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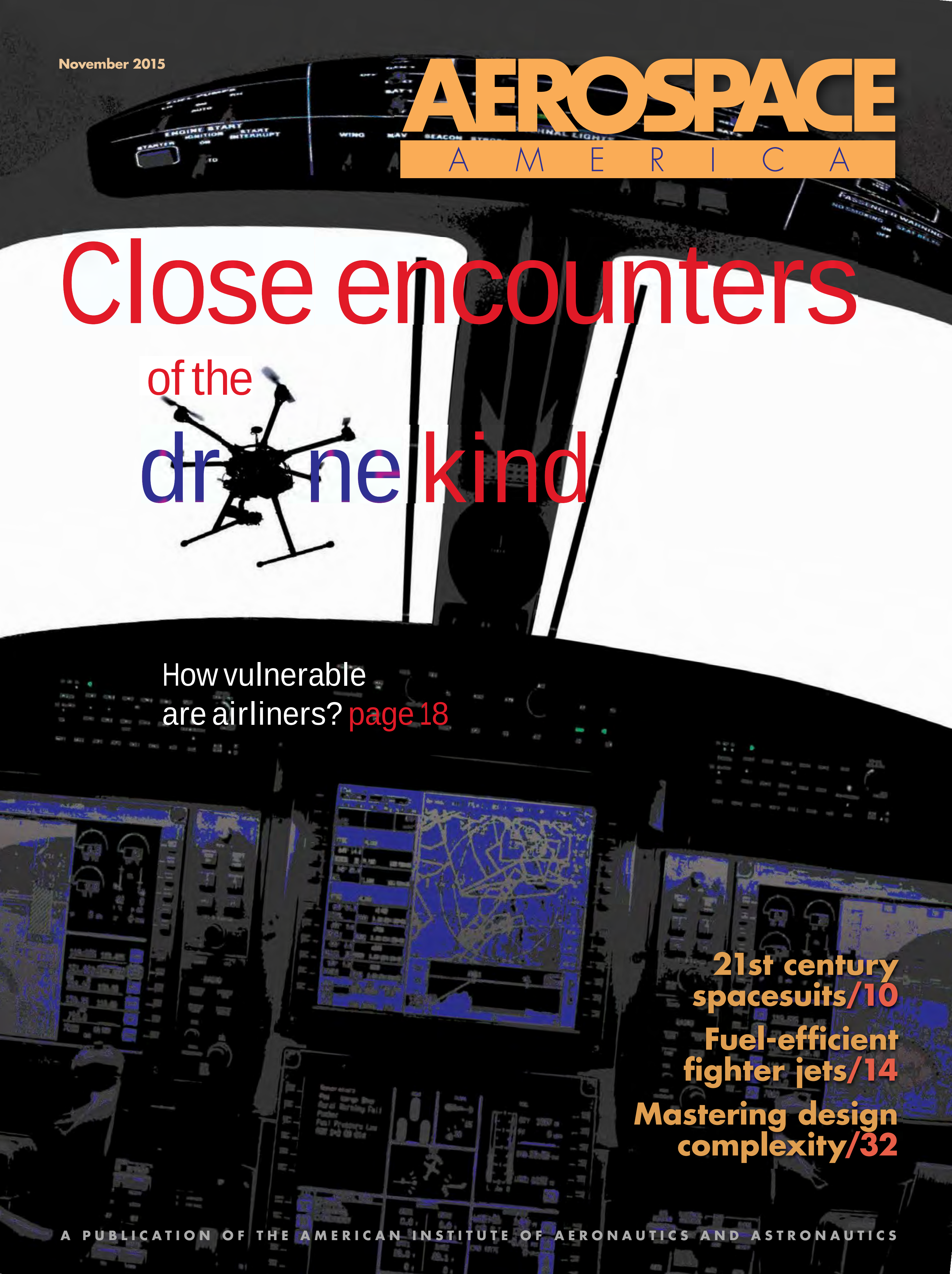
AEROSPACE AMERICA



Close encounters of the drone kind

How vulnerable are airliners? page 18

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Photo illustration by Jane Fitzgerald

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AIAA
Shaping the Future of Aerospace

Editor's Notebook

Managing the drone revolution

The FAA's balanced approach to managing the exploding small drone market seems to me to be underappreciated. The agency is under intense pressure from businesses and lawmakers not to stand in the way of a market that could grow to be worth $2 billion by 2020. The zest of those in the midst of this revolution is understandable, but the administration has an equally understandable responsibility to ensure the safety of the flying public.

The FAA is meeting this mandate by carving out a legal path for commercial operators via an exemption-petition process established in the 2012 FAA reauthorization law, and it is now mixing in a firmer enforcement hand, too. In October, the FAA proposed a $1.9 million civil penalty against the Chicago-based aerial photography company SkyPan International for allegedly operating 65 unauthorized flights in congested airspace, including 43 flights in air-traffic-controlled Class B airspace in New York. The company advertises itself as a "Section 333 UAS Exemption Holder," but that section of the 2012 reauthorization law doesn't allow successful petitioners to fly anywhere they want.

My hope is that if these allegations against SkyPan hold up, the fine won't be so punishing that it jeopardizes SkyPan's business, but still costly enough to send a clear signal to the industry that it must obey the FAA. SkyPan's sunset and panoramic views of cities are gorgeous, but they are not worth risking a midair collision. Avoiding a potentially deadly crash is in the drone industry's interest for ethical reasons and because it could set the drone revolution back years.

There are also broader implications to how the FAA and lawmakers choose to manage the drone revolution. Small drones, I'm sure, are not going to be the last aerospace revolution. I can imagine progress on autonomous control technologies, such as those in Google's self-driving car, merging with what is today a theoretical market for personal aircraft. If personal aircraft do take off — and it's admittedly a big if — my guess is that they could co-opt some of the small drone market. If I were one of those who could afford to own an autonomous flying car, I could dispatch it to pick up a package from Amazon or take aerial photos at sunset. Congress and the FAA would have to manage that revolution, too.

We should be grateful we have a vigorous FAA to keep us safe while consumers and the free market decide where our flying futures are headed.

Ben Iannotta
Editor-in-Chief

Another option for low-cost access

Don Nelson has provided an excellent discussion of a concept to revive the space shuttle in a commercial version [October Viewpoint, page 26]. The three orbiters would be used for commercial cargo launches as well as human exploration launches.

One statement is that the two options for human launch are either a large Apollo-class launcher with a capsule or a space shuttle.

An additional option should be considered: A partly reusable launcher, significantly smaller than Saturn 5 or the shuttle, that can launch a human vehicle. The human vehicle can be either a capsule such as Dragon or a small horizontal landing vehicle such as Dream Chaser. The launcher can also be used for larger cargoes without humans. With this concept, the cost of human launches is reduced by using the same vehicle many times for cargo launches.

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All letters addressed to the editor are considered to be submitted for possible publication, unless it is expressly stated otherwise. All letters are subject to editing for length and to author response. Letters should be sent to: Correspondence, Aerospace America, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807, or by email to: beni@aiaa.org.

Reducing aircraft separation creates software demands

Thales

Wake vortex is visible behind an aircraft as it passes through a patch of cloudy air.

World air traffic is expected to double by 2030, and many of the world's busiest airports are bumping up against limits in runway capacity, especially at peak. Construction of runways takes a decade or more, is expensive and often controversial.

Another way to boost capacity would be to reduce separation between aircraft after takeoff and during descent. The FAA and Eurocontrol are beginning to do this under their air traffic modernization programs through an initiative called RECAT, or re-categorization of separation standards. Because RECAT adds more complexity to separation calculations, companies, including France's Thales Air Traffic Management, are creating software to run the calculations and display the separations to air traffic controllers.

The initiative will mean managing air traffic much differently. For decades, every plane, from Airbus A380s to business jets, has been assigned to one of four categories based on weight. Air traffic controllers use the categories to set minimum separations, on the principle that heavy, leading aircraft create more turbulence, and light following aircraft are more vulnerable to turbulence.

The system was put in place in the U.S. following the turbulence-caused crash of Delta Air Lines training Flight 9570 in 1972 in Texas, which killed three pilots and an FAA inspector.

Under RECAT, the FAA and Eurocontrol are moving to set separations based on weight, aircraft model, wing design and eventually wind speed and direction. This is possible because of improved understanding of wake physics, the FAA says. For example, winglets can reduce wake vortices, and crosswinds shift wake vortices out of flight paths. In line with goals set by the International Civil Aviation Organization, the association of aviation regulators, national regulators are rolling out the recategorization in steps called RECAT 1, 2 and 3.

RECAT 1 expands to six the number of categories for leading and following aircraft. This results in a fairly simple matrix of aircraft characteristics and safe separations ranging from eight nautical miles, when an A380 or Antonov AN-124 is followed by a light business jet, to three miles when the light business jet flies ahead of the larger plane. Eurocontrol estimates this will boost peak runway capacity by 3 percent to 8 percent.

The U.S. began rolling out RECAT 1 in 2012. Runway capacity gains from RECAT 1 should average 3 percent to 4 percent, with bigger gains possible. For example, the FAA says, FedEx boosted capacity by 20 percent at Memphis International Airport in two years.

RECAT 1 is straightforward enough that controllers can maintain RECAT 1 separations with traditional software tools. But RECAT 2 will require a much more complex separation matrix. For its version of RECAT 2, Eurocontrol is considering assigning the 100 most common aircraft to more than two dozen categories of leading and following planes.

As part of TopSky, Thales' air traffic management product line, programmers have developed algorithms and display software for RECAT 2. It calculates safe separations and displays them as red and black chevrons on a screen, along with aircraft positions. It also alerts controllers when safe distances are violated.

Todd Donovan, vice president for strategy at Thales Air Traffic Management, says TopSky needs only current radar surveillance of aircraft positions, though accuracy would be slightly enhanced by the U.S. NextGen air traffic control initiative. Algorithms and display software have already been developed, and Thales says it is talking to air navigation service providers about implementation.

A related TopSky software, MAESTRO, could also use the refined separation standards to optimize the actual sequence of leading and following aircraft to further boost capacity.

ICAO hoped to see RECAT 2 in place by 2018, but Lionel Bernard Payre, a senior traffic engineer at Thales, doubts that will happen. The FAA is unlikely to start with RECAT 2 until it has finished implementing RECAT 1, which is still in progress.

Highly automated separation tools will also be needed for RECAT 3, which will combine aircraft models with situation-specific weather conditions. For example, a 7-knot crosswind removes the need for any separation simply for vortexes. Donovan says research must still be done on whether forecast winds or real-time wind data should be used. But U.K. controllers have already begun using headwind speeds to shorten landing separations at London's Heathrow Airport, the Wall Street Journal reported in September.

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Europe struggles to keep 2018 rover launch date

The European Space Agency and its industrial partners are having trouble agreeing on the price to complete the planned ExoMars spacecraft and rover in time for the planned launch in 2018 on a mission to search for chemical evidence of life on Mars.

If ESA were to miss the 2018 date, scientists would have to wait two years for Mars and Earth to move into position again for the journey, a delay that could cost up to 200 million euros. Neither side wants things to come to that, but as of October, ESA and the industrial team led by Thales Alenia Space and Airbus of France remained far apart in their bargaining, according to ESA officials.

ESA views the negotiations as a high priority and aims to complete them by December, says Rolf de Groot, the exploration program coordinator at ESA's European Space and Technology Centre in the Netherlands, which leads the ExoMars program. "It is going to be very challenging to reach the 2018 launch date, but we still think it is possible if there is flexibility on both sides," he says.

Francis Rocard, the head of solar system programs at the French Space Agency, CNES, says "ESA is pushing very hard" to keep the 2018 launch date. "We know that we are late in respect to the overall schedule, but we will do our best to comply," Rocard adds.

Walter Cugno, the ExoMars project manager at Thales Alenia Space in Italy, said that if there is a funding gap, "in the end, it is only a small gap comparing to what this project costs, so I don't believe that because of it, we will not complete the program."

Development of ExoMars, which includes an aeroshell, lander and rover, is spread across several locations in Europe, plus the U.K. and Russia, where NPO Lavochkin is building the lander. The components are scheduled to be delivered to the Thales Alenia Space facility in Cannes, France, where engineers and technicians will assemble them for launch. In May, ESA approved the ExoMars design (about six months behind the original schedule) after resolving an array of technical issues. This cleared the way for construction to begin with existing funds.

ESA says it has enough money to keep the work going until December 2016, when European ministers responsible for space budgets are scheduled to meet to consider a wide range of topics, including funding to complete ExoMars in time for its 2018 launch. It is unusual to have costs unsettled so late in a development program.

The financial uncertainly is a backdrop to a tight schedule that has included a multitude of engineering challenges, from testing a supersonic parachute and the rocket-propelled landing system to choosing a safe but promising landing site on Mars.

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Schiaparelli, the ExoMars entry, descent and landing demonstrator module (foreground) is shown next to the Trace Gas Orbiter. A possible funding shortfall is threatening EoxMars' 2018 launch date.

Engine integration key in France's futuristic airliner project

ONERA

Researchers in France are studying four possible configurations for the NextGen ONERA Versatile Aircraft, including a design with engines mounted in the rear fuselage.

Researchers at ONERA, France's national aerospace lab, are addressing one of the great challenges of jet engine/airframe integration as they work to prepare one of four possible configurations of their futuristic airliner for wind-tunnel tests in 2017.

The goal for the NextGen ONERA Versatile Aircraft, or NOVA, will be to burn 20 percent less fuel than the Airbus A320neo, one of the most fuel-efficient aircraft in its class. To achieve that goal, researchers at ONERA must accommodate a much larger engine with an ultra-high bypass ratio. Such an engine will be more fuel efficient than today's engines, because an enormous portion of the air cleaved by its front fan will bypass its combustion core. NOVA's engine will have a bypass ratio of about 16:1, or nearly 50 percent higher than that of CFM International's LEAP engines, which power the A320neo and will power the forthcoming Boeing 737 MAX.

The engine's front fan must be huge to produce such a high bypass ratio. NOVA's fuselage has been designed to create lift, but an engine the size of an ultra-bypass ratio engine creates lots of drag. Integrating the two is a design challenge, and engineers are looking at various options. Placing large engines under the wing would mean having to design a very tall undercarriage to maintain a safe distance between the engines and ground. Placing them at the rear of the fuselage would, because of their size, create a major problem of drag.

The designers chose to make the first configuration for wind-tunnel testing with engines under the wings. To ensure ground clearance, they have settled in a gull-wing configuration, a design that first flew in 1928 on the Polish PZL P.1 fighter. Today, the Russian Beriev B-12 seaplane also has gull wings.

Researchers also plan to test a second configuration in which the engines will be mounted in the rear fuselage. Other concepts that will be tested are a high aspect-ratio wing — a wing with a long span, like a high performance glider — with winglets that point down instead of up and a V-tail, rather than the more conventional T-tail, with engines integrated into the rear of the fuselage.

NOVA's lifting fuselage will deliver an aerodynamic efficiency gain of up to 5 percent over current types, the researchers predict, but this comes at a cost. The air flowing over the lifting fuselage flows straight into the engine at an uneven speed. This reduces engine performance because most engines cannot work efficiently with distorted air flow — what scientists call the boundary layer ingestion phenomenon. ONERA researchers are investigating ways to smooth the airflow around the lifting fuselage. They are also working on an engine-inlet that would create a more constant airflow and engine blades to better cope with distorted air flow.

Ludovic Wiart, a NOVA design engineer, says because its fuselage and the wings both provide lift, it's difficult to measure the lift/drag for specific parts of the aircraft in wind tunnels built for conventional airliner designs. So researchers are looking for new ways of measuring individual performance of these components.

"You cannot with conventional methods of measurement say what is the drag and what is the thrust" with the NOVA, Wiart says, because the air flowing over the fuselage will spill over to the closely-mounted engines. "You have to find a way to decouple them."

Wiart estimates half of the jetliner's 20 percent improvement in fuel efficiency will come from the engine design. The other half, he says, will result from aerodynamic improvements and better boundary-layer ingestion design.

NOVA will be designed to carry 180 passengers 3,000 nautical miles at the same speeds as today's airliners. If Airbus, ATR, Dassault and other airframe manufacturers were to adopt any of the design concepts, the jetliner could enter service in 2030.

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Lighter, more conductive power cables on the horizon

Leaders of a European research program plan to present findings at a meeting in Brussels next year describing their examination of methods for mixing carbon nanotubes — cylinders of carbon atoms — with copper to create lighter, more conductive power cables for aircraft and spacecraft.

Large aircraft can carry over two tons of copper power cables. Using lighter alternatives would dramatically extend aircraft range, increase payload and reduce carbon emissions. Satellites would be lighter at launch and could carry more stationkeeping fuel to stay in their proper orbits longer.

The 5.5 million euro UltraWire research project, which was started in 2013, includes 3.3 million euros ($3.8 million) from the European Commission and 1.7 million euros ($1.9 million) from industry. Researchers are examining how best to mix carbon nanotubes with copper in different configurations to create lighter power cables that also would carry more electric current than those in use today. For the moment, the researchers are giving no clues about the results of the program, because there are several patent and competitive issues that must be addressed before the results are announced in September 2016.

Researchers are also studying production processes that would be scalable to large volume manufacture.

UltraWire is the largest research project among various efforts in Europe, North America and China. Researchers are racing to develop the first industrial copper/carbon-nanotube products. Ultrawire inlcudes researchers from the U.K., Germany, Belgium, France, Poland and Finland.

The potential of the new compound was first proposed in June 2012 by Taysir Nayfeh, an associate professor at Cleveland State University in Ohio, and his research team. The team reported nanocarbon/copper wire with more than twice the conductivity of pure copper and with a potential to reach more than 100 times copper's conductivity.

A spool of pure carbon nanotube fibers. Combining nanotubes with copper could transmit much more current while reducing weight of power cables.

The Ohio researchers discovered the theoretical benefits; the UltraWire team is combing theoretical understanding with experimentation to try to overcome the practical difficulties of industrializing the process.

"The number one challenge is mixing copper and nanocarbon," says Krzysztof Koziol, a materials scientist at Cambridge University in the U.K. and the UltraWire project coordinator. "They are not easy to mix because of the significant absence of surface interactions between them. The second hurdle is to achieve improvements in electrical and thermal conductivity without impacting the structural integrity of the material."

Parallel research at Rice University in Houston has shown that although individual nanotubes can transmit nearly 1,000 times more current than copper, nanotubes fail before this capacity can be reached when mixed with other materials.

According to industry and academic experts, it is likely to be at least 10 years before an aerospace-standard power cable made of the new compound takes to the skies in an operational aircraft. Aerospace engineers are not the only ones interested in this work. Cable manufacturers, power generators, automotive manufacturers and others involved in power transmission are investing heavily. In the U.S., nanocarbon/metal companies are springing up around universities in Boston and Houston, all vying to be some of the first manufacturers to produce lighter current-carrying cables.

"Both copper and aluminium have serious disadvantages which offer big opportunities for new materials," says Bojan Boskovic, director of Cambridge Nanomaterials Technology Ltd. of the U.K. and the UltraWire exploitation and dissemination manager. Copper is a better conductor than aluminium but aluminium is much lighter."

A global consortium of industry and academic experts, the Nano-Carbon Enhanced Materials group, has been formed to look at the industrial potential of research from around the world and will meet in Houston in November to discuss results of nanocarbon copper composite research in the U.S.

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Japan said to eye maritime patrol exports

Observers in the U.K. expect that before the end of the year the Ministry of Defence will announce a plan to procure maritime patrol aircraft from abroad, a development that would put the U.K. on a course to restart maritime patrols that it ceased in 2011 and, perhaps more significantly, signal a major turning point for Japan's defense industry.

If all goes as experts in the U.K. expect, Kawasaki, the Kobe, Japan, supplier of the P-1 maritime patrol planes flown by the Japan Maritime Self-Defense Force, could vie for the U.K. export contract against likely competitor Boeing, manufacturer of the U.S. Navy's P-8 Poseidon jets. The participation by Kawasaki would mark Japan's boldest move yet to gain a foothold in the global military aerospace market. It was only in April 2014 that Japan lifted its post-World War II ban on exporting defense equipment.

How would the Japanese submarine hunter fare against the P-8? At least one British expert says the P-1 would do quite well.

Kawasaki

"In terms of technical specifications at the top end of the performance range, the P-1 is at least the equivalent of the Boeing P-8," says Douglas Barrie, senior fellow for military aerospace at the U.K.'s Institute for Strategic Studies.

The U.K. has imported all of its large aircraft for decades. The ministry of defense is waiting for the results of its defense review, scheduled for the final three months of 2015, before saying whether it will consider the P-1 in any maritime patrol bid. The review itself is not expected to start before the end of November, according to a defense ministry source.

For the U.K., the competition would mark a dramatic turnaround from 2010, when the country reviewed its military posture and announced an austerity plan that included retiring its MR2 Nimrod planes and ending a program to convert them into a new version called the MRA4. The U.K. is unlikely to develop its own plane, as it would cost far more than buying from abroad.

Boeing

Boeing used the 737-800 as the foundation for the U.S. Navy's P-8 Poseidon. So far, India is the only other customer for the maritime surveillance aircraft.

Other Japanese military exports are in the works too. Three months after lifting the export ban, Japan's National Security Council approved a collaborative deal between Mitsubishi Electric and European missile maker MBDA to develop a medium-range air-to-air missile for the F-35 Joint Strike Fighter. Mitsubishi is providing active, electronically scanned array technology of a type developed for the AAM-4B air-to-air missile for customers of the F-15s.

In addition, at the Aero India air show in Bengaluru in February, there were numerous press reports of an impending order from the Indian government for 12 US-2 amphibious aircraft made by ShinMaywa Industries, Ltd., of Takarazuka, Japan. As of early October, the deal had not been announced.

For the U.K., restarting the maritime patrol program would be a high-profile decision, one that the country might may be reluctant to chance

Japan's P-1 maritime patrol aircraft is a potential contender for an export contract from the U.K. Ministry of Defense.

with a brand new foreign partner such as Japan. The U.K.'s Royal Air Force has already bought three American RC-135W Rivet Joint electronic surveillance aircraft based on the C-135 airframe and flies Boeing C-17s and Lockheed Martin C-130Js. The British government might be especially skittish about taking a chance on a new partner after the controversy over the Nimrod MRA4, the planned successor to the MR2, which was nine years behind schedule and £789 million (about $1.2 billion) over budget when it was canceled in 2010.

"The decision-making process is probably going to err on the side of caution and the government will want to minimize any associated risk," says Barrie, "which would tend to make the Japanese case more difficult."

More difficult, perhaps, but not impossible.

Two years ago, the U.K. government signed a Defense Equipment Cooperation Framework and an Information Security Agreement with Japan to enable joint research, development and production of defense equipment, aimed at bringing the defense industries of both countries closer together.

There could also be other reasons for the British to buy Japanese. Whereas the P-8 is built on the Boeing 737-800 airframe, with 737-900 wings, the P-1's airframe was built specifically for it. Beyond that, the outcome of any competition between the two could be decided by the effectiveness of the submarine-detection equipment, the mission-control system and the radars as much as by the endurance performance of the airframe and engines — details Kawasaki has yet to reveal.

Evidence suggests that the marketing campaign has already started. The Japanese Maritime Self-Defense Force flew two P-1s to the Royal International Air Tattoo at Royal Air Force Fairford in July 2015, displaying some of the agile qualities of the aircraft.

"Japan will also probably be looking at the U.S. as a market for military aerospace exports, especially given how much U.S. defense equipment is bought by Japan," Barrie says. "But it's likely that Japan will be taking fairly cautious steps into the export market and only deal with countries they feel really comfortable with."

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After Luca Parmitano's near drowning during a 2013 spacewalk, NASA demonstrated how the helmet worn by the Italian astronaut accumulated water.

NASA video clip

21st century spacesuits

Five decades ago, the first spacewalks thrilled the public and nearly killed two pioneers of extra vehicular activities. NASA's spacesuits today are much improved but they are in short supply and challenging to maintain. Three-time spacewalker Tom Jones examines how next-generation suits can meet the challenges of lunar, asteroid and Mars exploration.

Luca Parmitano, an Italian astronaut working at the International Space Station in 2013, was 45 minutes into his second extravehicular activity when he felt cold water pooling, weightless, at the back of his communications cap. Flight controllers at first assumed that the water was merely a nuisance leak from a drinking valve inside his helmet. They were unaware that the glob was creeping steadily toward Parmitano's face. Realizing the water had to be coming from the suit's life-support system, controllers ordered Parmitano and his spacewalking partner, U.S. astronaut Chris Cassidy, to go back to the airlock.

It was nearly too late.

"The water came over my head, it reached over my eyes, and it covered my eyes and my nose," Parmitano recalled in a June talk at Rice University in Houston, according to a video recording. "In one instant and one motion, I was sensorially isolated, upside down, with no light and no communications."

Breathing through his mouth, Parmitano jerked his head from side to side but couldn't shake the water from his face. Only Parmitano 's coolness during the emergency and assistance from his crew mates saved him. Parmitano managed to enter the airlock, followed by Cassidy, who quickly secured the outer hatch behind them. Immediately, their crew mates inside repressurized the chamber and scrambled into the airlock to remove Parmitano's helmet and mop the water from his face.

NASA investigators determined that water entered the helmet ventilation duct from a backpack water separator that was clogged by mineral impurities in the ISS water used to supply the suit.

Parmitano's NASA spacesuit, called an extravehicular mobility unit, or EMU, was the same kind that I wore during three spacewalks at the ISS and it is still used on the space station. Compared to the Apollo suits worn on the moon, the EMU has more flexible joints and gloves and a higher-capacity cooling system. Yet, as Parmitano's experience shows, today's spacesuits are showing the effects of being based in orbit, far from their shuttle-era home in Johnson Space Center in Houston. NASA is grappling with how to maintain these EMUs even as it invests for the long term in an entirely new suit.

Old suits, new missions

The EMU was not designed to be maintained in space for long periods. After each space shuttle mission, the suits were returned to Houston for inspection and overhaul in a clean room. But with the shuttle now retired, NASA has only limited ability to return cargo from the ISS, which means the suits must stay on-orbit for years on end. Astronauts do their best to maintain the suits, but the station lacks a clean room and all the spares and tools needed for rigorous upkeep.

Water contamination — leading to corrosion, clogging, and component failure — is among the challenges facing NASA's EVA managers. Maintenance is also constrained by the tight EMU parts supply chain. Months are required to return a suit via a Dragon cargo flight, overhaul it in Houston and launch it back to ISS. NASA currently has four EMU hard upper torsos with four Primary Life Support Systems at the ISS. Four EMUs are kept ready there for spacewalks. One spacesuit was destroyed in June's Falcon 9-Dragon launch failure.

