edu. Vanderbilt University is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

UNIVERSITY OF MINNESOTA

Department of Mechanical Engineering
University of Minnesota
Faculty Openings

The Department of Mechanical Engineering at the University of Minnesota invites applications for two openings at the level of tenure-track assistant professor or untenured associate professor. Other levels of appointment may be considered in exceptional cases. The Department places higher value on the overall creativity and scholarly originality of the candidate's research than on his or her fit into a particular area of mechanical engineering.

The Department has about 40 faculty and grants about 200 Bachelors, 40 Masters and 20 Doctoral Degrees every year. The candidate's engineering expertise and documented research activities must demonstrate a strong potential toward enhancing both the Department's research and the undergraduate and graduate teaching missions. Successful candidates are expected to build strong, externally-funded, highly-visible research programs and to become recognized leaders in their field.

The University of Minnesota is one of only a few comprehensive land-grant universities that are located in the heart of a major metropolitan area. The Minneapolis-St. Paul area is rated among America's most livable cities and is home to 19 Fortune 500 companies. More than 4000 companies have been created by alumni and faculty of the University's college of engineering and science.

Review of applications will begin immediately and applications will continue to be received until the positions are filled. Additional information and application instructions can be found at www.me.umn.edu. Candidates may contact the chair of the search committee at searchchair@me.umn.edu. The University of Minnesota is an equal opportunity educator and employer. Women and minorities are encouraged to apply.

UNIVERSITY OF NOTRE DAME

DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING

EXPERIMENTAL FLUID MECHANICS AND FLOW CONTROL

The Aerospace and Mechanical Engineering Department at the University of Notre Dame in South Bend, Indiana invites applications for an open tenure-track faculty position at in the area of Experimental Fluid Mechanics and Flow Control. Preference will be given to candidates with demonstrated experience in experimental fluid mechanics including the application of advanced flow field diagnostics in research that emphasizes fundamental flow physics and/or flow control. The successful candidate is expected to develop his/her own externally funded research program and collaborate with colleagues within the Center for Flow Physics and Control at Notre Dame.

Applicants are sought at all professorial ranks.

Senior hires will be expected to take an active role in defining a vision that builds upon existing strengths in related areas to establish international leadership.

All applicants must have an earned doctorate in an appropriate discipline.

Successful candidates for senior positions will have an internationally distinguished record of research, scholarship, teaching and service consistent with appointment to the appropriate rank of tenured full or tenured associate professor.

Applicants for appointments as a tenure-track assistant professor must have demonstrated potential to achieve an internationally distinguished record of research, scholarship, teaching and service.

The University of Notre Dame is a US News and World Report top-20 national research university that offers a unique opportunity for professional growth in an environment that values scholarship, education and community. Current research at Notre Dame has a strong emphasis on interdisciplinary science that bridges traditional groups and even departmental boundaries, with clear ties to significant mechanical or aerospace applications. Notre Dame is dedicated to becoming a leading research university, and is investing millions of dollars in state-of-the-art facilities, including the new Stinson-Remick Engineering building with a world class nanofabrication facility and the Center for Research Computing. Notre Dame is also dedicated to promoting strategic research initiatives in areas including nanotechnology, advanced imaging, high-performance computing, and biological and medical diagnostics. The University of Notre Dame is located in South Bend, IN. The city of South Bend and surrounding counties have a vibrant and diverse economy with affordable housing, excellent school systems, and are within easy driving distance of Chicago and Lake Michigan.

Further information about the University and the Department can be found at: http://www.nd.edu/~ame/. Interested persons should send their curriculum vitae, three references and one-page statements of 1) research program plans and 2) teaching interests to: Dr. John Renaud, Chair, Department of Aerospace and Mechanical Engineering, 365 Fitzpatrick Hall, University of Notre Dame, Notre Dame, IN, 46556. Phone (574) 631-5430. Electronic submissions are recommended and should be sent to jrenaud@nd.edu. For full consideration, applications should be received by January 9, 2010. The University of Notre Dame is an Affirmative Action, Equal Opportunity Employer.