NASA

Astronauts Stan Love and Stephen Bowen assess the Modified Advanced Crew Escape Suit for mobility, dexterity and tool handling in the Neutral Buoyancy Lab at Johnson Space Center.

A better space suit

NASA has started technology work to develop the spacesuits it will need for missions to the moon, an asteroid or Mars. At Johnson Space Center, two efforts are underway to demonstrate the improvements needed in a next-generation suit. The first effort is aimed at producing a prototype suit designed to function in the free fall environment of deep space and in low gravity environments like the surfaces of asteroids or the Martian moons. Some features of this suit could later be adapted to work on planetary surfaces.

In August, Oceaneering Space Systems, a Houston deep-sea technologies firm that has long manufactured spacewalking hardware for NASA, completed a pressure garment (the airtight portion of a spacesuit) called the Prototype eXploration Spacesuit, or PXS. The PXS was made in partnership with ILC Dover, the David Clark Co. of Worcester, Massachusetts, and several other manufacturers.

The PXS's flexible upper torso with rigid sizing frame can be adjusted to fit a broader spectrum of astronaut body sizes. Some astronauts cannot serve on ISS crews because the current EMU sizes cannot fit them. The resizing capability also means that fewer suits may be needed at the station or on deep space mis-

NASA

Technicians at NASA's Johnson Space Center in Houston test the spacesuits that will be used aboard the Orion for deep-space missions. The suits are a closed-loop version of those worn by space shuttle astronauts.

Close calls for spacewalkers

1965 Cosmonaut Alexei Leonov could have died on history's first spacewalk when his stiff suit nearly prevented him from getting back into the spacecraft's airlock. Leonov was only able to squeeze in by bleeding down his suit pressure to dangerously low levels.

1966 Gemini 9-pilot Gene Cernan became dangerously overheated during the second U.S. spacewalk. Cernan's suit cooling system was overwhelmed by his struggle to maneuver his stiff, inflated suit in free-fall conditions. With few handholds and blinded by sweat and a fogged visor, Cernan groped his way to the Gemini cabin. His heart rate soared to 180 beats per minute. At the limit of his endurance, he managed to jam himself in, but couldn't seal the hatch. His commander, Tom Stafford, levered it shut and saved Cernan's life. Cernan lost 4 pounds during his 2-hour, seven-minute EVA spacewalk.

2013 Luca Parmitano, a European Space Agency astronaut, managed to get back to the International Space Station's airlock after a glob of water covered his eyes and nose. "Because of capillarity, [the water] went inside my nose — completely plugged my nose. It also got inside my ears," Parmitano recalled in a June talk. Parmitano's spacewalking partner, U.S. astronaut Chris Cassidy, peered inside Parmitano's helmet and saw on his head what "looked like half of a grapefruit-sized blob of water, kind of jiggling like a bowl of Jell-O." Parmitano was stoic about the real possibility of drowning. "It was fairly uncomfortable to have that water standing in front of your face," he said. Parmitano pictured "an Italian newspaper headline declaring, 'Italian Astronaut Drowns in Space.'"

sions, reducing stowage and supply chain demands.

Such a free-fall suit won't be ready by 2025, when an Orion capsule is scheduled to carry astronauts to a piece of an asteroid in NASA's Asteroid Redirect Mission. Therefore, NASA plans to use an upgrade of the shuttle's launch-and-entry suit, called MACES for the Modified Advanced Crew Escape Suit. MACES will be equipped with the EMU's gloves and an advanced life support system backpack.

"By giving the astronaut a super-snug fit in the MACES, we've shown it can give crews adequate dexterity for the ARM EVA tasks," says Steve Stich, director of exploration integration and science at Johnson Space Center. ARM astronauts will perform two EVAs with this suit as they examine and sample a boulder retrieved robotically from a near-Earth asteroid.

Last year, astronauts tested MACES suits under water in the Neutral Buoyancy Laboratory at Johnson, running up to four hours of simulated asteroid EVA jobs, such as sample retrieval and moving around a boulder's surface.

In a parallel effort, a Johnson-industry team, including ILC, is developing the Z-2 suit prototype pressure garment, aimed at testing mobility technologies for planetary surface work, such as on the moon or Mars. The Z-2 also adjusts to different-sized crew members but features a hard upper torso.

"We need to start down-selecting the best features offered by these two suits to build one down the road that we'll fly," Stich says. Stich has an annual budget of just over $30 million to maintain the current EMUs and develop its successor, but an operational suit is still years away. Stich says his team is eager to fly its follow-on design at the ISS, working out its operational kinks in low Earth orbit before it must perform at lunar distance and beyond.

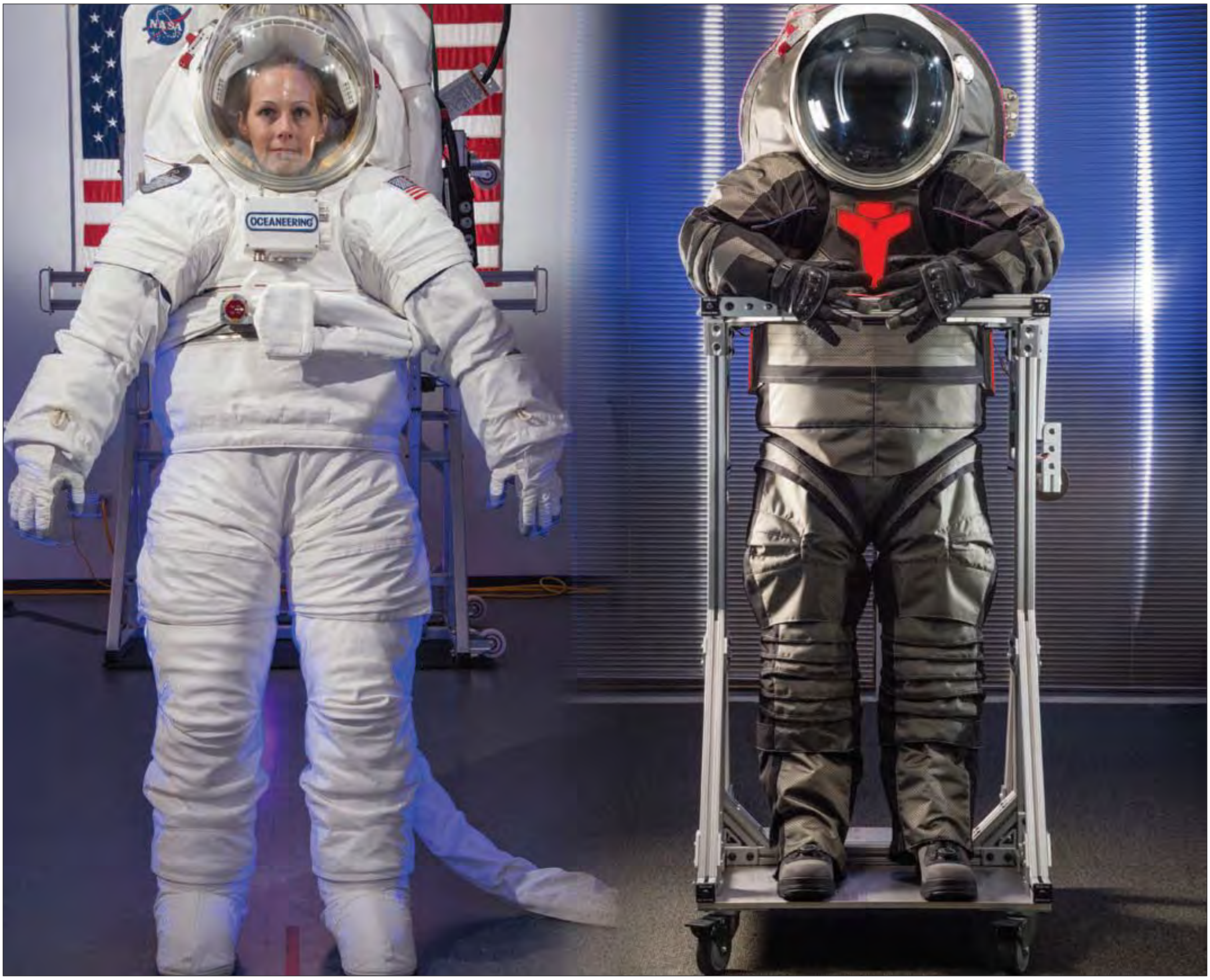
Seven areas of innovation

The technologies NASA will evaluate in trials of both suits include:

•Advanced Heat Rejection: Keeping a working astronaut cool on an EVA is the job of a new Spacesuit Water Membrane Evaporator. The current EMU relies on a device called an ice bed sublimator. Warm water from the astronaut's cooling loop runs through an ice bed formed in a porous metal block. The ice sublimates into the vacuum outside, taking heat from the cooling loop with it, but the porous block can become clogged by contaminants. The new system circulates body-warmed water to the evaporator, which vaporizes water into the vacuum outside, carrying the heat into space. The membrane evaporator promises to be less vulnerable to water contamination than the sublimator.

•Improved Backpack Maintenance: Astronauts have replaced the fan/pump/separator units — Parmitano's nemesis — as well as gas and water filters, and emergency oxygen tank assemblies of the EMUs aboard the ISS. Making future backpack systems easier to inspect, remove, upgrade, and repair is critical for long expeditions into deep space or on Mars.

•Modern Avionics: On my EMU, I pushed and pulled a cable to select the correct pressurization setting, and used a stovetop-style knob to control temperature. The 1970s-vintage fault-detection computer, displays, and mechanical control linkages on the EMUs will be upgraded to digital electronics for suit monitoring and control.



NASA Johnson Space Center

NASA's two spacesuit prototypes are the Prototype eXploration Suit, left, meant for use in free fall and low gravity, and the Z-2, which is testing mobility technology for surface exploration on the moon or Mars.

•Regenerable CO2 Removal: The current EMU uses metal-oxide cartridges to remove CO2 from the suit atmosphere, but these cartridges must be replaced and renewed inside the ISS. These might be replaced by a chemical-bed scrubber containing organic nitrogen compounds, called amines, to remove CO2 and water vapor. The scrubber would then vent these gases overboard during a heating cycle. The amine bed-system would operate continuously and eliminate the need for cartridge replacement.

•Simplified Suit Donning: A rear-entry hatch under the backpack, as on the Russian Orlan suit, would enable an astronaut to slip easily inside, considerably reducing the time needed to don the spacesuit. Rear-entry suits might also be designed to attach to a suit port outside a vehicle, simplifying EVA operations from a surface habitat or rover where dust is a concern.

•Thermal Protection: On Mars, the thin atmosphere (about 0.5 percent Earth surface pressure) can still conduct heat between the suit's outer insulation layer and the interior, and vice versa. Better thermal insulation systems will be needed to protect astronauts from temperature extremes.

•Higher Operating Pressure: A higher suit pressure would reduce the time astronauts must spend breathing oxygen before an EVA to reduce risk of decompression sickness, also known as the bends. The EMU operates at 4.3 pounds per square inch and the Russian Orlan at 5.7 psi; engineers would like a future suit to function at up to 8 psi. The design challenge is to keep the suit's limb joints and glove fingers flexible enough at these higher pressures to preserve dexterity and reduce fatigue.

NASA is gathering testing data from life-support and astronaut trials in the new suits. The agency is particularly interested in an astronaut's dexterity and ability to work in the suit, as worn on treadmills, in vacuum, thermal chambers and simulated free fall. If NASA's technology efforts succeed, the well-dressed astronaut's wardrobe will include a new EVA suit sometime in the mid 2020s.

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Powering fighter jets of the future

For the U.S. Air Force, fuel efficiency for its fastest warplanes has never been a top priority. Range can be extended with aerial refueling, and guzzling fuel is a small concern when dodging surface-to-air missiles, racing to secure hostile airspace or making bombing runs. These days, however, fuel costs are no longer an afterthought. The Air Force is searching for a military engine with dramatically better fuel burn, one that won't sacrifice performance and perhaps will even provide more thrust. Keith Button spoke to the engineers at the Air Force Research Laboratory, General Electric and Pratt & Whitney who have taken up that challenge.

The Air Force has set bold goals for the jet engines that will power its fighter planes possibly as soon as a decade from now. The service wants a 25 percent boost in fuel efficiency and a 10 percent increase in thrust.

For eight years, General Electric and Pratt & Whitney have been developing plans for components of these future engines, and an even more ambitious phase of work is anticipated to begin next year under the management of the Air Force Research Laboratory in Ohio. The lab issued a request for proposals in June for this Adaptive Engine Transition Program, which bidders expect to begin in the second half of 2016. The winners will carry out full-engine tests to prove they can meet goals for fuel-efficiency, thrust, flight weight, durability, reliability, maintenance and affordability.

If the adaptive engine research succeeds, the rewards could be enormous for the Air Force as well as for naval aviators. The Air Force has been laying the technical groundwork for development of its next fighter under a program called F-X, and the Navy has been researching a Next Generation Air Dominance plane to replace the F/A-18. If these planes were to burn 25 percent less fuel, that would equate to a 30 percent increase in combat radius, says Matt Meininger, manager of the current effort, called the Adaptive Engine Technology Development program. Greater range would mean less aerial refueling, which costs 10 times more than filling up on the tarmac. All told, the Air Force could burn a billion gallons less fuel between 2023 and 2040, Meininger says.

The Air Force and its contractors know basically how this might be done. The word adaptive in the program refers to an engine that can alternate from high-thrust mode, when more power is demanded, to high-efficiency mode, when more range is key.

This adaptive cycle would be a revolutionary change. A conventional engine generates most of its thrust from the high-speed jet of exhaust gases originating in the combustor in the core of the engine. This core generates enormous thrust, but it guzzles fuel. Some additional thrust is contributed by a fan at the front of the engine. This thrust is weaker but it is generated more efficiently.

Today's engines don't fully utilize those trade-offs because these air streams are fixed, relative to each other.

"We have a point in our flight profile that is the most stressing, where I have to have propulsion per-

GE Aviation

General Electric's Adaptive Versatile Engine Technology demonstrator, or Advent, achieved the highest temperature ever recorded inside a jet engine, the company reported in 2014. Advent tested heat-resistant ceramic-matrix composites. The white object on the right side, called a bell mouth, directed air into the engine, that has since been disassembled.

form. I design my engine to be able to accommodate that most stressing, or that most critical, design point," says Jimmy Kenyon, Pratt & Whitney's director of advanced programs and technology.

The contractors in the new phase will be designing competitive versions of an engine that makes more use of the core when maximum power is required and greater use of the fan when efficiency is paramount. A second goal is to make the core operate safely at higher pressures, which means higher temperatures. At the higher temperatures, more of the heat energy can be converted to thrust, improving thermal efficiency. Each innovation — shifting the streams and running the core hotter — are expected to contribute about half of the 25 percent fuel efficiency gain.

Managing air streams

If one could stand in front of a conventional engine and see the streams of air, the air pushed into the turbine and combustor would be at the center of the circle, while the air that bypasses the core would be in a ring around that center. In an adaptive-cycle engine, there is a third stream of air in a ring on the outside. One way to create this third stream could be to surround the fan hub with a series of blades — a FLADE, or fan-on-blade, design — to push air into a third stream. But exactly how the new engine will create the third stream and shift air among the streams, according to the Air Force, is "unique and highly controlled" information.

What is known is that when more air is kept in the bypass stream, fuel efficiency goes up. Channeling more air into the core stream decreases fuel efficiency but maximizes thrust.

More specifically, an adaptive-cycle engine varies the two propulsion parameters that have the greatest effect on thrust and fuel consumption. One is the bypass ratio. A higher bypass ratio means a greater portion of the air bypasses the less efficient core. The other is called the fan-pressure ratio. It describes the discharge pressure relative to fan inlet pressure. A higher pressure ratio means that the engine is using more air in its core. The new adaptive engine is expected to have a 50 percent higher pressure ratio across the compressor — the series of rotating blades that compress air for combustion. High-thrust flight translates to high pressure ratio and a low bypass ratio, with more air flow through the core and less through the fan. Both GE and Pratt & Whitney say their versions will generate 10 percent more thrust. In cruising conditions, the engine operates with a low pressure ratio and high bypass ratio to minimize fuel consumption.

In GE's adaptive engine design, the third stream — besides enhancing fuel efficiency by increasing the bypass ratio — provides a cool stream of air that can be channeled to specific areas of the engine and aircraft to absorb heat from the engine and aircraft, GE says. That could mean fewer hot fuel-induced flight restrictions that are imposed on current thermal management systems for engines on fighters like the F-35, says Dan McCormick, GE's general manager of adaptive cycle engine programs.

General Electric is drawing on the design of its higher-pressure-ratio LEAP engine for a proposed fuel-efficient, high-thrust engine for the U.S. Air Force's next fighter jet.

Improved core

The exit temperatures from the compressor in the new engine will be much higher, which is one of the technical hurdles that the engine designers are dealing with. Additional cooling materials are being developed for the hot section of the core — the combustor and the turbine.

For its version of the adaptive-cycle engine, GE has adapted the design of the high-pressure-ratio compressors used in the LEAP (Leading Edge Aviation Propulsion) engines that GE and Snecma of France are jointly developing for new airliners, including the Airbus A320neo, Boeing 737 MAX and China's COMAC C919. The compressor has fewer than 10 stages, but a higher compression ratio than current military engines.

"The system required to cool the vehicle systems is complex but it's going to be complex no matter what," McCormick says. "When you consider you're flying around at mid-Mach with some kind of big energy draw, where all the electronics have to be kept at 70 degrees [Fahrenheit] and the inlet temperature is 270 degrees, that's a thermal problem of some significance and we've been doing a lot of work on that."

The next generation of combat planes, unlike legacy aircraft, will have highly integrated systems that are designed at the same time, McCormick says. The traditional federated approach of designing an airframe and engine separately won't work.

A key requirement will be "a better understanding of how to put a propulsion system on an airplane and have that propulsion system be very highly integrated," he says. "From a power system and thermal management system standpoint, all of these things are going to have to be much more integrated with the propulsion system than they have been in the past."

Among the new technologies GE is using are ceramic-matrix composite materials, which weigh less than half of nickel-based materials for fan blades and some static parts. GE is also using additive manufacturing, the industrial version of 3D printing, to rapidly make and test prototype parts on the engine.

With a previous effort dating back to 2007, called the Adaptive Versatile Engine Technology program, GE developed a three-stream adaptive-cycle engine.

Under the Air Force's current program started in 2012, the Adaptive Engine Technology Development program, GE and Pratt & Whitney were contracted to further develop the adaptive engine technology. Both contractors are working independently — there is no sharing of information. GE had its preliminary design review in March and Pratt & Whitney held its in April. Each contractor gave briefings consisting of their analysis, test data, drawings and hardware to representatives of the Air Force, the Navy, NASA and Lockheed Martin. By the end of 2016, the contractors will perform rig tests of the adaptive engine's fan and the high-pressure core.

The core engine includes the high-pressure spool — the compressor, the combustor and the turbine. Wrapped around the core is the low-pressure spool, which consists of the adaptive fan on the front, a low-pressure turbine that drives the fan at the back, and an exhaust system.

GE's compressor and fan rig tests will be performed at the Air Force Research Lab at Wright-Patterson Air Force Base in Ohio. Its core test will be done at GE's Evendale, Ohio, plant. Pratt & Whitney's testing will be at the Air Force's Arnold Engineering Development Center at Arnold Air Force Base, Tennessee.

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Close encounters of the drone kind

The FAA, aircraft manufacturers and engine builders have a good sense of what can happen when birds strike airliners, and modern planes are built to be resilient to such damage. Experts are less sure about risks posed by the growing legions of drones. Michael Peck spoke to researchers who are trying to answer that question.

by Michael Peck
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When a 4-meter-long Shadow drone tore into a C-130 cargo plane in Afghanistan in 2011, online photos of the damage stirred lots of commentary about the risks drones might someday pose to airliners in civilian skies. The Shadow tore a ragged hole in the leading edge of the military plane's left wing. The C-130 landed safely at Bagram Airfield, but the photos published by the sUAS News website made it easy to wonder whether airliners, which store fuel in their wings, would be so lucky.

Photo illustration by Jane Fitzgerald

The answer is that no one knows for sure. The FAA requires tests to ensure that airliners can land safely after striking foreign objects, especially birds and ice. The FAA says it will be conducting tests beginning next year to assess the effects of unmanned aircraft hitting commercial aircraft or being ingested by their engines.

That question, largely an academic one in 2011, has taken on a new urgency with today's growing horde of hobbyist-controlled quadcopters soon to be joined by the first fleets of commercial cargo drones such as those planned by Amazon.

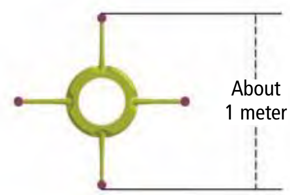
Until now, the FAA and researchers at NASA have handled the risk to airliners mostly by focusing on technologies for averting collisions. Sense-and-avoid technology is in development that would enable unmanned planes to detect and get out of the way of commercial aircraft. A different approach, called geofencing, is favored by Chinese drone manufacturer DJI in its popular Phantom line of small quadcopters. Software installed on the drone bars it from entering a specific GPS-defined zone, such as the area surrounding airports.

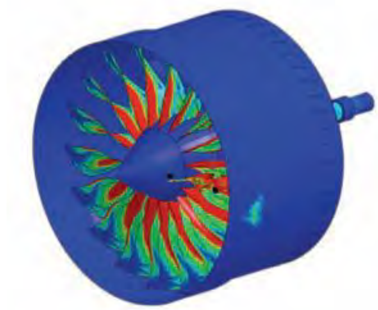
MODELING DRONE INGESTION

Researchers at Virginia Tech are using finite element modeling to predict the results of collisions between small drones and airliners. The sequence to the right models the effects on an engine with a titanium alloy casing. Researchers are now investigating composite casings.

1.5 milliseconds ....

A 5-kilogram quadcopter shown to scale with a jet engine.





The quadcopter impacts a fan blade on the right side of the engine; imbalance forces the blades into contact with the casing, creating stress indicated by the green.

Graphic: Modeling by Ph.D. students Yangkun Song and Kevin Schroeder of Virginia Tech's Crashworthiness for Aerospace Structures and Hybrids lab.

The damage to a C-130 transport plane after a collision with a Shadow drone in Afghanistan.

sUAS News

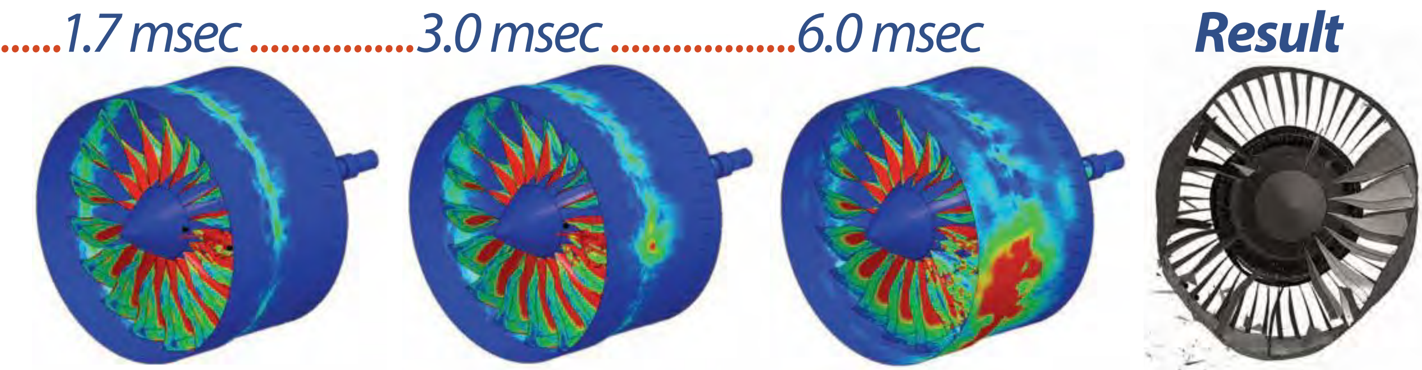
But what if all that technology fails — or if a bad actor decides to "jail break" the technology, aiming a drone or swarm of drones on a collision course with a passenger jet? Researchers are anxious to find out exactly how vulnerable planes might be.

When it comes to collisions, size matters. Most of the planes in the coming commercial drone revolution — a market that could soar to $1.9 billion by 2020, according to the firm MarketsandMarkets — are expected to be smaller than the 200-kilogram-class Shadow implicated in the 2011 collision. In July, for instance, a 5.9 kilogram quadcopter from the Australian company Flirtey made the first FAA-authorized, unmanned cargo flight by delivering 4.5 kilograms of medicine to rural Virginia. Airliners are not as rugged as military planes, and designers are beginning to incorporate new hybrid materials, which are combinations of metals and composites. This raises questions about whether those small drones might turn out to be just as potentially dangerous as the larger Shadow.

At Virginia Tech in Blacksburg, researchers are using finite-element-models of drones and aircraft to predict what could happen when small drones collide with airliners or are ingested by their engines. The models are eye opening. "If a drone hits a plane at takeoff, [the results] could be quite severe," says Javid Bayandor, director of Virginia Tech's CRASH Lab, short for Crashworthiness for Aerospace Structures and Hybrids. Bayandor founded the lab in 2012 to contribute to the design and certification of new aircraft and spacecraft through analysis.

In theory, this wave of drones shouldn't be a problem. To qualify as a model aircraft, and thus avoid the need for FAA certification, an unmanned aircraft must fly below 400 feet, stay at least 8 kilometers from an airport, and it cannot be flown for commercial purposes.

In reality, drones are sometimes flown commercially and hobby craft at times stray into airspace near airports because of technical malfunctions or pilot error. Today's quadcopters are typically flown by amateur enthusiasts with little training and no certification, unlike the case of the Shadow near



The remaining half of the quadcopter is ingested and is struck by a second blade; stress increases as parts of the blade hit the casing; loss of blade mass exacerbates the imbalance and stress.

Damage spreads to a third blade; the imbalance worsens; pieces of the drone are now impacting the casing.

The quadcopter is obliterated; three fan blades are catastrophically damaged; the remaining blades contact the casing; stress grows, shown in red, but the casing holds.

The titanium-alloy casing is significantly deformed.

Bagram Airfield, which presumably was flown by a well-trained soldier.

"Anyone can go on Amazon.com and buy a small quad or aircraft, and then decide they want to fly it near the airport," says Vince Pujalte, who heads the unmanned aircraft program at Embry-Riddle Aeronautical University in Prescott, Arizona. "The greatest concern should be on landing and takeoff."

There have been reports of numerous near-misses between small drones and manned aircraft. A Washington Post story in August detailed a dozen FAA-reported incidents — in a single day — of drones either flying too close to civilian and military planes, or too near airports.

Birds versus drones

Drones are often made of relatively soft materials compared to conventional planes, but they are not as soft as birds, which are notable for their delicate skeletons. Do-it-yourself websites show how to make drones out of plywood, fiberboard and only a bit of aluminum. Drones contain some heavier components, the densest and most potentially damaging parts being their battery packs and engines. Bayandor, for instance, is concerned that batteries could explode on impact. Masses of drones can be similar to birds: A quadcopter weighs about 1.4 kilograms, while the largest gull — the most common culprit in bird strikes, according to an FAA database — weighs about 1.8 kilograms. Canada geese are another threat, because they tend to gather and fly in flocks, and an individual specimen can weigh as much as 6 kilograms, according to the hunting and conservation website, ducks.org.

Birds are soft, but still a hazard. The Wright Brothers ran into a flock in 1905. The most famous recent incident was the US Airways "Miracle on the Hudson" case of 2009. Both engines on an Airbus A320 flamed out after ingesting geese at about 2,000 feet, forcing the pilot to make an emergency landing

A red-tailed hawk penetrated the wing of a Boeing 747 after the jet touched down at the Dallas/Fort Worth International Airport in February 2013.

Cathy Boyles, Dallas/Fort Worth International Airport on the river by Manhattan, miraculously without serious injuries or deaths. Another flight decades earlier did not end with a miracle. In 1960, an Eastern Airlines L-188 ran into a flock of 20,000 starlings over Boston Logan International Airport, damaging two of the four turboprop engines and causing a crash that killed 62 people.

Bird Strike Committee USA, an advocacy group for addressing the bird strike problem, estimates that birds cause more than $900 million a year in damage to U.S. civilian and military aircraft. Airports plagued by birds devote much effort to driving them away through a variety of methods, from clearing bird-friendly habitats near runways to using noisemakers or even shooting them.

"The biggest hazard [from birds] would be an impact that would result in the loss of multiple blades on a fan, so that the imbalance in the engine could make the airplane uncontrollable," says MIT aeronautics professor R. John Hansman, who did a probability analysis for the FAA on the risk of collisions between manned and unmanned aircraft.

To test civilian and military aircraft for survivability against bird strikes, manufacturers shoot birds at them.

"Did you ever have a Daisy BB gun?" asks Lockheed Martin's Steve Owens, an airframe certification engineer in Fort Worth who has conducted bird strike tests on aircraft such as the F-35 strike fighter. "We have a big Daisy BB gun, with a 4-inch diameter barrel. In place of your BB, you load up your anesthetized or recently deceased chicken."

A bird (Owens says it has to be a bird, and not a gelatin substitute, for a valid test) weighing about 2 kilograms is shot at a prescribed velocity at an aircraft on the ground. In the case of the F-35, tests showed that the preliminary canopy design needed to be changed to meet bird strike requirements. On the other hand, shooting chickens at the aircraft's vertical-lift fan inlet door showed that the door would remain intact, while the amount of bird remains falling into the lift fan was deemed acceptable.

The hard components inside drones could pose a special challenge. The battery for a Phantom 3 quadcopter weighs about .4 kilogram. That may not sound heavy, unless it happens to be in a quadcopter flying at 30 knots, which then hits an airliner landing at 180 knots, producing a potent punch of mass and velocity.

AP/Vasiliy Baziuk

A plane taking off from Canandaigua, New York, disturbs a flock of birds. According to a 2014 FAA report, wildlife strikes have killed more than 255 people and destroyed over 243 aircraft around the world between 1988 and 2013.

When birds and airplanes collide

Between 1990 and 2013, 138,257 strikes between wildlife (mainly birds) and civil aircraft were reported in the U.S., nearly 10 percent of which resulted in damage.

Aircraft components hit

	Number of cases	Percentage of total
1. Windshield	20,302	16 percent
2. Nose	17,654	14 percent
3. Wing/rotor	16,743	14 percent
4. Engine(s)	15,814	13 percent
5. Radome	15,415	13 percent

Aircraft components damaged

1. Engine(s)	4,321	29 percent
2. Wing/rotor	3,508	24 percent
3. Radome	1,433	10 percent
4. Other	1,156	8 percent
5. Windshield	926	6 percent

The identity of the bird species or species group is known in about half of the strikes.

Strikes by bird species

1. Mourning dove	6,124
2. American kestrel	3,593
3. Killdeer	3,369
4. European starling	3,348
5. Barn swallow	2,863

Source: FAA National Wildlife Strike Database Serial Report Number 20, July 2014

“Think of throwing the battery of the UAV at an airplane at 200 miles per hour,” says MIT’s Hansman. “What would happen if your car windshield was hit by a baseball at 200 miles per hour?”

A likely impact area would be the canopy or windshield. Other likely points are the forward-facing zones of the wings, engine inlets and empennage [tail] structure, according to Owens of Lockheed Martin. Commercial engines must pass FAA-mandated bird strike tests. Engine maker Pratt & Whitney, for example, said its commercial engines pass FAA-required impact and ingestion tests for birds, ice and hail.

For all the furor over drones, it’s actually birds that appear to be foremost on the minds of pilots.

“I can honestly say we take the threat of birds a lot more seriously,” says airline pilot and retired Air Force Lt. Col. John Varljen. The FAA has a panoply of regulations regarding bird strikes, including a requirement that aircraft be capable of safe flight and landing after colliding with a 3.6-kilogram bird, as well as mandating that windshields be able to withstand a 1.8-kilogram bird.

The regulations seem to be working.

“I’ve certainly hit birds,” Varljen says. “You may end up with a dent, but it’s generally no problem. Unless it’s a big bird like a turkey buzzard, the engine will generally eat it.”

Experts suspect that, barring an unlucky hit on a sensitive area like the cockpit, commercial aircraft are rugged enough to survive a collision with a small drone. Or if an engine is knocked out, a twin-engined aircraft could probably continue to fly on one engine.

“Most of the commercial airliners they would hit, it wouldn’t be a big deal,” Hansman says. “They would make a dent, but the aircraft would fly fine.”

But these analyses assume that the drone danger is inadvertent. What if terrorist groups strapped a couple of dynamite sticks to a quadcopter, or steered a flock of small drones into the path of an aircraft?

The U.S. Department of Homeland Security reportedly issued a warning to law enforcement agencies in August that terrorists might use unmanned aircraft to attack the U.S., although the bulletin reportedly made no specific mention of them being aimed at airliners.

AP/Matt Smith/Show Low Regional Airport

The pilot of an Ameriflight Beech C-99 cargo plane suffered facial lacerations and other minor injuries after his aircraft struck a bird on descent to Show Low Regional Airport in Arizona.

How hard would it be to maneuver a drone into the path of an airliner? Not very, says Pujalte of Embry-Riddle, who trained thousands of drone operators for the Army.

“In a few weeks, you absolutely could train somebody to do it,” he says. “All you have to do is go to the airport, get some distance away when the aircraft are on descent, park your car there on some perimeter road, and as soon as you see an aircraft approach, you launch one straight up.”

MIT’s Hansman isn’t so sure.

“How are you going to get the UAV in the right position? There is a 99 percent probability that if the UAV goes through the engine, it will just get chewed up and shot out the back. It’s not an efficient way to take down an airplane.”

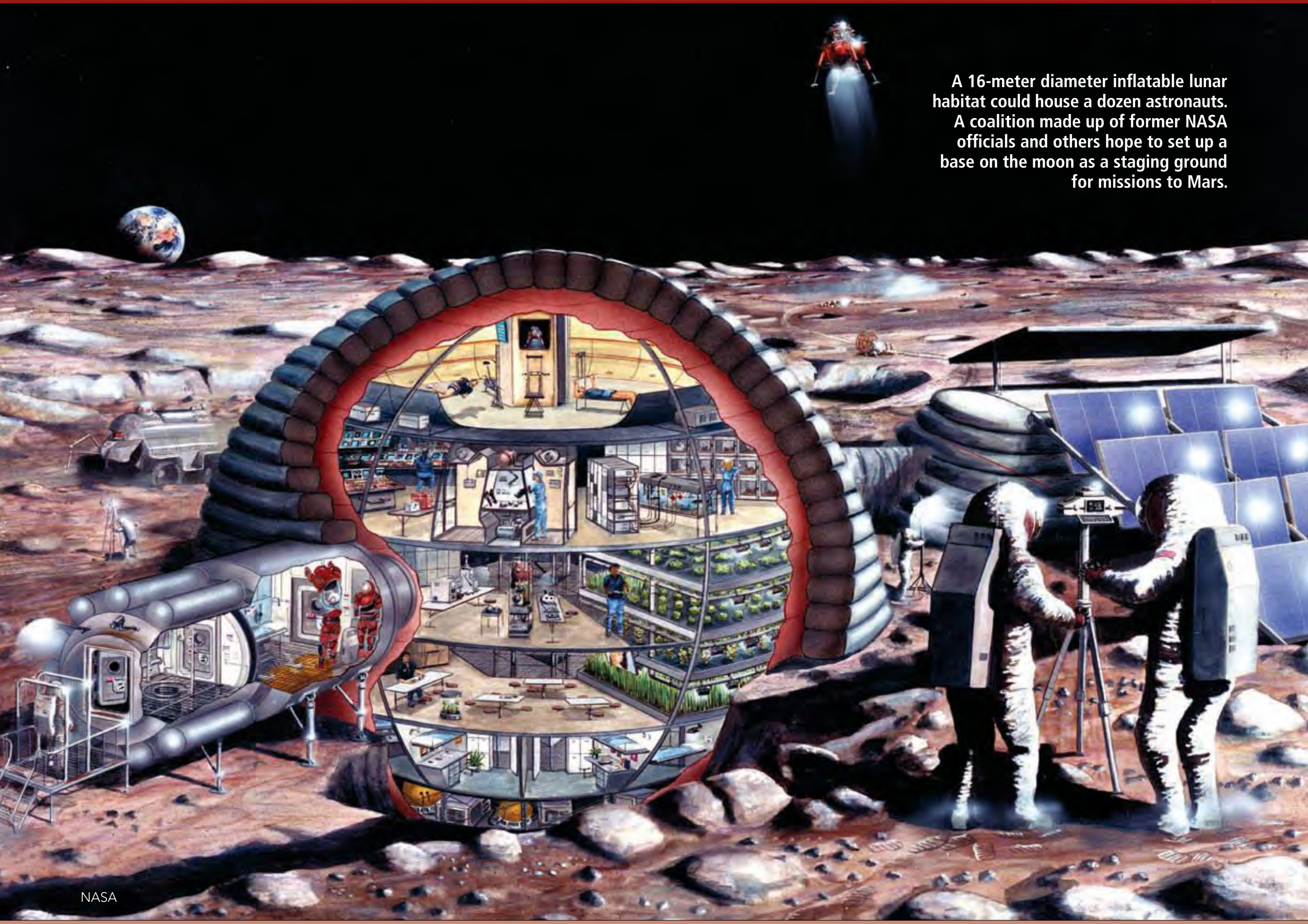
Actually, Hansman says, it’s the operators of another kind of aircraft who should worry.

“The aircraft that are more vulnerable than commercial aircraft are helicopters,” he says. “Helicopters tend to operate at those altitudes where UAVs fly, and the helicopter is very vulnerable in the tail rotor. If you were to take a hit in the tail rotor, you would probably lose control.”

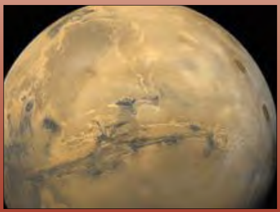
The question of a terror attack aside, experts say it seems more than likely that there will be a mid-air collision between a commercial aircraft and drone at some point. It is a test of strength that both would rather avoid. A

Ben Iannotta contributed to this article.

MARS via the MOON



A 16-meter diameter inflatable lunar habitat could house a dozen astronauts. A coalition made up of former NASA officials and others hope to set up a base on the moon as a staging ground for missions to Mars.



The 2016 U.S. presidential election is sure to be an opportunity to reconsider just about everything the government does. The Obama administration's Mars exploration strategy is no exception. Debra Werner spoke with the experts who want the next president to incorporate the moon into the country's Mars plan.

Standing before a crowd of about 700 people in Florida in 2012, then-presidential candidate Newt Gingrich made an unusual appeal for votes during the Republican primary. If he became president, Gingrich pledged, the United States would establish a permanent lunar base within eight years, paid for with government and private investment. He was largely echoing the previous Republican administration's call for a return to the moon no later than 2020 and a permanent outpost by 2024. But Gingrich's rivals lambasted the former House speaker as desperately out of touch:

"Ground Control to Major Newt: Nevada Needs Jobs, Not Moon Colony," was the title of a press release issued by the campaign of Mitt Romney, which put a $500 billion price tag on Gingrich's idea.

Yet despite the drubbing Gingrich took, backers of a moon base are not giving up. A coalition of former NASA managers and engineers hope one or more of the 2016 Republican or Democratic presidential candidates will adopt the idea of a privately owned moon base as a staging ground for missions to Mars. Development could be funded and managed by a NASA-led international group patterned after the European Organization for Nuclear Research, or CERN, the group that built the Large Hadron Collider for physics research.

If all goes as advocates hope, a crew of four private-sector astronauts would use robots to convert lunar ice into propellant and sell it to NASA. And it would cost a fraction of Romney's guesstimate: A July study paid for in part by a NASA grant concluded the new approach could have humans back on the moon in seven years at a cost of $10 billion spread among government and private sector partners. A permanent base could be established 10 years to 12 years later for an additional $30 billion.

The issue for the U.S. is whether it should stick with the Obama administration's moonless exploration plan once the

by Debra Werner
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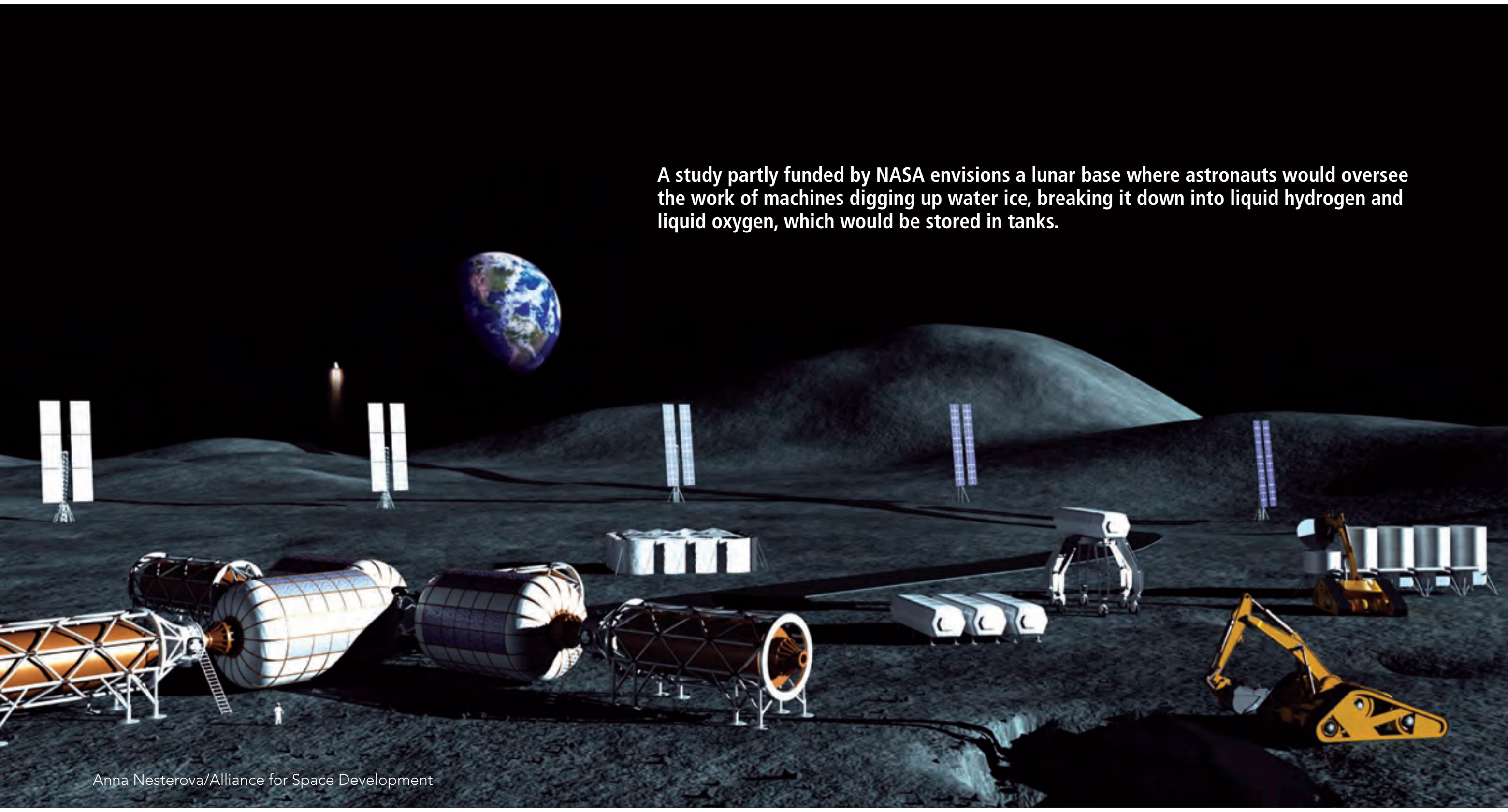
A study partly funded by NASA envisions a lunar base where astronauts would oversee the work of machines digging up water ice, breaking it down into liquid hydrogen and liquid oxygen, which would be stored in tanks.



Anna Nesterova/Alliance for Space Development

president leaves office in January 2017. The current strategy calls for sending humans to an asteroid in the 2020s, followed by Mars missions in the 2030s — all without ever touching the moon.

The next president could captivate the nation by proposing "an audacious, inspirational mission and do it within [NASA's] existing budget," says Charles Miller, a former NASA official and the informal spokesman for the lunar coalition. Miller says NASA would need to spend about $2.8 billion per year on the mission.

NASA seems to harbor no philosophical opposition to a moon base. Still, it's not embracing the idea too warmly, either. The Office of the Chief Technologist last year paid $100,000 to NexGen LLC of Arlington, Virginia, the five-person consulting firm where Miller is president, for a detailed evaluation of the lunar base concept.

Nonetheless, the agency cautioned against reading too much into NASA's intentions based on a single study grant.

"We hope this and our other grants provide new insight and innovative new ideas that help us advance our understanding of these processes as we advance our journey to Mars," a spokesman says.

NASA received the "Evolvable Lunar Architecture" report in July. Miller, the lead author, was NASA's senior advisor for commercial space from 2009 to 2012, when NASA's Commercial Orbital Transportation Services program took root with the privately owned capsules and rockets of Orbital Sciences and SpaceX.

"I knew this model, if properly applied, had significant implications beyond getting cargo and crew to the space station," Miller says. "I thought we should take a serious look at whether it could be used elsewhere."

Miller says he did not have time to evaluate the various previous proposals for a moon base until he won the $100,000 NASA grant in December 2014.

Under the proposal, robotic vehicles would travel to the lunar equator to test the new lunar lander and vehicle to return crew to Earth. In the second phase of the program, astronauts would travel to the lunar poles and set up mining and propellant production equipment. A spacecraft would transfer 200 metric tons of propellant a year to a depot positioned beyond the Earth and moon at the second Lagrange point, one of the places where a spacecraft can remain in orbit with little energy. Spacecraft bound for Mars would stop at this depot to take on propellant.

If any presidential candidates do consider this plan, they are likely to embrace it very quietly in light of Gingrich's experience.

"You won't hear much about it until Jan. 20, 2017," predicts Howard McCurdy, a space policy expert at American University in Washington, D.C., and a member of the review board that evaluated the report's conclusions.

Even if no one discusses the proposal publicly, the effort is important because the next administration is likely to take a fresh look at U.S. space exploration plans. In the past, that type of analysis often prompted NASA to change course. In 2010, for instance, President Barack Obama announced plans to cancel President George W. Bush's Constellation program aimed at sending astronauts to the moon and then Mars, opting instead to prepare crews to travel to an asteroid in preparation for Mars missions. Obama dismissed the notion of returning to the moon by saying, "We've been there before."

The been-there-done-that sentiment, however, may be waning.

"In general, there is a little bit of a drift back toward the idea of not just robotic but human lunar exploration," says Michael Lopez-Alegria, a former astronaut and former president of the Commercial Spaceflight Federation, a Washington-based industry association. "I'm glad to see this perceptible, not dramatic, but perceptible shift in the conversation."

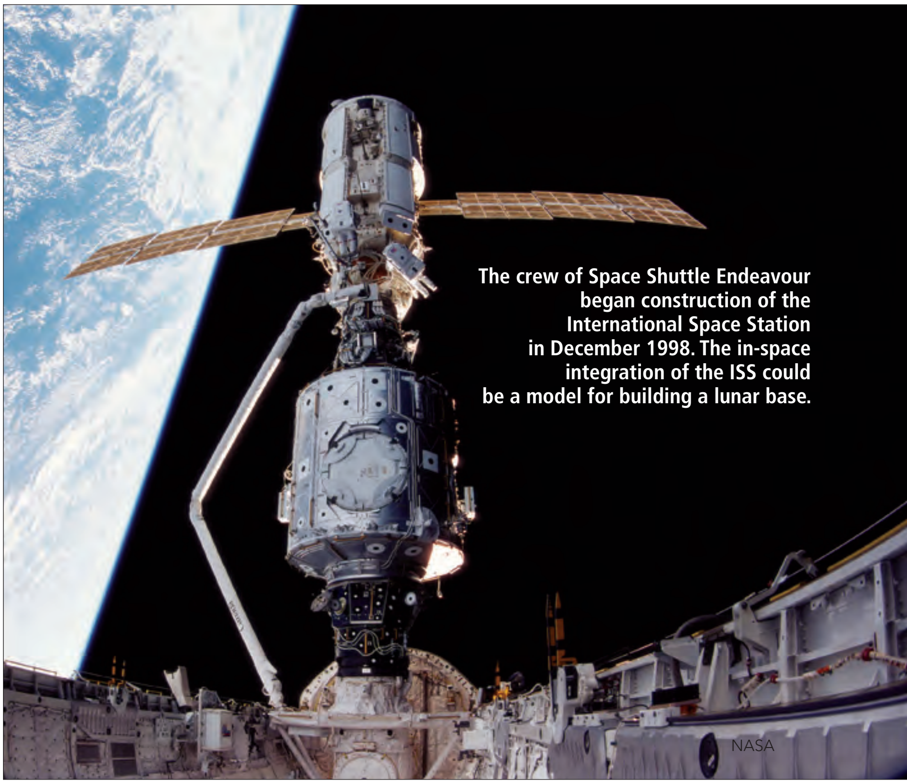
While that shift might be taking place in the U.S., elsewhere space agencies and commercial firms are forging ahead with robotic lunar missions of their own. Sixteen teams are competing in the $30 million Google Lunar XPRIZE competition, a race to land the first commercial robotic vehicle on the moon by the end of 2016. Meanwhile, India, Russia, China and Japan are building spacecraft to reach the moon. Johann-Dietrich Wörner, the European Space Agency's director general, is promoting the idea of nations joining forces to establish an international moon base, as distinct from the privately-owned base advocated in the July report.

"India, Russia, China, Japan, ESA all have interest in the moon more so than an asteroid" as a proving ground for technologies that would later be needed for missions to Mars, says Rob Kelso, a former manager of lunar commercial spacecraft at NASA's Johnson Space Center and one of the authors of the July report. "Using the moon as a place to do technology development and test systems to learn how to operate on Mars always made sense to me."

The report suggests that the U.S. try to marshal that global interest into an international partnership that would combine space agency expertise with private sector


NASA

The crew of Apollo 17 poses with a lunar roving vehicle trainer. Their mission in December 1972 was NASA's last moon mission.

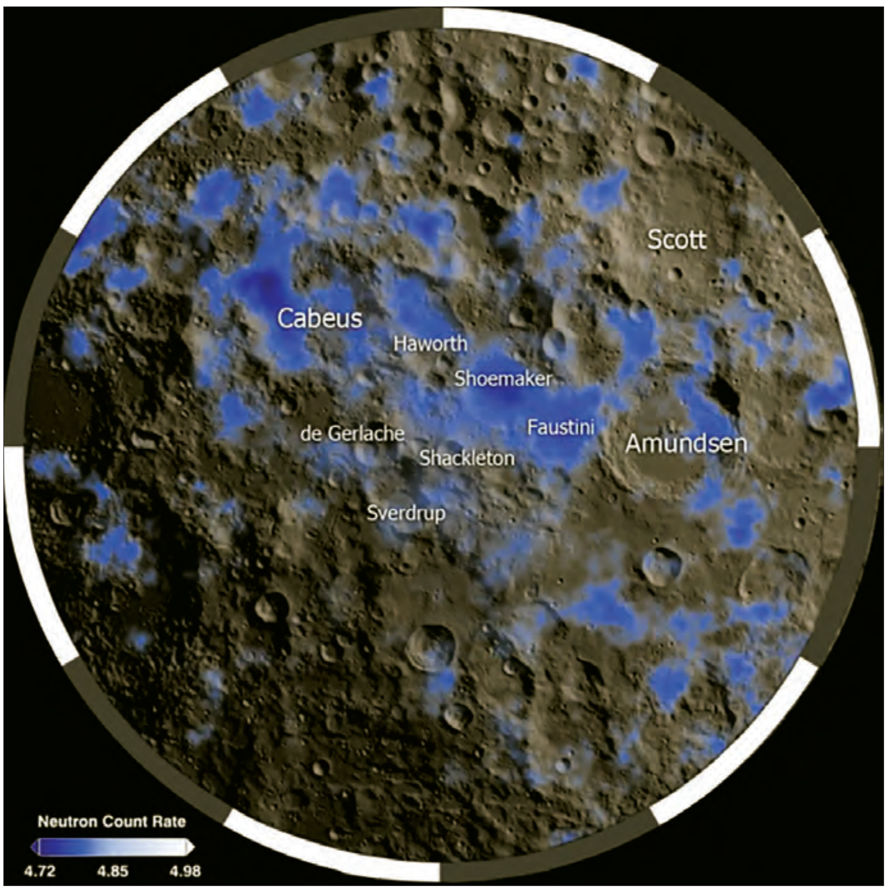

NASA

The crew of Space Shuttle Endeavour began construction of the International Space Station in December 1998. The in-space integration of the ISS could be a model for building a lunar base.

ownership and innovation, such as participants in the Google Lunar XPRIZE design.

The Apollo program cost about $25 billion, which with inflation works out to about $250 billion today. Miller and his team estimate that lunar missions could be conducted for one-sixth or one-seventh of

NASA/Goddard Space Flight Center



Locations of water ice deposits on the Moon's south polar regions taken by NASA's Lunar Reconnaissance Orbiter. Advocates for a privately owned moon base envision mining the water and breaking it down to produce liquid hydrogen and liquid oxygen propellant, which would be sold to NASA.

the Apollo costs. McCurdy agrees a dramatic reduction is possible.

"If you are really careful and you rely upon the accumulation of technological knowledge up to now, you can go back to the moon for a lot less than we spent the first time," he says. "We had to invent the Saturn 5 rocket, human orbital flight, lunar orbit rendezvous, flight computers and deep space communications. None of those things needs to be reinvented."

Plus, commercial firms are developing and producing spacecraft that can send mass into orbit at a much lower cost than previous generations of government-owned and operated launch vehicles. If the Saturn 5 still existed, in today's dollars it would cost NASA about $12 million to $15 million per metric ton of cargo delivered to low Earth orbit. By comparison, NASA's Space Launch System is designed to that job at a cost of $7 million per metric ton when it begins flying in 2018. SpaceX says its Falcon Heavy will cost $2 million per metric ton to low Earth orbit when it starts launching satellites in 2016.

Although less expensive, the Falcon Heavy is not powerful enough to boost astronauts along with their lunar lander toward the moon. If NASA or an international coalition decided to use Falcon Heavys or United Launch Alliance's still-to-be-developed Vulcan rocket for lunar missions, it would need to upgrade their second stages, add propellant to the existing second stages in low Earth orbit, or couple the various elements of a lunar mission — such as the crew capsule, habitat and lunar lander — with an additional propulsion system in orbit and assemble them there.

That assembly does not worry Gene Grush, a former propulsion and power division chief at NASA's Johnson Space Center and member of the team that reviewed the report. He favors sending astronauts to a permanent moon base using low-cost commercial rockets coupled with additional stages to propel them to lunar orbit.

"The International Space Station sets the bar for in-space integration," he says.

The authors of the July report suggest creating a program similar to NASA's Commercial Orbital Transportation Services effort, which spawned the SpaceX Dragon and Orbital Sciences Cygnus capsules. NASA shared the development costs of those vehicles, while holding out the promise that it would later award multibillion-dollar, fixed-price service contracts.

To return to the moon, the authors say NASA could pay two competing commercial spaceflight providers $5 billion each to develop new or upgrade rocket stages and crew vehicles. Then, private companies rather than government agencies would own and operate the spacecraft, the lunar base and the infrastructure to support that base with NASA and other space agencies serving as customers for the base and propellant produced there.

"The secret in all of this is public-private partnerships," Lopez-Alegria says. "It capitalizes on the commercial spaceflight industry, which has proven itself far more successful than most people anticipated."

Since NASA would want to share the development costs, the agency would have to convince companies that the entire project would not disappear with the next election or financial crisis, Miller says. That's why the proposed International Lunar Authority, which would be modeled after CERN, is so important. Government payments to CERN are established by international treaty, and something similar could be done to develop the moon base.

Later, when the moon base begins mining water and breaking it down to produce liquid hydrogen and liquid oxygen fuel, the International Lunar Authority would wean itself from government support and pay for ongoing operations with user fees and fuel sales.

Three-phase strategy

The base would be technically challenging to build.

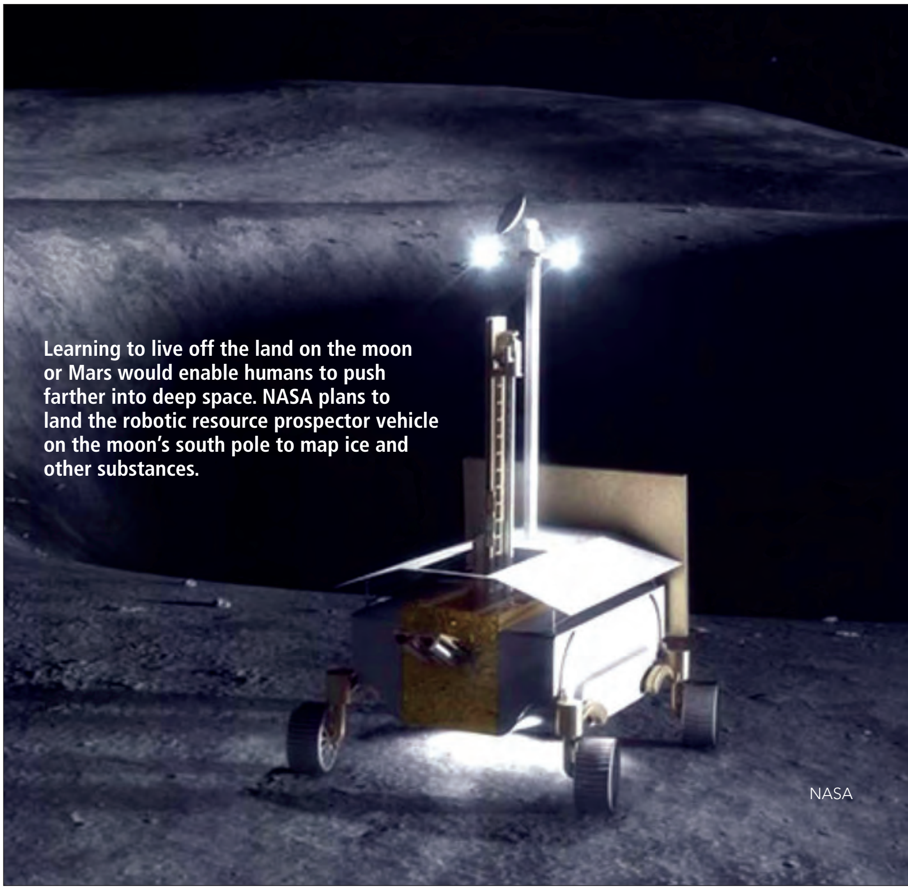
"We haven't built a lunar habitat in over 40 years," says Grush, the former propulsion and power chief at Johnson Space Center. "Lunar dust and the thermal environment make it very difficult."

Plus, no one has ever produced propellant on the moon or set up an orbiting fuel depot. Before tackling any of those jobs, NASA and its international partners would need to make sure the water on the moon is accessible. Several space missions have detected water ice. Most recently, NASA's Lunar Crater Observation and Sensing Satellite, or LCROSS, was purposely crashed into a shadowed crater in 2009 so researchers could look for evidence of water, which they found in the resulting impact plume. Researchers do not know how much ice exists or whether it is buried deep beneath the surface.

"We need to know as soon as possible how much water is available and how easy or hard it is to get to," Miller says.

In the first phase, NASA and its partners would land the crew near the lunar equator and then come home. During this phase mission partners also would demonstrate the life support systems needed for future manned missions. Meanwhile, back on Earth, companies and space agencies would be developing technologies for mining lunar ice and producing, storing and transporting liquid hydrogen and liquid oxygen propellants.

Astronauts would travel to the lunar poles in the second phase to begin testing these in-situ resource utilization techniques and select the site of a permanent lunar base. The astronauts would test drive rovers. Back on Earth, government and private researchers would be busy developing and testing reusable liquid fueled rockets as well as habitats to accommodate astronauts living on the moon for months at a time.

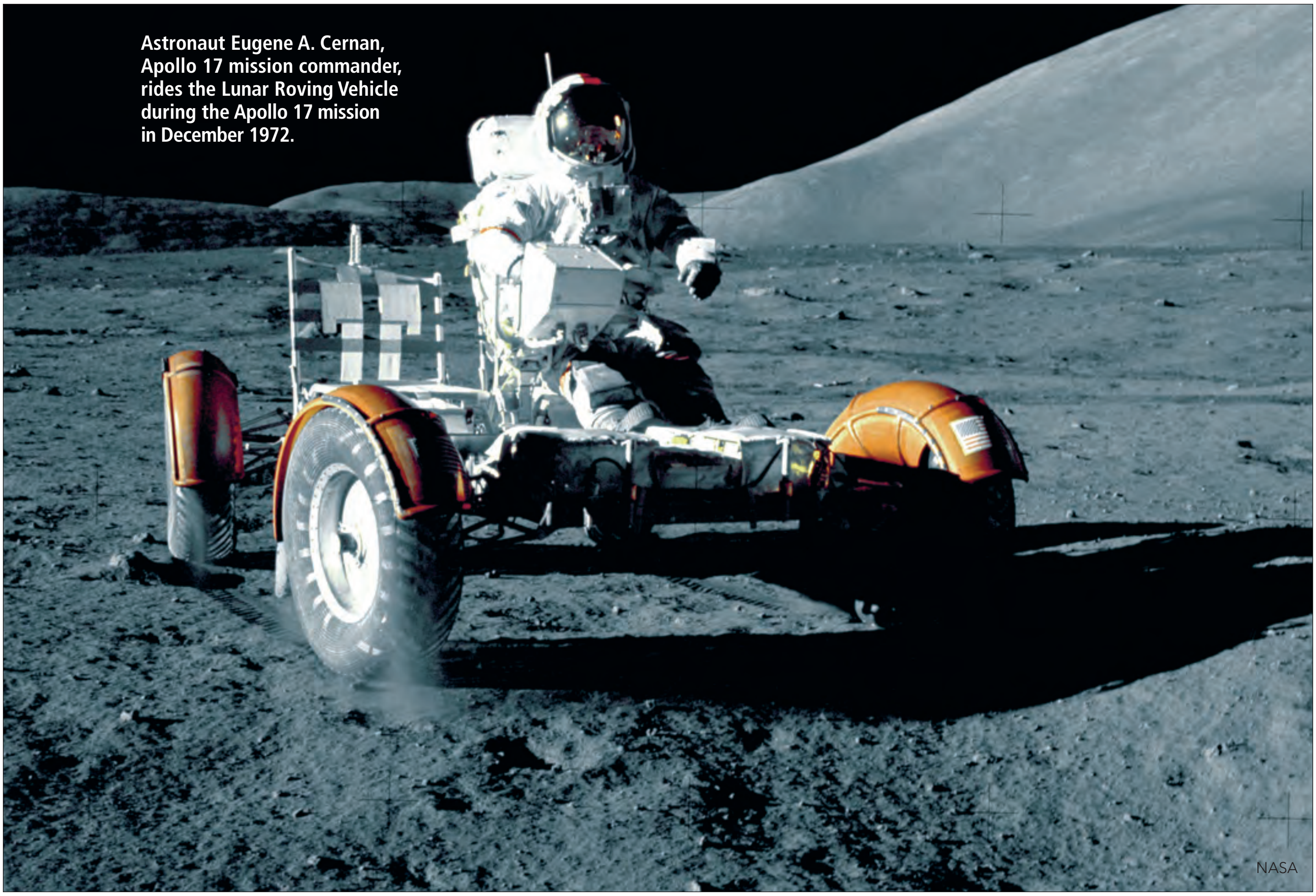


Learning to live off the land on the moon or Mars would enable humans to push farther into deep space. NASA plans to land the robotic resource prospector vehicle on the moon's south pole to map ice and other substances.

NASA

"You would encounter all sorts of new challenges that weren't faced by the Apollo astronauts," who spent at most a few days away from Earth, McCurdy says. "They went on camping trips. They didn't shave, didn't bathe, shook the dust off their space suits and came back."

Once those challenges are ironed out and the habitat, transportation and fuel



Astronaut Eugene A. Cernan, Apollo 17 mission commander, rides the Lunar Roving Vehicle during the Apollo 17 mission in December 1972.

NASA

production facilities are up and running, the International Lunar Authority would begin full-scale fuel production and delivery of liquid hydrogen and liquid oxygen to the propellant depot, where fuel could be transferred to spacecraft headed to Mars or other destinations. In this third phase of the program, a revolving crew of four international astronauts would live and work in the lunar outpost.

Obstacles

Miller predicts that the base can be built within NASA's top-line budget, but it also would mean identifying resources for a series of hitherto-unplanned lunar missions. Paying for the lunar proposal could complicate efforts to build and test NASA's next generation of space exploration vehicles, including the Orion astronaut capsule and the heavy-lift Space Launch System.

NASA receives $3 billion to $4 billion a year from Congress to fund human exploration beyond low Earth orbit, with most of that money going to Orion and SLS. There is no money for human lunar exploration and even many elements of a planned Mars mission have received little funding, including a space habitat for crews during their multi-month journey, a Mars lander and an ascent vehicle to carry astronauts back into orbit for the journey home.

However, there is one major part of NASA's budget that may shrink in the next decade, leaving room for new initiatives. NASA, Russia and Canada have agreed to support operations of the International Space Station only until 2024. The space station's other two partners, the European Space Agency and Japan Aerospace Exploration Agency, have not yet announced how long they will fund it.

When space station operations end, NASA might be able to begin funding lunar missions, "but I think it would be tough to find support in the short term because it's politically difficult and operationally illogical to scrap a current program and embark on something new," Lopez-Alegria says.

Unless, of course, a new president has other ideas.

MASTERING complexity

As impressive as it is to beam back images of Pluto or to whisk passengers around the globe in comfort and safety, the systems engineering practices underlying these products won't be adequate for a future of ever-evolving complexity. Aerospace engineering professors Dianne J. DeTurris and Steven J. D'Urso, members of AIAA's Complex Aerospace Systems Exchange forum, explain how lessons from the software industry can help aerospace engineers manage complexity.

VIEWPOINT

by Dianne J. DeTurris
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Back in 2001, a small team of software developers gathered at a Utah ski resort and crafted an entirely new philosophy and approach to computer programming.

Instead of complaining about changes to requirements, developers would embrace change as an opportunity for competitive advantage. Face-to-face conversations would be the preferred way to share information. Programmers would meet regularly with the business side of the house. An over emphasis on planning and documentation would end, replaced by an eagerness to adapt.

Those were among the key points of the team's "Manifesto for Agile Software Development," a document that has now been signed by many leading developers and sparked improved efficiency and productivity.

The aerospace engineering profession has reached a crossroads similar to that

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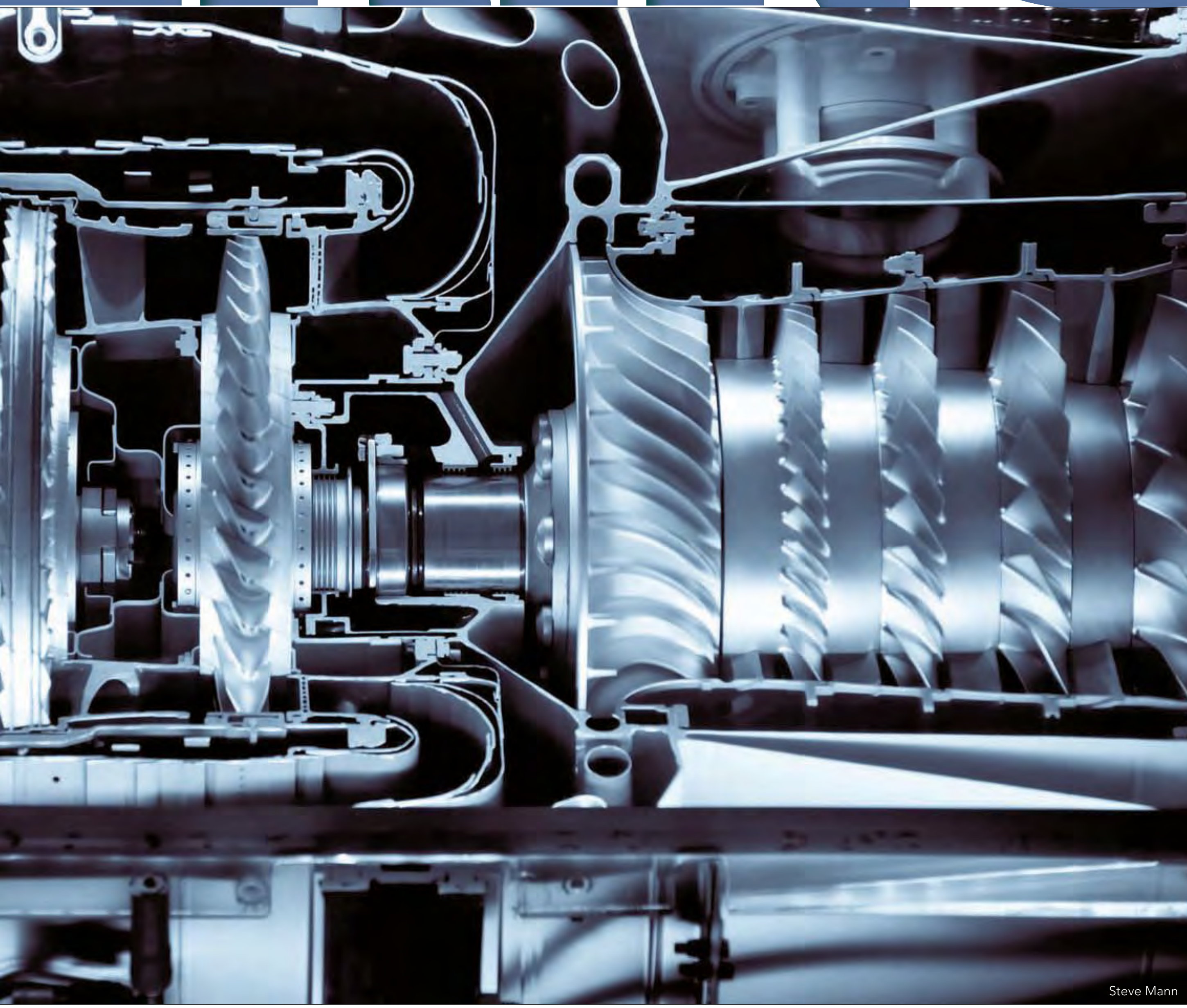
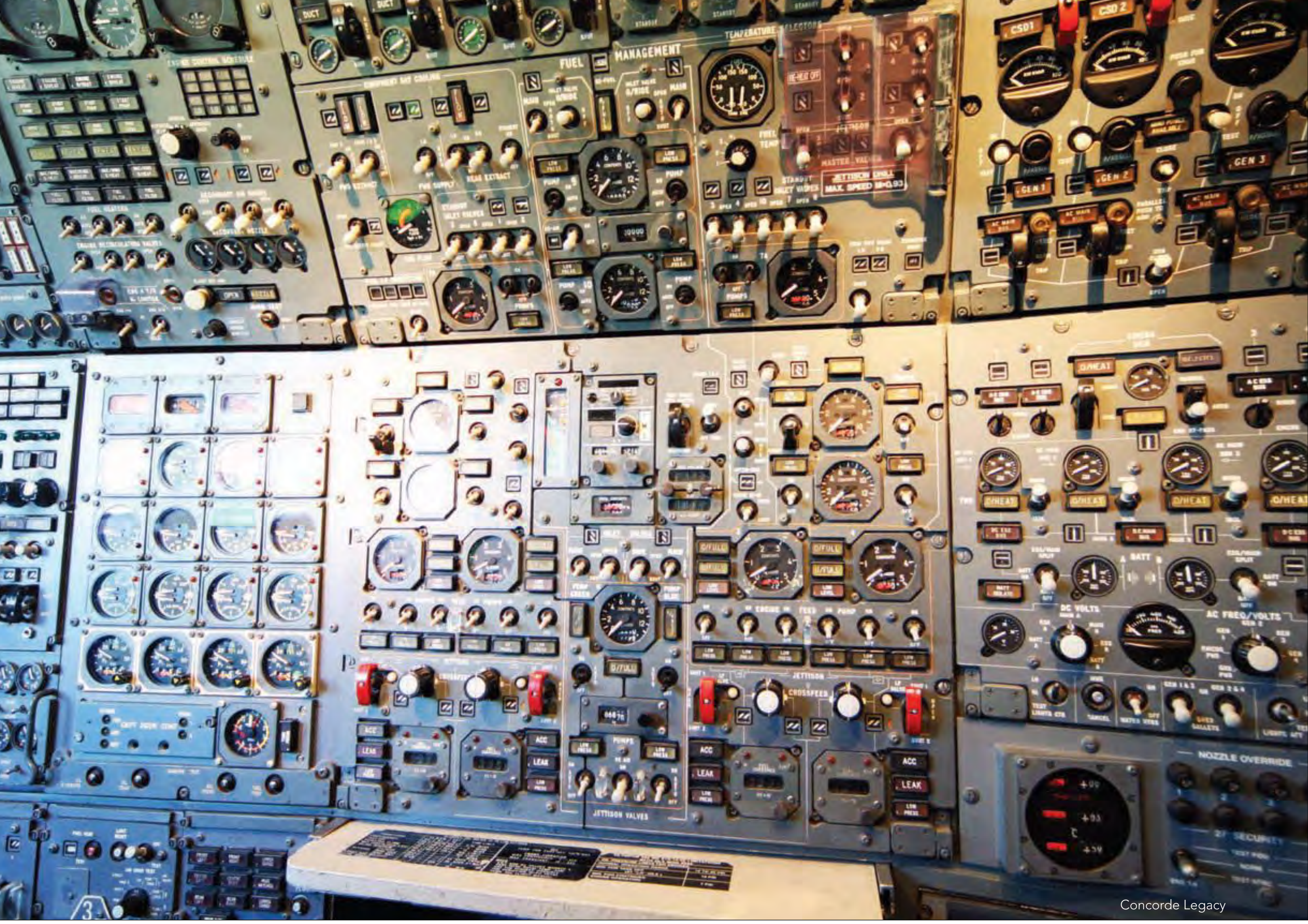

Steve Mann

Cutaway view of a jet engine. Aerospace systems engineers may be ripe for an overhaul in order to spark productivity and creativity.

faced by those programmers in Utah. Achieving the breakthroughs that our customers will demand in the coming years will require engineers to manage unprecedented design complexity and wrap in developments across a multitude of disciplines. We have to update some parts of systems engineering and completely overhaul others.

Since systems engineering is about management, process and control, as well as engineering and technology, we have to rethink the systems-based organizational practices we currently use. Part of the solution will be for thought leaders working in the aerospace industry to gather regularly, just as software leaders who embrace the Agile mindset do, and discuss techniques and ideas for addressing the challenges that arise from system complexity.

AIAA began doing this in 2012 when members of the aerospace community met



Flight engineer station of the supersonic Concorde jetliner, which had a three-person cockpit crew.

for the first time for a series of discussions collectively known as CASE, for the Complex Aerospace Systems Exchange. The CASE meetings are held during AIAA's regularly scheduled forums and have been attended by chief engineers, program managers, academics and systems engineering professionals who have run into this phenomenon and want to find out more.

CASE promotes the application of systems engineering as a strategy for dealing with the growing complexity of modern aerospace systems, including satellites, space probes, airliners or military planes. New systems are fundamentally different than older systems with respect to functionality and interconnections. Complexity can add delay and cost to the development cycle, and if current trends continue, some projects won't be completed at all.

Consider such military planes as the F-4, F-104, F-15, F-16 and F/A-18. It took five to seven years to bring each of these aircraft to initial operational capability after the award of the first prototype contract. Then, in the 1980s, the Air Force began funding work on an even more complex aircraft, the Advanced Tactical Fighter, now called the F-22. It took 19 years to develop the F-22, and at vastly higher cost than previous aircraft.

The appearance of unpredictable behavior — for instance, an unexpected airflow or electrical effect — is an indicator of complexity in a system. To cope, the design of a complex system must be inherently non-deterministic, meaning one has to appreciate and address unpredicted behavior as it appears.

History offers clear lessons about this. The F-15 air superiority fighter was built to a historic load and fatigue spectrum, because that is what engineers knew at the time. Engineers did not adequately consider that the F-15 would fly at a much higher angle of attack than its predecessors. An unpredicted vortex shed by the forebody and inlets impinged on the vertical tails at high angles of attack. This created a significant structural load and fatigue issue for the vertical tails. Ultimately, stronger materials were found to handle the intense loads from this unpredicted behavior. Today, systems engineers know to apply multi-disciplined analyses to predict these effects. However, the high complexity and non-linear fluid and structural mechanics make definitive predictions elusive.

CASE helps engineers prepare for the unpredictable and respond effectively when it does occur. Specifically, CASE helps them target resources at the right questions during the entire development process from concept definition through manufacturing. Consider the actual story of a pilot who once was asked what was important for a new aircraft being designed, and responded that it absolutely had to go faster than Mach 2. In further questioning, he acknowledged that he seldom flies at that condition. His goal was to be sure he would have sufficient excess thrust for dogfighting. Asking a pilot about how fast the airplane needed to go was the wrong question. The right question would have been, "What attributes does the aircraft need for effective dogfighting?" Fostering effective communication between stakeholders and designers, where each has his or her own perspective, is part of managing complexity.

And there are other places where complexity influences the quest for a total system design, including technical, functional, physical, operational, human or organizational issues, which requires a holistic approach. A company must manage large, diverse, and geographically dispersed teams and introduce organizational practices that embrace complexity. The idea is to be adaptable both technically and organizationally.

The reality of complexity

As systems become increasingly complex, an approach that emphasizes configuration status accounting or configuration management is no longer as effective. These conventional processes might be described as the functional equivalent of a systems engineering police force in which the processes guide people rather than people guiding the processes. When performed this way, systems engineering feels like something that is done to you rather than by you. Far better for complex systems is to embed systems engineers at all stages of development and have them be an organic part of the team. In this strategy, everyone on the project is engineering the total system and is part of the "total systems" engineering team.


Leading Edge Images/Glenn Bloore

The U.S. Air Force's F-22 Raptor took 19 years to develop in part due to its complexity.

For new complex systems, there is a high probability that a configuration management process will prove to be inadequate, resulting in schedule delays and large cost overruns. Unpredicted events emerge as minor concerns mentioned at the water cooler and loom larger the longer they remain unaddressed. The existence of an unpredicted condition indicates that we, as engineers, do not completely understand the system. We need to enhance our awareness of seemingly minor concerns and embrace them rather than push them away. To ignore these weak signals is to climb the technical ladder of system development only to find that when we get to the top, the ladder has been leaning on the wrong building.

The inability of an agency or company to effectively manage complexity is sometimes a result of overconfident or disengaged engineers. For instance, a natural tendency in systems engineering is to take the stance, "That can't be a problem, because we don't have any budget for it."

This posture emanates from the human condition that leans toward overconfidence, as described by Nobel Prize-winning psychologist Daniel Kahneman in his book, "Thinking, Fast and Slow." In contrast, there is a predisposition to disengage because of fear or frustration. This dynamic sets up an unending analytics black hole, in which you can never gather enough data to solve the complex problem. Seemingly minor, third-and fourth-order phenomena in a system can be combined to create a first-order problem because there are so many potential system states that they cannot be quantified. And no amount of experimentation can guarantee a solution to those problems.

To deal effectively with complex systems, it needs to be OK for people to say, "Hey wait a minute! What if we did this instead?" As an engineering community, we need to be able to observe the problem within the complexity context, pause the process to fix it, and further question the current functional architecture in the complex system. The systems process must include acknowledgment that something is not understood and solve it using complexity theory and practice.

Simply put, systems engineering must encompass complexity forethought and vision. When a disruption in the process appears, an effective total systems engineer will say, "Let's not ignore that observation." Experts in multiple domains can then be engaged. This kind of integrated approach is essential for successful complexity management.

For now, CASE will continue to address end-to-end systems engineering content within the aerospace community at AIAA forum workshops, paper sessions and through publications to build the capacity of the organization to deal with complexity. Ultimately, CASE helps us know when we are asking the right questions and addressing the right problems.

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Dianne J. DeTurris teaches aerospace engineering at Cal Poly State University in San Luis Obispo, California. She is on the AIAA Steering Committee for CASE. Steven J. D'Urso teaches aerospace systems engineering at the University of Illinois/Urbana-Champaign. He was session chair for the Concept Development of Complex Systems at CASE 2015.

Out of the

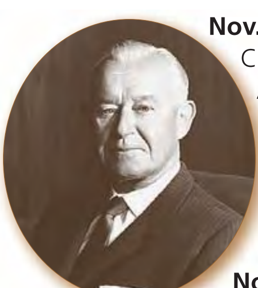
50 Years Ago, November 1965

Nov. 2 USSR launches the 26,900-pound Proton 2 satellite from the Baikonur Cosmodrome, the largest payload placed into space to date. The satellite carries scientific instruments to study cosmic particles of super-high energies as well as cosmic rays and their radiation dangers. New York Times, November 3, p. 5; Washington Post, November 3, p. A21.

Nov. 3 The X-15 No. 2, piloted by Air Force Lt. Col. Robert Rushworth, reaches 70,600 feet at 1,514 mph (Mach 2.31) in the first of two flights to test two 25-foot-long external propellant tanks that could boost the X-15's speed to more than 5,000 mph. Aviation Week, December 6, p. 72.

Nov. 5 North American Aviation's Space & Information Systems Division completes an seven-month Paraglider operational test program after completing a dozen consecutive flights and landings in tow-test vehicles at Edwards Air Force Base in California. The test uses a Gemini boilerplate capsule, suspended beneath an inflated Paraglider. A Los Angeles Airways Sikorsky S-61L helicopter tows the vehicle up to 10,000 feet and releases it for free flights that average about five minutes. NASA had proposed the Paraglider and evaluation tests for manned landings of spacecraft in general, but this means of landing is not adopted. Aviation Week, November 15, p. 34.

Nov. 6 NASA orbits its GEOS-A (Explorer 29) geodetic explorer satellite on the first improved Thrust-Augmented Delta launch vehicle in heavy rain from Cape Canaveral in Florida. The 385-pound satellite, designed and built by the Applied Physics Laboratory of Johns Hopkins University for NASA's Goddard Space Flight Center, is the first successful active spacecraft of the National Geodetic Satellite Program. The solar-cell powered satellite carries instruments to help define the structure of Earth's irregular gravitational field and refine the locations and magnitudes of large gravity anomalies. Aviation Week, November 15, p. 38; David Baker, Spaceflight and Rocketry, p. 185.



Nov. 8 Frederick H. "Pappy" Rohr, who built the fuel tanks for Charles Lindbergh's Spirit of St. Louis and later founded the Rohr Aircraft Corp. in 1940, dies in San Diego. The Rohr Corp.'s main products are aerostructures, including aircraft engine-related components such as nacelles, thrust reversers and mounting pylons for military and commercial aircraft. Aviation Week, November 15, p. 39.

Nov. 12 The Soviet Union launches its Venera 2 probe toward Venus. The 2,123-pound spacecraft later passes the planet at a distance of 14,900 miles, but fails to return data. New York Times, November 13, p. 10.

Nov. 15 A modified Boeing 707-349C with 40 scientists on board leaves Honolulu for a 26,263-mile global cruise at between 30,000 feet and 40,000 feet to study high-altitude meteorology, issues such as clear-air turbulence, the jet stream and cosmic radiation. Among other equipment, they will use time-lapse cameras to photograph the weather at five-minute intervals. New York Times, November 14, p. 23.

Nov. 19 The Sprint anti-ballistic missile undergoes its first successful firing from a special underground cell at the White Sands Missile Range, New Mexico. This is also the first U.S. missile to use the "pop-up" launch technique. Department of Defense Release 832-65.

Nov. 26 France orbits its first satellite, A-1, on a three-stage Diamant launch vehicle from the French test center at Hammaguir in the Algerian Sahara. The 88-pound satellite is comparable to the American Vanguard satellite but carries only a radio and radio transmitter and chemical batteries. It has no scientific equipment since the purpose of the launch is to test the Diamant booster. The Diamant vehicle consists of the first-stage liquid propellant rocket and the second and third stages with solid propellants. New York Times, November 27, pp. 1, 4; Aviation Week, December 6, p. 29.

Nov. 28 The Canadian Alouette 2 and the American Explorer 31 (also called the Direct Measurement Explorer) are launched together in a pick-a-back configuration by an Augmented Thor-Agena B booster from Vandenberg Air Force Base in California. Both satellites are to make related studies of the Earth's ionosphere. NASA Release 65-355.

Nov. 29 For the first time, the USSR transmits a color television program by satellite to France, using its Molniya 1 instrumented with the French SECAM color system. New York Times, November 30, p. 49.

75 Years Ago, November 1940

Nov. 1 Pennsylvania Central Airlines starts a 500-mile route from Norfolk, Virginia, to Knoxville, Tennessee. The

Past

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

route is soon known as the "Tobacco Road" and is flown by former United Air Lines Boeing 247s recently sold to PCA. Aircraft Year Book, 1941, p. 146.

Nov. 7 On the 27th anniversary of the Russian Revolution, aircraft designer Nikolai Nikolaevich Polikarpov is awarded the Order of Lenin and is named Hero of Socialist Labor. Polikarpov developed a number of notable military aircraft, such as the I-1, the first Soviet fighter built in series production; I-16, the first all-metal monoplane fighter in the world with a fully enclosed cockpit and re-tractable landing gear; and the U-2 training biplane, also known as the Po-2, that later serves as a World War II night harassment bomber, often flown by women combat pilots. Interavia, December 12, p. 6.

Nov. 9 Regular air communications begin between France and Madagascar when a Latecoere 523 flying boat, the Ville de St. Pierre, takes off from Marseilles to Madagascar. Interavia, November 19, p. 6.

Nov. 11 Italy belatedly participates in the Battle of Britain launching its only major air attack on England, though some Italian planes are said to have participated in a smaller-scale attack on Sept. 7. The Italian strike force is decisively defeated by the Royal Air Force and soon withdraws. A. van Hoorebeeck, La Conquete de L'Air, Vol. 2, p. 13.

Nov. 14 Because of hostilities in the Far East, the British government announces the creation of the new post of British Commander-in-Chief, Far East. This official is in charge of all British naval, field, and air forces in Singapore, Malaya, Burma and Hong Kong, with headquarters in Singapore. Air Chief Marshal Sir Robert Brooke-Popham, former governor of Kenya, is named to the new post. Interavia, November 19, 1940, pp. 13-14.

Nov. 14 The U.S. War Department announces it will deliver 40 Boeing B-17 Flying Fortress heavy bombers to Great Britain within a month. Interavia, November 19, p. 14.

Nov. 25 The all-wood de Havilland Mosquito D.H.98 bomber makes its first flight at Hartfield, England, which leads to large-scale production by July 1941. The bomber has a level speed of about 400 mph. Powered by two Rolls Royce Merlin engines, the Mosquito quickly gains an excellent reputation as a bomber, fighter and reconnaissance aircraft, its high speed rendering it virtually unstoppable for many years. E. M. Emme, ed., Aeronautics and Astronautics 1915-60, p. 40.

Nov. 25 The rugged Martin B-26 Marauder medium-range bomber, which is to be widely used during World War II, makes its first flight. Known as the "Widow Maker," among other names, the Marauder is tricky to fly, especially for inexperienced pilots, but proves itself extremely rugged and durable. At war's end, it is found to have the lowest loss rate of any U.S. bomber. Carrying as many guns as the larger B-15, the B-26 flies in tighter combat formations, making it a particularly dangerous bomber for Luftwaffe pilots to attack. Peter Bowers and Gordon Swanborough, United States Military Aircraft Since 1909, pp. 437-443.

Nov. 26 Lord Rothermere, British owner of the Daily Mail and champion of British aviation, dies at 72. Rothermere is known especially for having a twin-engined commercial airliner developed by Bristol Aeroplane at his own expense when he realized the former Imperial Airways lagged behind other large airlines. He wanted a twin-engine, six-seat design to compete with the latest transport from the U.S., particularly the Douglas DC-1, and that would have a top speed of 250 mph, faster than any aircraft in the Royal Air Force at that time. The Bristol Type 142 actually could fly faster than 300 mph. Because of its excellent performance, this plane was not placed into commercial service. Instead the RAF ordered a redesigned light bomber version that became the legendary the Bristol Blenheim. Interavia, November 26, p. 6, C.H. Barnes, Bristol Aircraft Since 1910, pp. 257-261.

100 Years Ago, November 1915

Nov. 5 The first confirmed U.S. catapult of an aircraft from a moving ship is accomplished from the U.S.S. North Carolina by Lt. Cmdr. H.C. Mustin, in Pensacola Bay, Florida, with an AB-2 flying boat. Roy A. Grossnick, United States Naval Aviation 1910-1995, p. 17.

Chair Department of Mechanical Engineering

BAYLOR UNIVERSITY

Baylor's School of Engineering and Computer Science invites applications for the position of Chair of Mechanical Engineering. The new Chair will communicate a clear vision for the future of education and research to a constituency that includes academia, government, industry and alumni. The successful candidate will hold an earned doctorate in Mechanical Engineering or a closely related field, and will demonstrate proven leadership, research achievement, excellent teaching, a commitment to professional activities, and outstanding English communication skills. The Department Chair reports to the Dean of the School and will be tenured as Professor of Mechanical Engineering.

Baylor's ABET accredited ME program now has 13 tenured/tenure-track faculty members and 4 lecturers/senior lecturers with the plan to grow to 27 total faculty by 2023. The faculty are internationally recognized in Biomechanical Experimentation, Design, and Simulation; Thermal and Energy Engineering; and Advanced Materials Engineering. Mechanical Engineering faculty conduct research in well-established laboratories and consortia housed within the Baylor Research and Innovation Collaborative (BRIC) (see www.baylor.edu/bric). The department offers B.S., M.S., and Ph.D. degrees in Mechanical Engineering. Jointly with the Department of Electrical and Computer Engineering, the department also teaches Pre-Engineering majors and offers B.S. in Engineering, M.S. in Biomedical Engineering and Master of Engineering degrees. Current enrollment is 265 pre-engineering, 400 undergraduate, and 28 graduate students. Additional information is available at http://www.ecs.baylor.edu/mechanicalengineering/.

The mission of the program is to educate students within a caring Christian environment in the discipline of Mechanical Engineering. Our graduates are to be equipped with the fundamental technical, communication, and teamwork skills to succeed in their chosen careers. They are to be empowered by innovative problem-solving creativity and an entrepreneurial mindset, and motivated by Christian ideals and a vocational calling to improve the quality of life worldwide.

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1) A current curriculum vitae
2) A vision statement for the growth of our new PhD program while maintaining excellence in undergraduate education
3) An individualized statement of teaching and research interests related to Baylor's programs
4) A statement describing an active Christian faith
5) Contact information for at least three professional references

Application review begins January 4, 2016 and will continue until the position is filled. Please submit materials to http://apply.interfolio.com/31180.

Chartered in 1845 by the Republic of Texas, Baylor University is the oldest university in Texas and the world's largest Baptist university. It is a member of the Big XII Conference and holds a Carnegie classification as a "high-research" institution. Baylor's mission is to educate men and women for worldwide leadership and service by integrating academic excellence and Christian commitment within a caring community. New faculty will have a strong commitment to the classroom and to discovering knowledge as Baylor aspires to become a top tier research university as described in Pro Futuris (http://www.baylor.edu/profuturis/).

Baylor University is a private not-for-profit university affiliated with the Baptist General Convention of Texas. As an Affirmative Action/Equal Opportunity employer, Baylor is committed to compliance with all applicable anti-discrimination laws, including those regarding age, race, color, sex, national origin, marital status, pregnancy status, military service, genetic information, and disability. As a religious educational institution, Baylor is lawfully permitted to consider an applicant's religion as a selection criterion. Baylor encourages women, minorities, veterans and individuals with disabilities to apply.

CAL POLY
ENGINEERING

ELECTRICAL ENGINEERING AND AEROSPACE ENGINEERING JOINT POSITION - The Electrical Engineering Department and Aerospace Engineering Department at Cal Poly, San Luis Obispo, invite applications for a full-time, academic year tenure-track faculty position at the Assistant or Associate Professor rank. The projected start date is September 15, 2016. Duties include teaching coursework in Electrical Engineering and Aerospace Engineering, building a collaborative research program in the area of Satellite Communication and Mobile Terrestrial Communications, and service to the department, university, and community. Desired areas of expertise include satellite electronics systems including the Cube Sat form factor, mobile terrestrial communication systems with a strong hands-on orientation in working with students. Rank and salary are commensurate with qualifications and experience. Candidates with research or private industry experience are encouraged to apply.

An earned doctorate in Electrical Engineering, Computer Engineering, Computer Science, Aerospace Engineering or related discipline is required. Candidates must have a strong commitment to teaching excellence and laboratory-based instruction, and exhibit potential for professional recognition via research and publication. Demonstrated ability in written and oral use of the English language is required.

To apply, please complete online application at WWW.CALPOLYJOBS.ORG using Requisition #103796. Review of applications will begin Jan. 4, 2016. Applications received after this date may be considered. Candidates should submit: (1) completed online application form; (2) current resume; (3) Ph.D. transcripts, (4) statement of goals and plans for teaching and research and (5) qualification summary and teaching preferences. Please see on-line posting for instructions where to mail documents that cannot be submitted on-line. Please be prepared to submit three references with email addresses when applying.

CAL POLY
SAN LUIS OBISPO

MICRO-SATELLITE & SPACE PROPULSION – The Aerospace Engineering Department at Cal Poly, San Luis Obispo, invites applications for a full-time, academic year, tenure-track faculty position at the Assistant or Associate Professor rank beginning no later than Fall 2016. Duties include teaching undergraduate and master's level courses, developing an externally funded research program in the area of micro-satellite space propulsion, expanding the space propulsion curricula; collaborating with the department's ongoing CubeSat initiatives; and providing service to the department, university, and community. Rank and salary is commensurate with qualifications and experience.

The position requires individuals who have demonstrated ability to provide undergraduate and graduate students with hands-on engineering education in a multidisciplinary, systems-based environment. A Ph.D. in engineering, or closely related field, is required. It is expected that the successful candidate will work with faculty from the department and the college of engineering to grow and sustain the department's CubeSat initiative in the area of propulsion systems and related technologies including nonchemical propulsion, advanced propulsion technologies, and supporting technologies. Industry experience, especially in the area of CubeSat or other micro-satellite propulsion systems, and a commitment to working in a multidisciplinary and collaborative setting are preferred.

Founded in 1901, Cal Poly is one of only five comprehensive polytechnic universities in the nation, with approximately 19,000 undergraduate, 120 post-baccalaureate, and 900 graduate students. U.S. News and World Report has ranked Cal Poly #1 among public master's universities in the western United States for 21 consecutive years. Aviation Week ranks Cal Poly as a top "go-to" school for aerospace industry employment. With approximately 400 undergraduate students and 15 faculty and staff, the Aerospace Engineering Department offers bachelor's degrees in Aerospace Engineering with concentrations in Aeronautics and Astronautics. The curriculum culminates with the award winning senior design sequence. The Department also maintains a graduate program offering a Master of Science. Our graduate students work with faculty on applied projects culminating in a rigorous thesis. The department's Astronautics concentration includes a space environments lecture and lab, a space propulsion lecture and lab, and courses in spacecraft attitude dynamics and control, spacecraft power and communication, and orbital mechanics. The department also is home to PolySat, a nationally recognized CubeSat group, as well as one of the only CubeSat integration and testing capabilities in the country. All of these activities provide students with "learn by doing" experiences throughout their academic career and beyond.

To apply, please visit www.calpolyjobs.org to complete the required online Cal Poly faculty application and apply to Requisition #103821. Applicants are encouraged to submit materials by the REVIEW BEGIN DATE: **December 1, 2015** for full consideration.

Cal Poly is strongly committed to achieving excellence through cultural diversity. The university actively encourages applications and nominations of all qualified individuals. EEO

AEROSPACE ENGINEERING & MECHANICS

SPACE/ASTRONAUTICS FACULTY POSITION

The Department of Aerospace Engineering & Mechanics (AEM) at The University of Alabama invites applications for a tenure-track faculty position in areas related to space and astronautics. It is anticipated that the successful candidate will join the faculty at the rank of tenure-track Assistant Professor, although exceptional candidates may be considered for higher rank depending upon experience and qualifications.

With 16 tenured and tenure-track faculty members, the AEM department enrolls 300+ undergraduate students in the ABET-accredited BSAE program and 50+ graduate students in the MS and PhD programs. The AEM Department is currently experiencing an era of unprecedented growth and expansion. The AEM department benefits from the University's rapid expansion in terms of facilities, including the recent construction of the $300 million Shelby Engineering and Science Quad. This four building complex provides over 900,000 square feet of state-of-the-art research and instructional space, the majority of which is devoted to the College of Engineering.

The University of Alabama is located on a beautiful 1,168 acre residential campus in Tuscaloosa, a dynamic and resilient community of over 150,000. The Tuscaloosa community provides rich cultural, educational, and athletic activities for a broad range of lifestyles. With technology-oriented government & industrial research centers (including the U.S. Army's Redstone Arsenal and the NASA Marshall Space Flight Center) in north Alabama and a growing aviation industrial sector (including Airbus aircraft manufacturing & engineering centers) in south Alabama, The University of Alabama is centrally located in Alabama's north-south aerospace corridor.

Applicants must have an earned doctorate degree in aerospace engineering or a closely related field. Applicants are to submit: a letter of application, a detailed CV, and contact information for at least three professional references. The successful applicant will be expected to develop a strong externally-funded research program, demonstrate a commitment to excellence in teaching & mentoring of students, and provide service to the profession, university, college of engineering and AEM department. All application materials must be submitted via The University of Alabama's employment website (https://facultyjobs.ua.edu/postings/37659). Review of applications will begin immediately and will continue until the position is filled. Inquiries should be addressed to Dr. Paul Hubner, Department of Aerospace Engineering & Mechanics, Box 870280, The University of Alabama, Tuscaloosa, AL 35487-0280 or sent by e-mail to phubner@eng.ua.edu.

Qualified women and minorities are encouraged to apply. The University of Alabama is an equal opportunity, affirmative action, Title IX, Section 504, ADA employer. Salary will be competitive and commensurate with experience level.

THE UNIVERSITY OF ALABAMA® | College of Engineering

Tenure-Track Faculty Positions in Mechanical Engineering

THE UNIVERSITY OF TOLEDO 1872

The Department of Mechanical, Industrial and Manufacturing Engineering at The University of Toledo is seeking outstanding candidates for multiple tenured or tenure-track faculty positions at the Assistant or Associate Professor levels. Candidates with strong qualifications in any area of mechanical engineering will be considered, but preference will be given to candidates with research expertise in experimental thermal/fluids, mechanical design, and materials.

The department currently has 18 tenure-track or tenured faculty members and an enrollment of more than 800 undergraduate students and 90 graduate students pursuing B.S., M.S. and Ph.D. degrees. The faculty conduct funded research in excess of $4M per year across a broad range of areas. The department has a large number of experimental and computational facilities including a well instrumented subsonic wind tunnel, a small turbine engine laboratory, and flow visualization facilities. There has been a long history of collaboration with the regional automotive, energy, and glass related industries, as well as the NASA Glenn Research Center. More information about the department can be found at: http://eng.utoledo.edu/mime.

All successful candidates are expected to contribute to and play a leadership role in advancing research and teaching in their respective areas of expertise and to contribute to the diversity of the University's academic community. The University of Toledo is a comprehensive public metropolitan research university established in 1872. In addition to the College of Engineering, other professional colleges include Business Administration, Law, Medicine, Natural Sciences and Mathematics, and Pharmacy providing abundant opportunities for collaborative education and research within the University.

Applicants must have an earned doctoral degree in mechanical engineering or a related field and are expected to teach undergraduate and graduate level courses in their fields of expertise, supervise graduate student research, and develop and grow a strong, externally funded research program. Interested applicants should submit a detailed curriculum vitae, statements of research and teaching interests, and names and contact information of at least four professional references. All applicants for this position are required to complete the application online at The University of Toledo's web site: https://jobs.utoledo.edu and submit all supporting application materials, prepared in PDF format, online. Review of applications will begin December 2015 and will continue until the positions are filled.

The University of Toledo is an equal access, equal opportunity, affirmative action employer and educator

AFIT

AIR FORCE INSTITUTE OF TECHNOLOGY

FACULTY POSITION
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AFB, DAYTON OH

The Department of Aeronautics and Astronautics seeks applicants for a tenure-track Aerospace Engineering faculty position (preferably at the assistant or associate professor level). The departmentÕs most urgent needs are in the following areas: Propulsion, Controls, or Aerodynamics. In addition to an earned Ph.D. in Aeronautical Engineering, Astronautical Engineering, Mechanical Engineering or a related field, the candidate should have a demonstrated or a potential ability in teaching at the graduate level and in conducting independent research for the Air Force and other government agencies. Good communication skills, both oral and written, are essential. Applicants **must** be U.S. citizens and **must** currently possess or be able to obtain/maintain a SECRET clearance. If selected, applicants must produce proof of citizenship at time of appointment. Link to full posting can be found at https://www.usajobs.gov/GetJob/ViewDetails/416590500

The Department offers both M.S. and Ph.D. degrees in Aeronautical Engineering, Astronautical Engineering, Space Systems and Materials Science. The Department has several state-of-the-art computer and experimental laboratories. Interested candidates should send a resume and the names of three references to:

Dr. Brad S. Liebst
Professor and Head
Department of Aeronautics and Astronautics
Air Force Institute of Technology
AFIT/ENY
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
Phone: (937) 255-3069
e-mail: Bradley.Liebst@afit.edu

The Air Force Institute of Technology is an Equal Opportunity/Affirmative Action employer.

Massachusetts Institute of Technology

Come work with us!

Tenure-Track Faculty Position

Department of Aeronautics and Astronautics

The department of Aeronautics and Astronautics at MIT invites applications for a tenure-track faculty position with a start date of July 1, 2016, or thereafter. The department is conducting a search for exceptional candidates with a strong background in any discipline related to Aerospace Engineering, broadly defined. We are seeking highly qualified candidates with a commitment to research and education. Faculty duties include teaching at the graduate and undergraduate levels, advising students, and conducting research.

Candidates should hold a doctoral degree in a field related to aerospace engineering by the beginning of employment. The search is for a candidate to be hired at the assistant professor level; however, under special circumstances, a senior faculty appointment is possible.

Applications must include a cover letter, curriculum vitae, 2-3 page statement of research and teaching interests and goals, and names and contact information of at least three individuals who will provide letters of recommendation. Applications must be submitted as a pdf at https://school-of-engineering-faculty-search.mit.edu/aeroastro/register.tcl.

Letters of recommendations must be submitted directly by the recommenders at https://school-of-engineering-faculty-search.mit.edu/letters.

To ensure full consideration, complete applications should be received by December 1, 2015. Note: Applications will be considered complete only when both the applicant materials and at least three letters of recommendations are received.

For more information on the Department of Aeronautics and Astronautics at MIT, please visit http://aeroastro.mit.edu/

MIT is building a culturally diverse faculty and strongly encourages applications from female and minority candidates. MIT is an Equal Opportunity/Affirmative Action employer.

http://web.mit.edu

AIAA Bulletin

AIAA Headquarters Has Moved!

We are excited to announce that as of **2 November 2015**, the AIAA Headquarters office relocated to:

12700 Sunrise Valley Drive, Suite 200
Reston, VA 20191-5807

All office phone numbers and email addresses remain the same. We look forward to welcoming our members into our new space in the near future.

NOVEMBER 2015

AIAA Directory

AIAA HEADQUARTERS
12700 Sunrise Valley Drive, Suite 200
Reston, VA 20191-5807
www.aiaa.org

To join AIAA; to submit address changes, member inquiries, or renewals; to request journal fulfillment; or to register for an AIAA conference.
Customer Service: 800/639-AIAA†

Other Important Numbers: ***Aerospace America*** / Greg Wilson, ext. **7596** • ***AIAA Bulletin*** / Christine Williams, ext. **7575** • **AIAA Foundation** / Karen Thomas, ext. **7520** • **Book Sales** / **800.682.AIAA** or **703.661.1595**, Dept. 415 • **Communications** / John Blacksten, ext. **7532** • **Continuing Education** / Megan Scheidt, ext. **7511** • **Corporate Members** / Tobey Jackson, ext. **7570** • **Editorial, Books and Journals** / Heather Brennan, ext. **7568** • **Exhibits and Sponsorship** / Tobey Jackson, ext. **7570** • **Honors and Awards** / Carol Stewart, ext. **7538** • **International Affairs** / Betty Guillie, ext. **7573**; Emily Springer, ext. **7533** • **Journal Subscriptions, Member** / **800.639.AIAA** • **Journal Subscriptions, Institutional / Online Archive Subscriptions** / Michele Dominiak, ext. **7531** • **Media Relations** / Duane Hyland, ext. **7558** • **Public Policy** / Steve Sidorek, ext. **7541** • **Section Activities** / Chris Jessee, ext. **7517** • **Standards, Domestic** / Hilary Woehrle, ext. **7546** • **Standards, International** / Nick Tongson, ext. **7515** • **Student Programs** / Rachel Dowdy, ext. **7577** • **Technical Committees** / Betty Guillie, ext. **7573**

† U.S. only. International callers should use 703/264-7500.

All AIAA staff can be reached by email. Use the formula first name last initial@aiaa.org. Example: megans@aiaa.org.

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

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

Event & Course Schedule

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
2015			
11–14 Nov†	31st Annual Meeting of the American Society for Gravitational and Space Research (ASGSR)	Alexandria, VA (Contact: Cindy Martin-Brennan, 703.392.0272, executive_director@asgsr.org, www.asgsr.org)	
2016			
2–3 Jan	2nd AIAA CFD Aeroelastic Prediction Workshop	San Diego, CA	
2–3 Jan	Guidance of Unmanned Aerial Vehicles	San Diego, CA	
2–3 Jan	Systems Requirements Engineering	San Diego, CA	
3 Jan	Structural Dynamics of Rocket Engines Tutorial	San Diego, CA	
4 Jan	AIAA Associate Fellows Recognition Ceremony and Dinner	San Diego, CA	
4–8 Jan	AIAA SciTech 2016 (AIAA Science and Technology Forum and Exposition) **Featuring:** 24th AIAA/AHS Adaptive Structures Conference 54th AIAA Aerospace Sciences Meeting AIAA Atmospheric Flight Mechanics Conference 15th Dynamics Specialists Conference AIAA Guidance, Navigation, and Control Conference AIAA Information Systems—Infotech@Aerospace Conference AIAA Modeling and Simulation Technologies Conference 18th AIAA Non-Deterministic Approaches Conference 57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 9th Symposium on Space Resource Utilization 3rd AIAA Spacecraft Structures Conference 34th Wind Energy Symposium	San Diego, CA	**2 Jun 15**
25-28 Jan†	Annual Reliability and Maintainability Symposium (RAMS)	Tucson, AZ (Contact: Sean Carter, seancarter67@gmail.com, www.rams.org)	
14–18 Feb†	26th AAS/AIAA Space Flight Mechanics Meeting	Napa, CA (Contact: Ryan Russell, 512.471.4190, ryan.russell@utexas.edu, www.space-flight.org/docs/2016_winter/2016_winter.html)	
8–10 Mar	AIAA DEFENSE 2016 (AIAA Defense and Security Forum) **Featuring:** AIAA Missile Sciences Conference AIAA National Forum on Weapon System Effectivenss AIAA Strategic and Tactical Missile Systems Conference	Laurel, MD	**8 Oct 15**
5–12 Mar†	2016 IEEE Aerospace Conference	Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, Erik.n.nilsen@jpl.nasa.gov, www.aeroconf.org)	
19–21 Apr†	16th Integrated Communications and Surveillance (ICNS) Conference	Herndon, VA (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, http://i-cns.org)	
5 May	Aerospace Today ... and Tomorrow—An Executive Symposium	Williamsburg, VA	
16–20 May†	SpaceOps 2016: 14th International Conference on Space Operations	Daejeon, Korea	**30 Jul 15**
30 May–1 Jun†	22nd AIAA/CEAS Aeroacoustics Conference	Lyon, France	**9 Nov 15**
30 May–1 Jun†	23rd Saint Petersburg International Conference on Integrated Navigation Systems	Saint Petersburg, Russia (Contact: Ms. M. V. Grishina, +7 812 499 8181, icins@eprib.ru, www.elektropribor.spb.ru)	
13–17 Jun	AIAA AVIATION 2016 (AIAA Aviation and Aeronautics Forum and Exposition) **Featuring:** 32nd AIAA Aerodynamic Measurement Technology and Ground Testing Conference 34th AIAA Applied Aerodynamics Conference AIAA Atmospheric Flight Mechanics Conference 8th AIAA Atmospheric and Space Environments Conference 16th AIAA Aviation Technology, Integration, and Operations Conference AIAA Flight Testing Conference	Washington, DC	**5 Nov 15**

DATE	MEETING (Issue of *AIAA Bulletin* in which program appears)	LOCATION	ABSTRACT DEADLINE
	8th AIAA Flow Control Conference **46th AIAA Fluid Dynamics Conference** **17th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference** **AIAA Modeling and Simulation Technologies Conference** **47th AIAA Plasmadynamics and Lasers Conference** **46th AIAA Thermophysics Conference**		
15 Jun	**Aerospace Spotlight Awards Gala**	Washington, DC	
5–8 Jul†	**ICNPAA 2016 Mathematical Problems in Engineering, Aerospace and Sciences**	University of La Rochelle, France (Contact: Prof. Seenith Sivasundaram, 386.761.9829, seenithi@gmail.com, www.icnpaa.com)	
25–27 Jul	**AIAA Propulsion and Energy 2016 (AIAA Propulsion and Energy Forum and Exposition)** **Featuring:** **52nd AIAA/SAE/ASEE Joint Propulsion Conference** **14th International Energy Conversion Engineering Conference**	Salt Lake City, UT	**12 Jan 16**
12–15 Sep	**AIAA SPACE 2016 (AIAA Space and Astronautics Forum and Exposition)** **Featuring:** **AIAA SPACE Conference** **AIAA/AAS Astrodynamics Specialist Conference** **AIAA Complex Aerospace Systems Exchange**	Long Beach, CA	
25–30 Sept†	**30th Congress of the International Council of the Aeronautical Sciences (ICAS 2016)**	Daejeon, South Korea (Contact: www.icas.org)	**15 Jul 15**
25–30 Sept†	**35th Digital Avionics Systems Conference**	Sacramento, CA (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, www.dasconline.org)	
26–30 Sept†	**67th International Astronautical Congress**	Guadalajara, Mexico (Contact: http://www.iafastro.org/guadalajara-to-host-iac-2016)	
17–20 Oct†	**22nd KA and Broadband Communications Conference and the 34th AIAA International Communications Satellite Systems Conference**	Cleveland, OH (Contact: Chuck Cynamon, 301.820.0002, chuck.cynamon@gmail.com)	

For more information on meetings listed above, visit our website at www.aiaa.org/calendar or call 800.639.AIAA or 703.264.7500 (outside U.S.).

†Meetings cosponsored by AIAA. Cosponsorship forms can be found at https://www.aiaa.org/Co-SponsorshipOpportunities/.

AIAA Continuing Education courses.

From the **Corner** Office

GIVING THANKS AND GIVING BACK

Michael Griffin, Chair, AIAA Foundation

As we are now in the season of giving, I wanted to focus this column on the AIAA Foundation and how it has influenced so many lives since its establishment in 1996. With your support, the AIAA Foundation has made an impact on hundreds of thousands of students at the K–12 and university levels.

Through the generosity of members like you, our educational programming has:

- Supported more than 200 student branches, 8,000 student members, and 4,000 Educator Associates
- Provided more than 1,200 K–12 Classroom Grants, impacting over 120,000 precollege students
- Awarded aerospace scholarships to more than 1,300 undergraduate and graduate students
- Sponsored more than 400 student conferences, engaging more than 13,000 students
- Sponsored design competitions that have generated more than 1,200 teams, engaging more than 14,000 students

And while the programs and the outreach are most impressive and influence our future workforce, we have an opportunity to do more and reach more students with your support. At the AIAA Propulsion and Energy 2015 forum this summer, we heard that students and young professionals are lacking skills needed by employers, including presentation skills, technical writing, and team participation. AIAA's student conferences and design competitions not only provide these fundamental skills, they also allow for peer-to-peer and peer-to-professional networking. As the Foundation continues to grow, we will be able to offer more programming designed to build solid bonds between the current generation of the aerospace workforce and the next generation – making sure that the next generation is well positioned to continue in the efforts to shape the future of aerospace.

To illustrate in better detail what your donations mean to the Foundation and the rationale behind why people contribute to the Foundation, I thought I would share some of the feedback given to us about the generous donations we have received and why they were given. By sharing these voices, we hope that you will recognize how critical your support of the Foundation is and that you will continue to give generously in support of our mission.

I was active in my AIAA student branch for four years, and while working at a JPL information session, I introduced myself to my current boss Dave Mohr. The next year, I emailed him my resume and he offered me an internship because he remembered me from the event and liked that I was an AIAA officer. That internship turned into another one the summer after my junior year, and eventually into full-time employment, all thanks to my involvement in AIAA student programs!
Samantha Walters (A 2015 Recipient of the Alexander R. Norris Space View Internship; AIAA member since 2010)

Generous investments in my education, such as this scholarship from the AIAA Foundation, are a huge support in making my ultimate goal an achievable reality. Being an active participate in AIAA throughout my college career has played an extremely significant part in defining my career. For the rest of my life, I will remember and value the role that AIAA has played in my growth and development as an engineer and a professional.
Braden Hancock (2014 Recipient of the George and Vicki Muellner Scholarship; AIAA member since 2011)

The AIAA National Student Conference Awards are well regarded and I believe helped me get into the Ph.D. program at Stanford University. But even if I had not won, the self-motivation, organization, planning, and execution that I practiced in doing the project on which my AIAA award was based have helped me succeed in life generally. Technical sufficiency is a given in all the projects that competed for the award, but public speaking, clarity of communication, and translation of a potentially esoteric technical subject into terms that a broader audience might find compelling are aspects of winning the award that have greatly helped me in later life. I am truly grateful for that experience.
Ian Sobieski (Managing Director, Band of Angels; AIAA member since 1988)

As an educator, AIAA has been an amazing resource for professional development workshops and grants to enrich my classroom curriculum. My students have launched rockets hundreds of feet into the air and soldered circuit boards for the underwater remotely operated vehicles. My hope is to inspire the next generation of scientists and engineers, and AIAA helps me to provide those meaningful experiences in the classroom.
Kaci Heins (6th grade science, Northland Preparatory Academy; AIAA Educator Associate, member since 2011)

I selected AIAA to administer this internship in my father's name because of AIAA's mission and program fostering aerospace ingenuity and collaboration, which reflects my father's own professional career and commitment to aerospace.
Laurie Pearson (Daughter of the late Alexander Norris; founder of the current AIAA internship program)

I give to help young people realize what they can accomplish in aerospace.
John Tracy (CTO, The Boeing Company; AIAA Fellow, member since 1985)

So as we begin to close out this year, I hope you will join the AIAA Foundation Board of Trustees and me in making a donation to the Foundation. Your support is critical to continuing to enhance and offer the educational programs, conferences, and competitions that underpin our long-standing legacy to attract, educate, and build tomorrow's aerospace leaders so that they can shape the future of aerospace.

For more information and to make a donation, please visit www.aiaafoundation.org.

AWARDS PRESENTED DURING ICSSC 2015

AIAA congratulates recipients of the following awards, which were presented during the 33rd AIAA International Communications Satellite Systems Conference (ICSSC) held in September on the Gold Coast of Australia.

AIAA Aerospace Communications Award
Edward Ashford, President of Ashford Aerospace Consulting, for mentoring and education contributions in satellite communication.

Communication Systems Technical Committee Outstanding Committee Member Award
Thomas Butash, Founder of Innovative Aerospace IS, for many years of dedicated service and contributions.

AIAA Aerospace Communications Best Paper
"Spatially Superposed Highly Efficient 32APSK Transmission System," AIAA 2015-4334, Masayoshi Tanaka and Takahiro Ohkub, Nihon University.

Edward Ashford

Thomas Butash

AIAA Aerospace Communications Best Student Paper
"On the Accuracy of Simplifed Volterra Series Models for Multicarrier Satellite Systems using Faster-than-Nyquist Signaling," AIAA 2015-4307, Thomas Delamotte, Robert T. Schwarz and Andreas Knopp, Munich University of the Bundeswehr.

AIAA K–12 STEM ACTIVITIES

Supriya Banerjee and Angela Diggs, AIAA K-12 STEM Section Engagement and Best Practices Committee

The AIAA Foundation recently established the K–12 STEM Committee; the committee has several working groups focused on various aspects of K–12 STEM programming across AIAA. The Section Engagement Working Group's role is to maintain awareness of K–12 STEM activities in the sections and communicate those activities to sections/regions to promote strong K–12 STEM programming across AIAA. Each month we will highlight an outstanding K–12 STEM activity; if your section would like to be featured, please contact us directly.

Girl Scout Aerospace Badge Event (AIAA St. Louis Section)

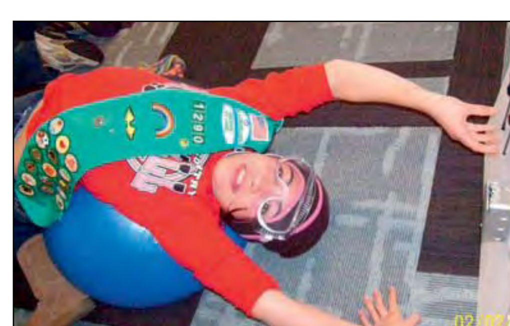
Karen Copper

Sixty-seven girl scouts and 15 leaders/parents visited The Boeing Company to participate in a workshop to earn their Aerospace badge. Twenty-three volunteers from Boeing Women in Leadership, AIAA, and the Girl Scouts Council of Greater St. Louis planned, organized, and led the day's events; AIAA led the Astronaut activity.

AIAA volunteers introduced the girls to the activity with a PowerPoint presentation showing the environment that astronauts experience in space aboard the shuttle and space station, the physical demands on the astronauts' body, and the team attitude required in such tight quarters. The girls learned about U.S. women astronauts, the diversity in educational backgrounds, and the wide cross-section of age, ethnicity and experience of the women. Handouts with links to the NASA astronaut biography website and the AIAA Careers in Aerospace booklets were available for the girls to take.

For the activity, five lab stations "in space" were assembled. Each station consisted of an exercise ball and a foam core lab bench complete with gloves, goggles, tools, metal outlet box, cover, and hardware all attached with Velcro to the board. Each lab station was staffed with 2 or 3 "astronauts."

To give the girls the sense of working under distracting circumstances like the astronauts experience in space, each child had the opportunity to "suit up" in the goggles/gloves, sit on the ball, lean over backward to attach the cover to the outlet box—all the while taking care to "control" their hardware on the Velcro board to prevent the pieces from floating away from them. The intention of working backward with their head upside down was to gain the sense of the "puffy face" syndrome the astronauts experience in space. The other team members held the feet of the working "astronaut" to provide stability on the ball.



REGIONAL LEADERSHIP CONFERENCE HELD IN SEPTEMBER

The 2015 Regional Leadership Conference was a success again this year. There were 46 attendees from 29 different sections including a member from Sydney, Australia. The conference kicked off with a reception the night before, where conference attendees, AIAA Board members, and staff were able to meet and network. In addition, an awards ceremony at the reception celebrated and publicized the hard work done over the past year by all the sections, and recognized the recipients of first-place section awards. Annalisa Weigel, vice president of Member Services, presented the first-place winners with their awards.

The conference started the next morning with sessions throughout the day. Attendees particularly enjoyed a session where they were able to exchange ideas and share their experiences, successes, and challenges. Attendees also enthusiastically participated in a competitive event, "Channeling Your Inner MacGyver." In this event, teams created a method for launching a whiffle ball using a box of diverse items, with the object being to propel the ball farthest.

Celebrating the Class of 2016

Each year, the Institute recognizes exemplary professionals for their accomplishments in engineering or scientific work, outstanding merit and contributions to the art, science, or technology of aeronautics or astronautics.

The Class of 2016 Associate Fellows will be officially recognized during the Associate Fellows Recognition Ceremony and Dinner, to be held in conjunction with **AIAA SciTech 2016** on Monday evening, 4 January 2016, at the Manchester Grand Hyatt in San Diego, California.

For a complete listing of the Class of 2016 Associate Fellows, please visit **www.aiaa.org/2016AssociateFellows/**

Please support your colleagues, and join us for the induction of the 2016 Associate Fellows. Tickets to this celebrated event are available on a first-come, first-served basis and can be purchased for $100 via the AIAA SciTech 2016 registration form, 2016 Associate Fellows Dinner event registration form, or onsite (based on availability).

Business attire/semi-formal attire is requested. For more information, please contact **Patricia A. Carr,** Program Manager, Membership Advancement Program, at **triciac@aiaa.org** or **703.264.7523.** On the web, please visit **www.aiaa-SciTech.org/Recognition.**

AIAA
Shaping the Future of Aerospace

15-888

SECTION OFFICERS 2015–2016

AIAA has 60 sections throughout the United States and overseas organized into seven AIAA Regions. Each section offers technical programs, public policy events, STEM outreach, networking opportunities and many other activities tailored to local aerospace professionals, students, and educators. The officers of each section are all volunteers who work hard to develop and execute these activities on behalf of their local colleagues. The officers for 2015–2016 are listed below.

Region I - North East

Ferdinand Grosveld	Director
Supriya Banerjee	Deputy Director, Career & Professional Development
Raymond Sedwick	Deputy Director, Education
John Crassidis	Deputy Director, Honors & Awards
Justin Likar	Deputy Director, Membership
Timothy Dominick	Deputy Director, Public Policy
Carolyn Slivinski	Deputy Director, STEM K-12
Benjamin Jimenez	Deputy Director, Student Affairs
Stephen Rizzi	Deputy Director, Technical
Vignesh Ramachandran	Deputy Director, Young Professionals
Adam Zachar	Regional Student Liaison

Central Pennsylvania

Mark Maughmer	Chair
Michael Micci	Audit Committee Chair
Robert Melton	Membership Officer
Jack Langelaan	Secretary, Public Policy Officer
David Spencer	Treasurer
Joseph Horn	Vice Chair

Connecticut

David Hobbs	Chair, Honors & Awards Chair
Justin Likar	Membership Officer
Timothy Wagner	Newsletter Editor
Caroline d'Otreppe	STEM K-12 Officer
Stephen Rocketto	STEM K-12 Officer
Wesley Lord	Treasurer

Delaware

Breanne Sutton	Chair
Timothy McCardell	Career and Professional Development Officer
Joseph Scroggins	Communications Officer
William Donaldson	Education Officer
Di Ena Davis	Membership Officer
Timothy Dominick	Public Policy Officer
Eric Spero	Vice Chair, RAC Representative
Douglas Burg	Secretary
Elishabet Lato	STEM K-12 Officer
David Fox	Technical Officer
Erika Conly	Treasurer
Daniel Nice	Young Professional Officer

Greater Philadelphia

Cavon Cormack	Chair
Nicholas Altobelli	Communications Officer
Ian Bournelis	Membership Officer
Michael Brychcy	Technical Officer
Steven Matthews	Treasurer

Hampton Roads

Craig Hutchinson	Chair
Richard Winski	Career and Professional Development Officer
Kenneth Walkley	Corporate Liaison
Steven Bauer	Council Member
Karen Berger	Council Member, STEM K-12 Officer
Robert Calloway	Council Member
William Kilgore	Council Member
Laurence Leavitt	Council Member
James Pittman	Council Member
William Tomek	Council Member, Technical Officer
Dan Vicroy	Council Member
Richard Wahls	Council Member
Elizabeth Ward	Council Member
Courtney Winski	Council Member
Eugene White	Honors & Awards Chair
Marlyn Andino	Membership Officer
Troy Lake	Membership Officer
John Lin	Newsletter Editor
Melissa Carter	Public Policy Officer
Steven Dunn	Public Policy Officer
Sally Viken	RAC Representative
Jeff Flamm	Scholarship Officer
Angie Bukley	Secretary
Jeremy Pinier	Social Media Officer
Shann Rufer	STEM K-12 Officer
Jacob Bean	Student Liaison
Patrick Clark	Student Liaison
Gregory Buck	Treasurer
Dale Arney	University Liaison Officer
Colin Britcher	History Officer, University Liaison Officer
Mayuresh Patil	University Liaison Officer
Alaa Elmiligui	Vice Chair
Christopher Rumsey	Website Editor
Rebecca Stavely	Young Professional Officer
John Wells	Young Professional Officer

Long Island

David Paris	Chair
Anthony Agnone	Council Member, Education Officer
Nicholas DiZinno	Council Member, Website Officer
Joseph Fragola	Council Member, Programs Officer
Muhammad Hayan	Council Member
Peter Kontogiannis	Council Member
John Leylegian	Council Member, Newsletter Publisher
Emil Schoonejans	Council Member
Jason Tyll	Council Member
Wilfred Mackey	Treasurer, RAC Representative, Honors & Awards Chair
Edward Deutsch	Secretary
Gregory Homatas	Vice Chair

Mid-Atlantic

Vignesh Ramachandran	Chair
Robin Vaughan	Chairman Emeritus
Tom Milnes	Communications Officer
Joshua Higginson	Honors & Awards Chair
Barbara Leary	Honors & Awards Chair
Surya Raghu	Programs Officer
Ronald McCandless	Public Policy Officer
Nicholas Rotunda	Secretary
Tom Milnes	STEM K-12 Officer
Kristine Ramachandran	Treasurer
Scott Fry	University Liaison Officer, Young Professional Officer
Brendan McAndrew	Vice Chair

National Capital

Martin Frederick	Chair
Brendan Andrus	Secretary
Michel Santos	Treasurer
David Brandt	Vice-Chair, Operations
Richard Ohlemacher	Vice-Chair, Programs

New England

David Padgett	Chair
Anthony Linn	Communications Officer
John Blandino	Secretary
John Wilkes	STEM K-12 Officer
Xinyun Guo	Treasurer
Anthony Linn	Vice Chair

Niagara Frontier

Walter Gordon	Chair
Andrew Garrell	Treasurer
John Crassidis	Vice Chair

Northeastern New York

Farhan Gandhi	Chair
Howard Brilliant	Membership Officer
Todd Wetzel	Treasurer
Jean-Paul Reddinger	University Liaison Officer
Xiaoqing Zheng	Website Editor

Northern New Jersey

Raymond Trohanowsky	Chair
Yin Chen	Honors & Awards Chair
Anthony Farina	Programs Officer
Fred Swern	Treasurer

Southern New Jersey

Michael Konyak	Chair
Catherine Jaggard	Education Officer
Mary-Ann Boyce	Membership Officer, Young Professional Officer
Kenneth Knopp	Public Policy Officer
Ashley Jurekovic	Secretary
Scott Doucett	Treasurer
Mike Paglione	Vice Chair

Region II - South East

Mark Whorton	Director
Cynthia Williams	Deputy Director, Career and Professional Development
Cassondra Dellinger	Deputy Director, Education
Richard Russell	Deputy Director, Finance
Thomas Hancock	Deputy Director, Honors & Awards
G. Alan Lowrey	Deputy Director, Membership
R. Steven Justice	Deputy Director, Public Policy
John Fay Deputy	Director, STEM K-12
Thomas Mensah	Deputy Director, Technical
Tracie Prater	Deputy Director, Young Professionals

Atlanta

Edward Hutchins	Chair
Brian Dater	Officer Specialized
Aaron Harcrow	Officer Specialized
R. Steven Justice	Officer Specialized
Corey Spiegel	Officer Specialized
Elizabeth Balga	Secretary
Neil Hall	Treasurer
Kenneth Cooksey	Vice Chair

Cape Canaveral

David Fleming	Chair
Jared Brewer	Communications Officer
Bruce Vu	Honors & Awards Chair
Kevin Simmons	Member
Tristan Clouse	Membership Officer
Jarvis Hudson	Public Policy Officer
Luke Roberson	RAC Representative
Anthony Mansk	Secretary
Brian Kaplinger	STEM K-12 Officer
Taylor Dacko	Treasurer
Matthew Zuk	Vice Chair
Sharif Abdel-Magid	Young Professional Officer

Carolina

Keith Young	Chair
Allison Carney	Chair-elect
John Paul Shebalin	Communications Officer, North Carolina Liaison
Theodoros Spanos	Education Officer
Kayley Seawright	Membership Officer
Brian Kirby	Programs Officer
Madeline Augustin	Secretary
Jonathan Maddux	Treasurer
Nhatanh Ha	Website Editor
Snehal Patel	Young Professional Officer

Central Florida

Aaron Blevins	Chair
Eliot Ramey	Career and Workforce Development Officer
Josh Giffin	Secretary, Communications Officer, Membership Officer
Seetha Raghavan	Education Officer
Randal Allen	Honors & Awards Chair; STEM K-12 Officer
Gerald Lutz	Other
James McBrayer	Other
Christopher Stevens	Other
Giovanni Bonfanti	Programs Officer
Jason Hopkins	Public Policy Officer
Jaysen Mulligan	Student Liaison
Christopher Parks	Student Liaison
Brent York	Technical Officer
Eliot Ramey	Treasurer
Richard Lind	University Liaison Officer
Seetha Raghavan	University Liaison Officer
Yunjun Xu	University Liaison Officer
Amanda DePreta	Vice Chair
Jose Castillo	Young Professional Officer
John Davis	Young Professional Officer

Greater Huntsville

Kurt Polzin	Chair
Joseph Herdy	Council Member
Jesse Jones	Education Officer
Sheree Gay	Honors & Awards Chair
Kunning Xu	Newsletter Editor
Keith Koenig	Officer Specialized
Robert La Branche	Public Policy Officer
Tamara Cottam	Secretary
Megan Beattie	STEM K-12 Officer
Neal Allgood	Student Liaison
John Lassiter	Technical Officer
Darby Cooper	Treasurer
Brandon Stiltner	Vice Chair
Arloe Mayne	Website Editor
Cody Crofford	Vice Chair, Young Professional Officer

Greater New Orleans

Laurence de Quay	Chair
Megan Harrington	Membership Officer
Mounir Sabbagh	Membership Officer
Carla Guzzardo	Secretary
Dawn Davis	Treasurer

Northwest Florida

Benjamin Dickinson	Chair
Michael Sytsma	Membership Officer
Chi Mai	Secretary, Web Editor
Michael Kelton	Treasurer
Angela Diggs	Vice Chair

Palm Beach

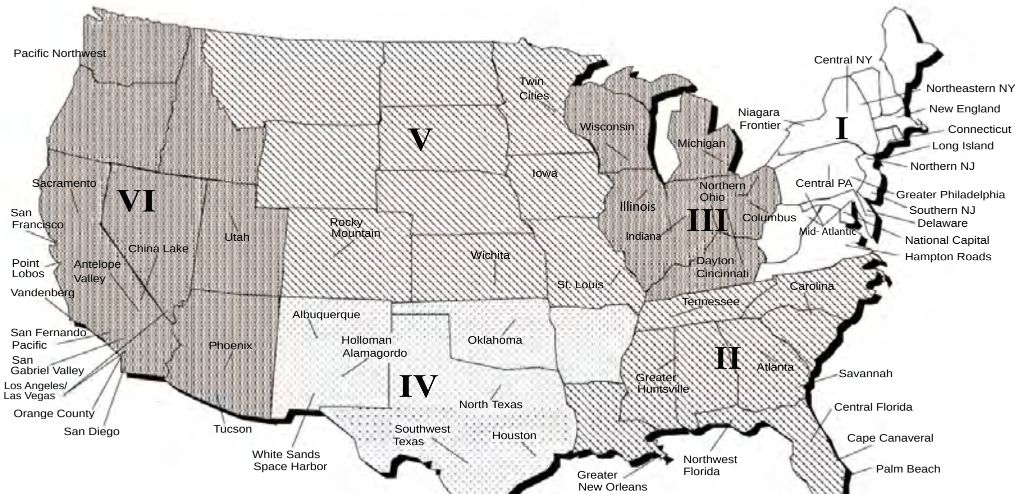
Michael Popp	Chair
Bruce Trembly	Treasurer, Career and Professional Development Officer
Claude Joyner	Programs Officer

Savannah

Jason Riopelle	Chair
Cameron Carson	Career and Professional Development Officer
Kevin Shea	Career and Professional Development Officer
Suzanne Swaine	Honors & Awards Chair
Christopher Kabureck	Membership Officer
Jonathan Hughes	Officer Specialized
Ryan Stanford	Officer Specialized
Anne Carobine	Programs Officer
Wendy Pifer	Programs Officer
Suzanne Swaine	Scholarship Officer
Craig Willis	Secretary
James Fowlkes	STEM K-12 Officer
Alex Rummel	STEM K-12 Officer
Charles Harrison	Treasurer
Miguel Amador	Young Professional Officer

Tennessee

Joseph Sheeley	Chair
Joseph Wehrmeyer	Honors & Awards Chair
Trevor Moeller	Member
Martha Simmons	Member



AIAA Regions I–VI. Region VII territory is everything outside the U.S.

Frank Steinle	Membership Officer
Benjamin Mills	Secretary
James Burns	STEM K-12 Officer
Taylor Swanson	Technical Officer
Nissa Smith	Treasurer
Andrew Redmon	University Liaison Officer
Dustin Crider	Vice Chair
William Mallory	Young Professional Officer

Region III - Central

Daniel Jensen	Director
Suresh Aggarwal	Deputy Director, Education
Leo Burkardt	Deputy Director, Finance
Sivaram Gogineni	Deputy Director, Honors & Awards
Oliver Leembruggen	Deputy Director, Membership
John Sordyl	Deputy Director, Public Policy
Robert Bruckner	Deputy Director, Technical
Janice Gong	Deputy Director, Young Professionals

Columbus

Corso Padova	Chair, Honors & Awards Chair
Thomas Ramsay	Membership Officer
Jolanta Janiszewska	Secretary, Newsletter Editor
Ellis Hitt	Treasurer
Thomas Ramsay	Website Editor

Dayton/Cincinnati

Michael List	Chair, Secretary
Oliver Leembruggen	Communications Officer, University Liaison Officer
Aaron Altman	Education Officer
Marc Polanka	History Officer, Honors & Awards Chair
Richard Anthony	Officer Specialized
Mark Mears	Officer Specialized
Cynthia Obringer	Officer Specialized
Margaret Ratcliff	Officer Specialized
Ryan Schmit	Officer Specialized
Richard Wills	Officer Specialized
C. F. Lance Chenault	Other
Michael White	Public Policy Officer
Sivaram Gogineni	RAC Representative
Jose Camberos	STEM K-12 Officer
Darius Sanders	Treasurer
Aaron Altman	University Liaison Officer
Jayesh Mehta	Vice Chair
Robert Mitchell	Young Professional Officer

Illinois

Harry Hilton	Chair
John Prussing	Treasurer
David Carroll	Young Professional Officer

Indiana

Andrew Pool	Chair
Sarah Arnac	Secretary
Peter Schenk	Treasurer

Michigan

Thomas Mirowski	Chair
Dustin Moyer	Communications Officer
Michelle Clarke	Education Officer
Karen Swinkey Mirowski	Honors & Awards Chair
George Placinta	Programs Officer
John Sordyl	Public Policy Officer
Jeffrey Herbon	Treasurer
Jonathan Vartanoff	Vice Chair
Janice Gong	Young Professional Officer

Northern Ohio

James Gilland	Chair
Kevin Melcher	Chairman Emeritus
Edmond Wong	Communications Officer
Geoffrey Landis	Honors & Awards Chair
Jeffrey Csank	Membership Officer
Leo Burkardt	Officer Specialized
Christine Pastor-Barsi	Officer Specialized, Treasurer
Amber Abbott-Hearn	Public Policy Officer
Jonathan Litt	Secretary
Julie Kleinhenz	STEM K-12 Officer
Albert Juhasz	Technical Officer
Joseph Connolly	University Liaison Officer
Jason Wolf	University Liaison Officer
Peggy Cornell	Vice Chair
Edmond Wong	Website Editor
Roger Tokars	Young Professional Officer

Wisconsin

Todd Treichel	Chair
Anand Vyas	Officer Specialized
Martin Chiaverini	Public Policy Officer
Todd Treichel	STEM K-12 Officer
Christopher St Clair	Treasurer
Patrick Satyshur	Website Editor
Jonathan McCabe	Young Professional Officer

Region IV - South Central

Jayant Ramakrishnan	Director
Yung-Kang Sun	Deputy Director, Career & Professional Development
Douglas Yazell	Deputy Director, Communications
Mirza Faizan	Deputy Director, Education
James Walker	Deputy Director, Finance
Shirley Brandt	Deputy Director, Honors & Awards
Thomas Moore	Deputy Director, Public Policy
Edgar Bering	Deputy Director, STEM K-12
Sarah Shull	Deputy Director, Technical
Ryan Weisman	Deputy Director, Young Professionals

Albuquerque

Joel Mozer	Chair
Stephen Seiffert	Honors & Awards Chair
Erin Pettyjohn	Membership Officer
Sally Smith	Newsletter Editor, Website Editor
William McCasland	Corp Liaison
Donald Nash	Officer Specialized
Arup Maji	Programs Officer
Mark Fraser	Public Policy Officer
Terry Caipen	Secretary
Elfego Pinon	STEM K-12 Officer
Robert Malseed	Treasurer
Randy Truman	University Liaison Officer
Millay Morgan	Vice Chair
Ryan Weisman	Young Professional Officer

Holloman-Alamogordo

George Ayers	Chair

Houston

Alan Sisson	Chair
Jennifer Wells	Chair-elect
Fred Ouellette	Council Member
Angela Beck	Honors & Awards Chair
Shirley Brandt	Officer Specialized
David Dannemiller	Officer Specialized
Douglas Yazell	Officer Specialized
Laura Sarmiento	Programs Officer
Wayne Rast	Public Policy Officer
Kathleen Coderre	Publicity Officer
Lea Hougland	Secretary
Edgar Bering	STEM K-12 Officer
Fred Ouellette	Treasurer
Justine Wiles	Vice-chair, Technical
Irene Chan	Website Editor

North Texas

James Sergeant	Chair
Mirza Faizan	Education Officer
Kristin Milam	Secretary
Terry Burress	Treasurer
William Stein II	Vice Chair

Oklahoma

Alfred Striz	Chair
Andrew Arena	Secretary
Frank Chambers	Treasurer
Richard Gaeta	Vice Chair

Southwest Texas

Joan Labay-Marquez	Chair
Aubrey Mason	Membership Officer
James Crean	Public Policy Officer
Thomas Moore	Secretary
George Hindman	Technical Officer
Pablo Bueno	Treasurer
Aubrey Mason	Vice Chair
Elliott Bryner	Website Editor

White Sands Space Harbor

Stephen McDougle	Chair
Robert Cort	Education Officer, Honors & Awards Officer
Joe Bullington	Officer Specialized
Stephen McDougle	Treasurer

Region V - Mid-West

Laura Richard	Director
Karen Copper	Deputy Director, Career and Professional Development
Barrett McCann	Deputy Director, Education
Larry Frutiger	Deputy Director, Finance
Andrew Carlson	Deputy Director, Honors & Awards
Gary White	Deputy Director, Membership
James Casler	Deputy Director, Technical
Matthew Cannella	Deputy Director, Young Professionals

Iowa

Michael Gries	Chair
Vinay Dayal	Programs Officer
Travis Sippel	Programs Officer
Sridher Kaminani	Secretary
Albert Ratner	Treasurer
Nithin Kolencherry	Vice Chair

Rocky Mountain

Paul Anderson	Chair
Frederick Slane	Career and Professional Development Officer
Brian Gulliver	Chair-elect
Pamela Burke	Council Member
John Eiler	Education Officer
Orval Powell	Honors & Awards Chair
Jeremiah Schneider	Membership Officer
Adrian Nagle	Newsletter Editor
Pamela Burke	Officer Specialized
Heather McKay	Officer Specialized
Marshall Lee	Programs Officer
Christopher Zeller	Programs Officer
Tracy Copp	Public Policy Officer
Arthur Hingerty	Public Policy Officer
Jason Kuchera	Public Policy Officer
Kevin Mortensen	Secretary
Brendan Coyne	STEM K-12 Officer
Nicholas Zinner	STEM K-12 Officer
John Reed	Technical Officer
Roger McNamara	Treasurer
Erik Eliasen	Vice Chair
Ioan Feier	Vice Chair
Taylor Lilly	Vice Chair
Michael Stoellinger	Vice Chair - Wyoming
John Grace	Website Editor
Lisa Holowinski	Young Professional Officer

St. Louis

William Alban	Chair
Daniel Brzozowski	Advisor
Todd Michal	Advisor
Rudolph Yurkovich	Advisor
Karen Copper	Career and Professional Development Officer, Communications Officer
John Mohr	Communications Officer
Trent Duff	Education Officer, History Officer
Charles Svoboda	Education Officer
Samuel Butler	Honors & Awards Chair
Bradley Sexton	Other
Frank Youkhana	RAC Representative
Thomas Rehmeier	Secretary
Kyle Zimmer	STEM K-12 Officer
Jeffrey Geear	Technical Officer
Chris Tavares	Treasurer
Robert Dowgwillo	Vice Chair
Joseph Henits	Website Editor, Young Professional Officer

Twin Cities

Kristen Gerzina	Chair

Loretta Trevino	Education Officer
Christopher Sanden	Membership Officer, Secretary
James Casler	Officer Specialized
Weston Kirch	Programs Officer
Joshua Kohn	STEM K-12 Officer
Frank Hoffmann	Treasurer
Andrew Carlson	Website Editor

Wichita

Mike Brennison	Chair
Minisa Childers	Education Officer
Vicki Johnson	Honors & Awards Chair, Newsletter Editor
Dustin Tireman	Membership Officer, Programs Officer
Robert Stuever	Public Policy Officer
David Mayo	Secretary
Thomas Atambo	STEM K-12 Officer
Jonathan Latall	Treasurer
Linda Kliment	Vice Chair

Region VI - West

Jane Hansen	Director
Jeffrey Jepson	Deputy Director, Career and Workforce Development
Marcus Kruger	Deputy Director, Finance
Oleg Yakimenko	Deputy Director, Education
Ranney Adams	Deputy Director, Honors & Awards
Jeffrey Jepson	Deputy Director, Membership
Matthew Angiulo	Deputy Director, Public Policy
Elishka Jepson	Deputy Director, STEM K-12
Jeffrey Laube	Deputy Director, Technical
Brian Pomeroy	Deputy Director, Young Professionals

Antelope Valley

Benjamin Marchionna	Chair
Jason Lechniak	Education Officer
Brendan McCracken	Education Officer
Michael Bociaga	Programs Officer
Nichole Moore	Programs Officer
Clifton Davies	Treasurer
Erik Larson	Vice Chair

China Lake

Jeffrey Scott	Chair
Ying-Ming Lee	Council Member
Randall Drobny	Membership Officer, Young Professional Officer
Ying-Ming Lee	Newsletter Editor
Steven Goad	RAC Representative, Public Policy Officer
Edward Jeter	Secretary, Website
William Sturgeon	Treasurer
Michael Petersen	Vice Chair
Nicola Sarzi Amade	Advisory Committee

Los Angeles-Las Vegas

Jeffery Puschell	Chair
Weston Hanoka	Career and Workforce Development Officer
Ninh Le	Career and Workforce Development Officer
Pamela Deliz	Chapter Officer
Dennis Wonica	Chapter Officer
Lisa Kaspin-Powell	Communications Officer
Brian Franz	Education Officer
Robert Friend	Honors & Awards Chair
Jeff Guild	Honors & Awards Chair
Alvin Leung	Honors & Awards Chair
Sofia Russi	Las Vegas Chapter Representative
Seymour Ferdman	Membership Officer
Rick Garcia	Membership Officer
Richard Van Allen	Officer Specialized
Gina Amanatullah	Programs Officer
Greg Larson	Programs Officer
Dana Puschell	Programs Officer
Pamela Deliz	Public Policy Officer
Charles Kilmer	Public Policy Officer
Michael Todaro	Public Policy Officer
Karl Garman	Secretary
Dan Mikkelsen	STEM K-12 Officer
Claire Aguada	Student Liaison
Brian Franz	Student Liaison
Ian Kunze	Student Liaison
Weston Hanoka	Technical Officer
Gary Moir	Technical Officer
Marsha Weiskopf	Treasurer
Michael Todaro	Vice Chair
Ian Kunze	Young Professional Officer

Orange County

Amir Gohardani	Chair
Martin Bayer	Career and Professional Development Officer
Philip Schulze	Chair-elect
Dino Roman	Chairman Emeritus
Joseph Justin	Council Member
Janet Koepke	Council Member
John Rose	Council Member
Omid Gohardani	Director-At-Large
Robert Koepke	Director-At-Large
Janet Koepke	Education Officer
Keith Flitner	Honors & Awards Chair
James Martin	Programs Officer
Kamal Shweyk	Public Policy Officer
Bob Welge	RAC Representative, Membership Officer
Philip Ridout	Treasurer
Omid Gohardani	Website Editor
Jonathan Hart	Website Editor
Philip Schulze	Young Professional Officer

Pacific Northwest

Elana Slagle	Chair
Marcus Kruger	Chairman Emeritus
Adriana Blom	Council Member
Tamaira Ross	Council Member
William Van Valkenberg	Council Member
Emmanuel Domingo	Honors & Awards Chair
Karl Rein-Weston	Liaison
Stanley Ferguson	Membership Officer
Priscilla Martinez	Newsletter Editor
Paul Vijgen	RAC Representative
Kimberly Hinson	Secretary
Grant Funk	State Representative: Alaska
Inanc Senocak	State Representative: Idaho
Roberto Albertani	State Representative: Oregon
Marcus Kruger	STEM K-12 Officer
Elana Slagle	STEM K-12 Officer
Christopher Roberdeau	Treasurer
Paul Vijgen	Vice Chair
Patrick Remy	Website Editor
Alex Kreul	Young Professional Officer

Phoenix

Dan Frey	Chair
Dennis Barbeau	Career and Professional Development Officer
Rob Trepa	Chairman Emeritus
Matthew Cunningham	Council Member, STEM K-12 Officer
Keith Jenkins	Council Member, Technical Officer
Thomas Martin	Council Member
Richard Kale	Membership Officer
Joshua Loughman	Public Policy Officer
Richard Kale	RAC Representative, Secretary
Mathew Allyn	Student Liaison
Garrick Williams	Treasurer, Young Professional Officer
Joshua Loughman	Vice Chair

Point Lobos

Giovanni Minelli	Chair
Stephen Tackett	Secretary
Andy Newton	STEM K-12 Officer
Daniel Bursch	Treasurer
Lara Magallanes	Vice Chair
Jae-Jun Kim	Website Editor

Sacramento

Brian Pomeroy	Chair
James Hornick	Chairman Emeritus
Andre White	Communications Officer
Brian Pomeroy	Programs Officer
Stephen Reiff	Public Policy Officer
Susana Munoz	Treasurer
Philip Meyer	Young Professional Officer

San Diego

Katherine Kucharski	Chair
Christopher McEachin	Education Officer
Tatiana Roy	Education Officer
Keith Glassman	Honors & Awards Chair
Brian Quan	Membership Officer
Robin Felver	Newsletter Editor
Kevin Burns	Officer Specialized
Marcia Crawford	Programs Officer
Jay Woodard	Programs Officer
John Kucharski	Public Policy Officer
Cesar Martin	RAC Representative
Greg Marien	Scholarship Officer
Steven Jacobson	Secretary
Joel Perez	STEM K-12 Officer
Brianna MacNider	Student Liaison
Martin Miller	Treasurer
Mark Anderson	University Liaison Officer
Ioana Broome	Vice-chair, Long-range Planning
Cesar Martin	Vice-chair, Technical
William Eberts	Website Editor
Marjorie Rima	Young Professional Officer

San Fernando Pacific

L. Dean Miller	Chair, Honors & Awards Chair
Carl Ehrlich	Membership Officer, Technical Officer, Treasurer
Robert Tarn	Secretary
Christine Hansen	State Representative: Hawaii
Corinne Cho	Website Editor

San Francisco

Eric Toldi	Chair
Sylvee Proehl	Honors & Awards Chair, Membership Officer
Lauren Marie Taylor	Other
Jose Ramil Seneris	Public Policy Officer
Needa Lin	Secretary, STEM K-12 Officer
Watson Attai	Treasurer
Stephanie Gowell	Vice Chair
Richard Kwan	Website Editor
Eric Wahl	Website Editor

San Gabriel Valley

Joshua Rottenbacher	Chair
Candice Nunez	Honors & Awards Chair
Natanael Portillo	Membership Officer
Angus McRonald	Newsletter Editor
Sevan Kenderian	Programs Officer
Mar Vaquero	Programs Officer
Ashok Mathur	Public Policy Officer
Gerald Hintz	Treasurer
Sevan Kenderian	Website Editor
Jill Hardash	Young Professional Officer

Tucson

Brian Biswell	Chair
Rajka Corder	Membership Officer
Matthew Angiulo	Public Policy Officer
Michelle Rouch	Society & Aerospace Technology Section Officer
Elishka Jepson	STEM K-12 Officer
Mehrdad Rouhani	Treasurer
Eric Hoffman-Watt	Vice Chair

Utah

Spencer Brown	Chair
John Metcalf	Chair-elect
Jeffrey Boulware	Education Officer
James Thacher	Liaison
Charles Vono	Liaison, Membership Officer
Spencer Brown	Newsletter Editor
James Thacher	Officer Specialized
John Metcalf	RAC Representative, STEM K-12
Mark Snaufer	Treasurer
Jeffrey Boulware	Young Professional Officer

Vandenberg

Keegan McCoy	Chair
Fletcher Hartshorn	History Officer
Marty Waldman	Las Vegas Chapter Representative
Mark Hawes	Programs Officer
David Beil	Treasurer
Graham Doig	University Liaison Officer
Jaime Larios-Barbosa	Vice Chair
Hanna Calvert	Young Professional Officer

Region VII - International

Luisella Giulicchi	Director
Cees Bil	Deputy Director, Education
Klaus Broichhausen	Deputy Director, Honors & Awards
Joao Luiz Azevedo	Deputy Director, Membership
Essam Khalil	Deputy Director, Membership
Christian Mari	Deputy Director, Technical
Michael West	Deputy Director, Australia
Joao Luiz Azevedo	Deputy Director, South America

Adelaide

Mark Ramsey	Chair
Matthew Tetlow	Chairman Emeritus
Leslie Sheppard	Council Member
Mark Bateup	Membership Officer
Chris Butt	Secretary
Ian Tuohy	Technical Officer
Richard Jones	Treasurer
Min Kwan Kim	University Liaison Officer
Stewart Jones	Vice Chair

Sydney

Evan Smith	Chair
Rounak Manoharan	Communications Officer
Courtney Bright	Council Member
Tristan Foon	Council Member
Michael Spencer	Council Member,Honors & Awards Chair
Alexandra Le Fevre	Membership Officer
Andrew Neely	STEM K-12 Officer, Technical Officer
Jacob Hacker	Student Liaison
Alex Ngo	Student Liaison
Alexandra Le Fevre	Area Liaison
Benjamin Morrell	Area Liaison
David Wilson	Treasurer
Kee-Choon Wong	University Liaison Officer
Andrew Gong	Vice-chair, Operations
Matthew Vella	Vice-chair, Technical
Timo Moisiadis	Website Editor
Arnab Dasgupta	Young Professional Officer

AIAA ORANGE COUNTY SECTION: AN EVENTFUL YEAR

The AIAA Orange County (OC) Section had an eventful year filled with many exhilarating activities, which have inspired both the section members and the Orange County community as a whole. Below a number of these activities are highlighted with a particular focus on the Twelfth Annual AIAA Southern California Aerospace Systems and Technology Conference.

During 2014 and 2015, the AIAA OC Section has pursued its Speaker Programs as well as supported various activities such as Design/Build/Fly, and engaged in a variety of STEM activities through active participation, mentorship, and support. As evidenced by the 2014/2015 Sections Awards in the Large Section Category, the AIAA OC Section had a very successful year:

- Outstanding Section – 1st Place
- Outstanding Activity – 1st Place (tied with AIAA Cape Canaveral Section)
- Public Policy – 1st Place
- STEM K–12 – 1st Place
- Membership – 1st Place
- Communications – 3rd Place

ASAT 2015

The Twelfth Annual AIAA Southern California Aerospace Systems and Technology Conference and Banquet, the premier event of the Orange County Section, was held on 2 May. This conference brought together Southern California engineers, researchers, educators, students, leaders, and enthusiasts. The one-day program consisted of 32 presentations in a number of parallel tracks, which included a designated track for Cubesats. Each session was kicked off by a highly regarded keynote speaker: Tom Croslin, vice president, Boeing Commercial Airplane and Darin Russell, videographer and aerial photographer at Lockheed Martin. The banquet speaker was Joseph Vogel, director of Air Launch Space Access, The Boeing Company. The banquet included an overview of Section activities for the year and presentation of awards for Student of the Year, awarded to Violet Malyan (University of California, Irvine), and Young Professional of the Year, Jun Yoon (Boeing Company).

Similar to other years, ASAT 2015 accepted unclassified presentations on all aspects of aerospace systems, technology, vehicle design, program management, policy, economics and education and was structured in three major categories:

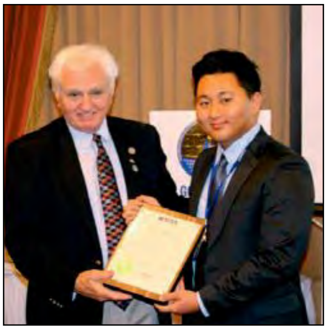
- Aircraft Systems and Technology
- Space Systems and Technology
- Aerospace Public Policy and Education

New for ASAT 2015 was the Gohardani Presentation Award in Aeronautics and Aerospace sponsored by the Springs of Dreams Corporation, a nonprofit organization. This award, including a monetary prize and a certificate, was presented to two individuals who had the most inspirational presentations of ASAT 2015, Eleni Fafoutis (Santa Margarita Catholic High School) and Austin Williams (Tyvak Nano-Satellite Systems). For ASAT 2015, the AIAA Orange County section also chose to sponsor one of the awards.

Dr. Amir S. Gohardani, Eleni Fafoutis (one of the two winners of the 2015 Gohardani Presentation Award in Aeronautics and Aerospace), and Dr. Omid Gohardani.

ASAT 2015 was carefully planned to provide a forum to exchange new ideas, review achievements, and enable networking opportunities for future aerospace endeavors. John Rose, AIAA Associate Fellow, served as the ASAT 2015 Conference Chair and made the following statement: “Local or regional technical conferences are an important aspect of professional development. Not all engineers or students are able to attend a national conference so these local events provide a venue for people to talk about their accomplishments, network, and learn about new areas of technology, policy, and STEM activities going on with their section and industry.”

Year after year, the ASAT conference has brought together the aerospace sector of Southern California with the hopes of revitalizing the rich history of leadership and innovation in the area. This is a tradition that will hopefully continue well beyond the conference’s first 12 years.



Left: Bob Liebeck, Violet Malyan (AIAA OC Section Student of the Year), and Dr. Gene Justin. Right: Dr. Gene Justin and Jun Yoon (AIAA OC Section Young Professional of the Year).

John Rose (ASAT 2015 General Chair) and keynote speaker, Darin Russell.

2015 BEST PAPERS

During 2015, the following papers were recognized as a "Best Paper." Authors were presented with a certificate of merit. Congratulations to each author for achieving technical and scientific excellence!

AIAA Aeroacoustics Best Student Paper
AIAA 2015-2537, "Spatial Stability Characteristics of Non-Circular Jets," Francisco Lajús Jr., Cesar Deschamps and André Valdetaro Gomes Cavalieri.

AIAA Aerodynamic Measurement Testing Best Paper
AIAA 2015-1696, "Pressure Monitoring using Hybrid fs/ps Rotational CARS," Sean Kearney, Sandia National Laboratories, and Paul Danehy, NASA Langley Research Center.

AIAA Aerodynamic Decelerator Systems Technology Best Student Paper
AIAA 2015-2117, "Flight Testing of Autonomous Parafoils Using Upper Surface Bleed Air Spoilers," Edward Scheuermann, Michael Ward, Martin Cacan, and Mark Costello, Georgia Institute of Technology; and Keith Bergeron, U.S. Army Natick Soldier Research, Development, and Engineering Center.

AIAA Aerospace Communications Best Paper
AIAA 2015-4334, "Spatially Superposed Highly Efficient 32APSK Transmission System," Masayoshi Tanaka and Takahiro Ohkub, Nihon University.

AIAA Aerospace Communications Best Student Paper
AIAA 2015-4307, "On the Accuracy of Simplifed Volterra Series Models for Multicarrier Satellite Systems using Faster-than-Nyquist Signaling," Thomas Delamotte, Robert T. Schwarz and Andreas Knopp, Munich University of the Bundeswehr.

AIAA Aerospace Power Systems Best Paper
AIAA 2014-3640, "High Power Density Modular Electric Power System for Aerospace Applications," Scott Steffan and Gregory Semrau, Moog Inc.

AIAA Aerospace Power Systems Best Student Paper
AIAA 2014-3459, "Non-Cooled Power System for Venus Lander," Denise Salazar, The University of Texas at Austin; Geoffrey Landis, NASA Glenn Research Center; and Anthony Colozza, Vantage Partners, LLC.

AIAA Air Breathing Propulsion Systems Integration Best Papers
AIAA 2014-0722, "Numerical and Experimental Investigations on Highly Integrated Subsonic Air Intakes," Thomas Berens, Luis Ruiz-Calavera and David Funes-Sebastian, AIRBUS Defence and Space; Anne-Laure Delot, ONERA; Magnus Tormalm, Swedish Defense Research Agency (FOI); Martin Rein, German Aerospace Center (DLR); Michael Säterskog, Saab; Nicola Ceresola, Alenia Aermacchi; and Ludovic Zurawski, MBDA.

AIAA 2014-3684, "Propulsion System Dynamic Modeling of the NASA Supersonic Concept Vehicle for AeroPropulsoServo-Elasticity," George Kopasakis, Joseph W. Connolly, and Jonathan A. Seidel, NASA Glenn Research Center.

AIAA Aircraft Design Best Paper
AIAA 2014-3012, "A Requirements-driven Methodology for Integrating Subsystem Architecture Sizing and Analysis into the Conceptual Aircraft Design Phase," Imon Chakraborty, David Trawick, and Dimitri Mavris, Georgia Institute of Technology; Mathias Emeneth, PACE Americas Inc.; and Alexander Schneegans, PACE GmbH.

AIAA Applied Aerodynamics Best Paper
AIAA 2014-2139, "Uncertainty Quantification and Certification Prediction of Low-Boom Supersonic Aircraft Configurations," Thomas K. West, Missouri University of Science and Technology; Bryan W. Reuter, University of Texas at Austin; Eric L. Walker, Bill Kleb, and Michael A. Park, NASA Langley Research Center.

AIAA Atmospheric Flight Mechanics Best Paper
AIAA Paper 2015-1477, "High Angle of Attack Model Identi-fication with Compressibility Effects," Joaquim Neto Dias, IPEV - Instituto de Pesquisas e Ensaios em Voo, Sao Jose dos Campos.

AIAA Atmospheric Flight Mechanics Best Student Paper
AIAA 2015-0748, "Non-Iterative Adaptive Limit and Control Margin Estimation with Concurrent Learning," Gonene Gursoy and Ilkay Yavrucuky, Middle East Technical University.

AIAA Computational Fluid Dynamics Best Paper
AIAA 2015-2605, "Improving High-Order Finite Element Approximation Through Geometrical Warping," Devina Sanjaya and Krzysztof Fidkowski, University of Michigan.

AIAA CFD Flow Visualization Showcase
Most Artistic Flow Visualization Animation: AIAA 2015-2617, "The Effect of Initial Conditions on Streamwise Vortices in the Initially Laminar Mixing Layer," William McMullan and Stephen J. Garrett, University of Leicester.

Most Quantitatively Descriptive Flow Visualization Animation: AIAA 2015-3410, "EPIC – An Extract Plug-In Components Toolkit for in-Situ Extracts Architecture," Earl Duque and Daniel Hiepler, Intelligent Light; Robert Haimes, Massachusetts Institute of Technology; Christopher Stone, Computational Science and Engineering, LLC; Steven Gorrell, Matthew Jones, and Ronald Spencer, Brigham Young University.

Most Comprehensive Flow Visualization Animation: AIAA 2015-3419, "A Multi-Phase CFD Technique with Cavitation and Fluid-Structure Interaction" H. Q. Yang, CFD Research Corporation; Peter J. Disimile, University of Cincinnati; and Gregory J. Czarnecki, Wright–Patterson Air Force Base.

AIAA David Weaver Best Student Paper
AIAA 2014-2247, "Microscale Simulations of Porous TPS Materials: Application to Permeability," Eric C. Stern, Ioannis Nompeli, Thomas Schwartzentruber and Graham Candler, University of Minnesota.

AIAA Electric Propulsion Best Paper
AIAA 2014-3710, "The Effect of Background Pressure on SPT-100 Hall Thruster Performance," Kevin D Diamant, The Aerospace Corporation; and Raymond Liang and Ron L Corey, Space Systems/Loral, LLC.

AIAA Fluid Dynamics Best Paper
AIAA Paper 2015-1518, "Large Eddy Simulation of a Three-Dimensional Compression Ramp Shock-Turbulent Boundary Layer Interaction," David Dawson and Sanjiva Lele, Sanford University.

AIAA Ground Testing Best Paper
AIAA 2014-2800, "Skin Friction Sensor Validation for High-Speed, High-Enthalpy Flow Applications," Ryan Meritt and Joseph Schetz, Virginia Polytechnic Institute and State University.

AIAA Guidance, Navigation and Control Best Student Paper
AIAA 2015-1320, "Continuation Analysis of Nonlinear Systems with Equality Constraints on States, Parameters, and Eigenvalues," Max Spetzler, University of Washington.

AIAA High Speed Air Breathing Propulsion Best Paper
AIAA Paper 2014-3743, "A Priori Analysis of Flamelet-Based Modeling for a Dual-Mode Scramjet Combustor," Jesse R. Quinlan and James McDaniel, University of Virginia; Tomasz Drozda, NASA Langley Research Center; and Guilhem Lacaze and Joseph Oefelein, Sandia National Laboratories.

AIAA Hybrid Rockets Best Paper
AIAA 2014-3646, "Evaluation of Paraffin-based Fuels for Hybrid Rocket Engines," Mario Kobald, C. Schmierer, Helmet Ciezki, Stefan

Schlechtriem, German Aerospace Center DLR; and Elena Toson and Luigi De Luca, Politecnico di Milano.

AIAA Hybrid Rockets Best Student Paper
AIAA-2014-3868, "Effects of Injector Design on Combustion Stability in Hybrid Rockets Using Self-Pressurizing Oxidizers," Benjamin Waxman, Brian Cantwell and Jonah Zimmerman, Stanford University; and Greg Zilliac, NASA Ames Research Center.

AIAA Hypersonic Systems and Technologies Best Paper
AIAA 2014-2372, "System Studies on Active Thermal Protection of a Hypersonic Suborbital Passenger Transport Vehicle," Tobias Schwanekamp, Frank Meyer, Thomas Reimer, Ivaylo Petkov, Anke Tröltzsch and Martin Siggel, German Aerospace Center.

AIAA Intelligent Systems Best Paper
AIAA 2013-4584, "Robust Trajectory Planning for Autonomous Parafoils under Wind Uncertainty," Brandon D. Luders, Ian Sugel, and Jonathan P. How, Massachusetts Institute of Technology.

AIAA Intelligent Systems Best Student Paper
AIAA 2015-0115, "A Constrained Markov Decision Process Framework for Flight Safety Assessment and Management," Sweewarman Balachandran, University of Michigan.

AIAA Liquid Propulsion Best Paper
AIAA 2014-3681, "Combustion Stability Characteristics of the Project Morpheus Liquid Oxygen / Liquid Methane Main Engine," John C. Melcher & Robert L. Morehead, NASA Johnson Space Center.

AIAA Modeling & Simulation Best Paper
AIAA 2014-2206, "Transfer of Training on the Vertical Motion Simulator," Peter Zaal, NASA Ames Research Center; Jeffrey Schroeder, Federal Aviation Administration; and William Chung, SAIC.

AIAA Multidisciplinary Design Optimization Best Paper
AIAA-2014-3274, "Aerostructural Optimization of the Common Research Model Configuration," Gaetan Kenway and Joaquim Martins, University of Michigan; and Graeme Kennedy, Georgia Institute of Technology.

AIAA Multidisciplinary Design Optimization Best Student Paper
AIAA 2015-3355, "A Discrete Adjoint Framework for Unsteady Aerodynamic and Aeroacoustic Optimization," Yuxiang Beckett Zhou, Tim Albring, and Nicolas Gauger, TU Kaiserslautern; and Thomas Economon, Francisco Palacios, and Juan J. Alonso, Stanford University.

AIAA Nuclear and Future Flight Propulsion Best Paper
AIAA 2014-3520, "Developing the Pulsed Fission-Fusion (PuFF) Engine," Robert Adams, NASA Marshall Space Flight Center; Jason Cassibry, University of Alabama-Huntsville; David Bradley, Yetispace, Inc.; Leo Fabisinski, International Space Systems Inc.; and Geoffrey Statham, ERC Inc.

AIAA Plasmadynamics and Lasers Best Paper
AIAA 2015-0935, "Electric Field Measurements in a Dielectric Barrier Nanosecond Pulse Discharge with Sub-nanosecond Time Resolution," Benjamin Goldberg, Ivan Shkurenkov, Igor Adamovich and Walter Lempert, Ohio State University; and Sean O'Byrne, University of New South Wales at the Australian Defence Force Academy.

AIAA Plasmadynamics and Lasers Best Student Paper
AIAA 2015-0679, "A Latency-Tolerant Architecture for Airborne Adaptive Optic Systems," William R. Burns, Eric J. Jumper and Stanislav Gordeyev, University of Notre Dame.

AIAA Propellants and Combustion Best Paper
AIAA 2014-0647, "Microspheres Composite of Nano-Al and Nanothermite: An Approach to Better Utilization of Nanomaterials," Haiyang Wang, Guoqiang Jian, Jeffery Delisio and Michael Zachariah, University of Maryland.

AIAA Shahyar Pirzadeh Memorial Award for Outstanding Paper in Meshing Visualization and Computational Environments
AIAA 2014-0294, "Conservative Fitting for Multi-Disciplinary Analysis," John Dannenhoffer, Syracuse University; and Robert Haimes, Massachusetts Institute of Technology

AIAA Space Architecture Best Paper
ICES 2014-264, "Habitat Design & Assessment at Varying Gravity Levels," David Akin, Katherine McBryan, Nicholas Limparis, Nicholas D'Amore and Christopher Carlsen, University of Maryland.

AIAA Spacecraft Structures Best Paper
AIAA 2014-1511, "Testing and Application of Numerically Determined Expandable and Foldable Space Structures," Daniel Kling, Jonathan Hinkle, Ryan Cook and Cliff Willey, ILC Dover; and William Doggett, NASA Langley Research Center.

AIAA Thermophysics Best Paper
AIAA 2015-0213, "NASA Langley Experimental Aerothermodynamic Contributions to Slender and Winged Hypersonic Vehicles," Scott Berry and Karen Berger, NASA Langley Research Center.

AIAA/AAS Astrodynamics Specialists Best Paper
AIAA 2014-4216, "A New Regularization Method for Fast and Accurate Propagation of Roto-Translationally Coupled Asteroids," Hodei Urrutxua, Escuela Tecnica Superior de Ingenieros Aeronauticos; and Jesús Pelaez. Technical University of Madrid.

AIAA/AAS Space Flight Mechanics Best Paper
AAS 2014-355, "High-Altitude Deployment of Landers to Asteroid Surfaces Using National Manifolds," Simon Tardivel and Daniel Scheeres, University of Colorado at Boulder; and Patrick Michel, University of Nice-Sophia Antipolis.

American Society for Composites Student Paper in Composites Award
AIAA 2015-1438, "Buckling Analysis and Optimization of Blade Stiffened Variable Stiffness Panels," Broderick Coburn and Paul Weaver, University of Bristol; and Zhangming Wu, University of Strathclyde.

ASME/Boeing Best Paper
AIAA 2014-1520, "In-Flight Aeroelastic Stability of the Thermal Protection System on the NASA HIAD, Part I: Linear Theory," Benjamin Goldman and Earl Dowell, Duke University; and Robert Scott, NASA Langley Research Center.

Collier Research HyperSizer/AIAA Structures Best Paper
AIAA 2014-1530, "Internally Reinforced Adhesively Bonded Metal to Composite Joints," Stephen Clay, Air Force Research Laboratory; and Vipul Ranatunga, Miami University.

Jefferson Goblet
AIAA 2015-1132, "High-Fidelity Aerostructural Optimization with Integrated Geometry Parameterization and Mesh Movement," Zimi Zhang, Shahriar Khosravi and David Zingg, University of Toronto.

Lockheed Martin Student Paper in Structures
AIAA 2015-0975, "Development of Methods for Characterization of Hydrodynamic Ram Cavity Dynamics," Andrew Lingenfelter and David Liu, Air Force Institute of Technology.

Harry H. and Lois G. Hilton Student Paper in Structures
AIAA 2015-0461, "A Novel Two-Parameter Linear Elastic Constitutive Model For Bond Based Peridynamics," Naveen Prakash and Gary Seidel, Virginia Polytechnic Institute and State University.

Southwest Research Institute Paper Award in NDA
AIAA 2015-1144, "A Fleet Risk Prediction Methodology for Mistuned IBRs Using Geometric Mistuning Models," Emily Henry and Joseph Slater, Wright State University; and Jeffrey Brown, Air Force Research Laboratory, Wright-Patterson AFB.

OBITUARIES

AIAA Senior Member Plotkin Died in July

Dr. Kenneth J. Plotkin died on 17 July. He was 70 years old.

Dr. Plotkin attended the Polytechnic Institute of Brooklyn, where he earned his bachelor's degree, and he earned a Ph.D. in Aerospace Engineering at Cornell University. In April 1972, he began his career as an acoustician at Wyle Laboratories. Dr. Plotkin worked at Wyle Laboratories for 43 years, rising to the position of Chief Scientist. During his time at Wyle, he did important work in the areas of aircraft and highway noise modeling, atmospheric sound propagation, community noise, rocket noise, high-speed fluctuating flow, truck tire noise, psychoacoustics, community noise, noise control, and sonic boom.

Dr. Plotkin was a world-renowned expert on sonic boom, a Fellow of the Acoustical Society of America, and had been a member of AIAA for over 50 years.

AIAA Associate Fellow Paolini Died in September

August (Augie) M. Paolini died on 7 September 2015.

Mr. Paolini graduated from The Aeronautical University in Chicago, IL. After graduation, he supported the U.S. war effort at Boeing Aircraft Corp in Seattle, WA, as an aeronautical engineer.

After World War II ended, Mr. Paolini moved to St. Louis, MO, where he joined the McDonnell Aircraft Corp. When McDonnell won the bid to produce the Mercury space capsule, which was at the very forefront of the U.S. space program, Mr. Paolini became project manager for the flight testing of the Mercury space capsule. As the Mercury program evolved into the Gemini program, Mr. Paolini managed the space-chamber testing of the Gemini capsule.

Mr. Paolini had been an AIAA member since 1941. Donations can be made in his name to the AIAA Foundation, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.

AIAA Associate Fellow Pletcher Died in September

Richard Pletcher, 80, died 12 September 2015.

Mr. Pletcher graduated from Purdue University with a Mechanical Engineering degree in 1957. He soon departed for active duty in the U.S. Navy, where he served as Ensign and Lieutenant (junior grade) for three years in the Pacific.

After military service, Mr. Pletcher attended graduate school at Cornell University where he received the Master of Science and Ph.D. degrees. From 1965 to 1967, he worked as a senior research engineer at United Aircraft Research Laboratories in Hartford, CT, and then joined the faculty in the Department of Mechanical Engineering at Iowa State University.

Mr. Pletcher was active in several technical societies including the American Society of Mechanical Engineers (ASME) and AIAA. He was a Fellow in ASME and an AIAA Associate Fellow. He received awards from Iowa State University for both teaching and research. Mr. Pletcher received the ASME Heat Transfer Memorial Award in Science in 2009. He was an associate editor of the *Journal of Heat Transfer* and served on the editorial advisory board of *Numerical Heat Transfer*. Mr. Pletcher conducted basic and applied topics in fluid dynamics and heat transfer. He served as principal investigator for numerous research grants from sponsors such as NSF, NASA, the Army Research Office, Allison Gas Turbines, John Deere, Department of Energy, Air Force Office of Scientific Research and served as a consultant to industry and government. He gave many invited lectures throughout the world. He authored or co-authored over 80 journal articles and several books, the most notable of which was *Computational Fluid Mechanic and Heat Transfer*, a textbook that survived three editions over a 30-year period. He served as major or co-major professor for 33 doctoral students and 17 master's students.

AIAA Fellow Lilley Died in September

Professor **Geoffrey Lilley** died on 20 September at age 95. He was one of the leaders in the field of research that became known as aeroacoustics and received the 1984 AIAA Aeroacoustics Award for major contributions to aeracoustics research, including sonic boom and jet noise, and particularly for his theory of the generation and radiation of sound by turbulence and the practical suppression of jet noise.

Professor Lilley began work as a general engineering apprentice with Kodak, where he designed and installed a sophisticated air conditioning system. In 1938, he joined Vickers-Armstrongs, and worked on both aircraft and high-speed bombs. He remained there throughout World War II, during which time he also served in the Home Guard and completed a BSc and then an MSc in engineering and a diploma from Imperial College.

In 1946 he was one of the founders of the College of Aeronautics at what is now Cranfield University. Much of his early research concerned the effects of supersonic speed on air crew, buildings, animals and people below the flight path. He joined the government's Supersonic Transport Aircraft Committee and became involved in engine noise suppression work using Cranfield's wind tunnel facilities.

In 1963 Lilley was appointed professor of Aeronautics at Southampton University, where he built on connections that he had with the Royal Aircraft Establishment at Farnborough. He remained at Southampton for the rest of his career, leading the department to world-class status not only in aeronautics, but in such related fields as ship design and lorry spray control.

Professor Lilley was the leader of the Concorde technical team that persuaded the Port Authority of New York that the new Anglo-French supersonic aircraft could meet strict U.S. noise restrictions. In 1976 the U.S. Congress banned Concorde landings, citing concern over sonic booms. Lilley and his team were given the job of countering U.S. technical objections line by line and succeeded in persuading the Americans to back down.

AIAA Associate Fellow McLane Died in September

James "Jim" C. McLane III died on 22 September.

Mr. McLane graduated from Texas A&M University in 1969 with a B.S. in Aeronautical Engineering, obtaining his P.E. License shortly after.

Mr. McLane began work for Mooney Aircraft as an Associate Engineer focusing on engine installations. He transitioned into the oil & gas industry with Brown & Root in Houston, before advancing his career at Gulf Interstate Engineering as a Senior Engineer in 1980. He helped design a pipeline built in the Alaskan permafrost to bring North Slope natural gas to the lower continental United States.

In 1986, Mr. McLane was hired as a Systems Engineer with Boeing Aerospace Operations to review the reliability and safety of the space shuttle's mechanical systems. During his 12-year career with Boeing he wrote requirements/standards documents (JSC 17481, JSC 16994), served on the panel that created NASA STD3000, and refined designs for the Space Station Freedom project. After Boeing, he was Ground Support Equipment Design Engineer with United Space Alliance through 2006. His list of inventions included NASA lab equipment, service cameras, and machines to recharge astronaut breathing tanks. In 2006, Mr. McLane returned to Gulf Interstate as a Senior Principal Engineer in the gas & oil pipeline design division.

Mr. McLane wrote the controversial essay "Spirit of the Lone Eagle," which suggested a single, manned, one-way mission to Mars without returning. His writings also appeared in *Aviation Week*, *L.A. Times*, *The Space Review*, and *Harper's Magazine*. He was also a judge at the Space Settlement Design Competition at Johnson Space Center for the last several years and he was a long-time member of the AIAA Houston.

CALL FOR NOMINATIONS

Recognize the achievements of your colleagues by nominating them for an award! Nominations are now being accepted for the following awards, and must be received at AIAA Headquarters no later than **1 February**.

Any AIAA member in good standing may serve as a nominator and are urged to read award guidelines to view nominee eligibility, page limits, letters of endorsement, etc. Please note that the nomination form, related materials and the three required AIAA member letters of endorsement must be submitted to AIAA by the nomination deadline. Nominators are reminded that the quality of information is most important.

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

Awards are presented annually, unless otherwise indicated. However AIAA accepts nomination on a daily basis and applies to the appropriate award year.

Aerospace Power Systems Award is presented for a significant contribution in the broad field of aerospace power systems, specifically as related to the application of engineering sciences and systems engineering to the production, storage, distribution, and processing of aerospace power.

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

The industry-renowned **Daniel Guggenheim Medal** was established in 1929 for the purpose of honoring persons who make notable achievements in the advancement of aeronautics. AIAA, ASME, SAE, and AHS sponsor the award.

Durand Lectureship for Public Service, named in honor of William F. Durand, recognizes for notable achievements by a scientific or technical leader whose contributions have led directly to the understanding and application of the science and technology of aeronautics and astronautics for the betterment of mankind.

Energy Systems is presented for a significant contribution in the broad field of energy systems, specifically as related to the application of engineering sciences and systems engineering to the production, storage, distribution, and conservation of energy.

George M. Low Space Transportation Award honors the achievements in space transportation by Dr. George M. Low, who played a leading role in planning and executing all of the Apollo missions, and originated the plans for the first manned lunar orbital flight, Apollo 8. (Presented even years)

Haley Space Flight Award is presented for outstanding contributions by an astronaut or flight test personnel to the advancement of the art, science, or technology of astronautics. (Presented even years)

J. Leland Atwood Award recognizes an aerospace engineering educator for outstanding contributions to the profession. AIAA and ASEE sponsor the award. ***Note***: Nominations should be submitted to ASEE (**www.asee.org**) no later than **15 January**.

Missile Systems Award — Technical Award is presented for a significant accomplishment in developing or using technology that is required for missile systems.

Missile Systems Award — Management Award is presented for a significant accomplishment in the management of missile systems programs.

Propellants and Combustion Award is presented for outstanding technical contributions to aeronautical or astronautical combustion engineering.

Space Automation and Robotics Award recognizes leadership and technical contributions by individuals and teams in the field of space automation and robotics. (Presented odd years)

Space Science Award is presented to an individual for demonstrated leadership of innovative scientific investigations associated with space science missions. (Presented even years)

Space Operations and Support Award is presented for outstanding efforts in overcoming space operations problems and assuring success, and recognizes those teams or individuals whose exceptional contributions were critical to an anomaly recovery, crew rescue, or space failure. (Presented odd years)

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

Space Systems Award recognizes outstanding achievements in the architecture, analysis, design, and implementation of space systems.

von Braun Award for Excellence in Space Program Management recognizes outstanding contributions in the management of a significant space or space-related program or project.

The **William Littlewood Memorial Lecture**, sponsored by AIAA and SAE, perpetuates the memory of William Littlewood, who was renowned for the many significant contributions he made to the design of operational requirements for civil transport aircraft. Lecture topics focus on a broad phase of civil air transportation considered of current interest and major importance.

Nominations should be submitted by **1 February** to SAE at **http://www.sae.org/news/awards/list/littlewood/**.

Wright Brothers Lectureship in Aeronautics commemorates the first powered flights made by Orville and Wilbur Wright at Kitty Hawk in 1903. The lectureship emphasizes significant advances in aeronautics by recognizing major leaders and contributors. (Presented odd years)

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

For further information on AIAA's awards program, please contact Carol Stewart, Manager, AIAA Honors and Awards, carols@aiaa.org or 703.264.7538.

To submit articles to the *AIAA Bulletin*, contact your Section, Committee, Honors and Awards, Events, Precollege, or Student staff liaison. They will review and forward the information to the *AIAA Bulletin* Editor. See the AIAA Directory on page **B1** for contact information.

Upcoming AIAA Continuing Education Courses

Courses at AIAA Science and Technology Forum 2016 (AIAA SciTech 2016)
www.aiaa-scitech.org/CoursesWorkshops

2–3 January 2016

2nd AIAA Aeroelastic Prediction Workshop **(Organized by the AIAA Structural Dynamics Technical Committee)**
How well do modern computational aeroelastic tools predict flutter? How well do they predict unsteady aerodynamic phenomena? How do choices of spatial and temporal parameters and turbulence model affect the solution? How does the presence of separated flow influence the accuracy of the calculations? These are questions being addressed in the 2nd AIAA Aeroelastic Prediction Workshop (AePW-2). AePW-2 will focus on assessing the state of the art of computational methods for predicting unsteady flow fields and aeroelastic response.

The goals of the workshop are to:

- Provide an impartial forum to evaluate the effectiveness of existing computer codes and modeling techniques
- Identify computational and experimental areas needing additional research and development

Systems Requirements Engineering **(Instructor: John C. Hsu, Ph.D.,P.E.)**
Requirements analysis and specification development are the most important contribution at the onset of a program/project. It will set a corrective direction to guide the program/project preventing redesign and rework later on. This course will help familiarize you with an effective method for defining a set of requirements of a system. The focus is on the initial problem of space definition, defining user needs, concept of operations, systems, segment, subsystem requirements, and architecture. Gain an understanding of the following requirements of engineering activities: elicitation of requirements, system requirements analysis, requirements integration, interface requirements and control, functional analysis and architecture, requirements management, and verification and validation of requirements. Learn about the principles and characteristics of organizing well-written requirements and specifications.

Key Topics
- Requirements elicitation and analysis leading to concept of operations
- Systems requirements analysis and requirements fundamentals
- Requirements integration and management
- Specification development
- Functional analysis and architecture
- Interface requirements and control

Guidance of Unmanned Aerial Vehicles **(Instructor: Dr. Rafael Yanushevsky)**
This course presents a rigorous guidance theory of unmanned aerial vehicles. It can be considered as the further development and generalization of the missile guidance theory presented in the author's book, *Modern Missile Guidance* (2007). Guidance of the unmanned aerial vehicles (UAVs) differs from missile guidance. Its goal is different. Moreover, since UAVs can perform variety of functions, the goal depends on a concrete area of their application. To address a wide class of guidance problems for UAVs, a more general guidance problem is formulated and a class of guidance laws is developed. In addition, the obstacle avoidance problem for UAVs is discussed and avoidance algorithms are considered.

Key Topics
- Generalized guidance laws for UAVs
- Waypoint guidance problem
- Rendezvous problem
- Conditional rendezvous problem
- Guidance of a swarm of UAVs
- Obstacle avoidance algorithms

3 January 2016

Structural Dynamics of Rocket Engines Tutorial **(Instructor: Andy Brown, Ph.D.)**
Structural dynamics plays a key role in the design, test, and operation of rocket engines. This talk will discuss some of the types of analyses that are required, such as the Campbell Diagram in turbomachinery, the "side-loads" fluid/structure interaction problem in overexpanded rocket nozzles, and the necessity of a system loads model for the generation of interface design loads. The role of modal and hot-fire test for verification will also be discussed. As structural dynamics is frequently a root cause in failure investigations, we'll be able to see some spectacular video of these failures as well.