Close encounters of the drone kind

How vulnerable are airliners? page 18

21st century spacesuits/10
Fuel-efficient fighter jets/14
Mastering design complexity/32
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EDITOR'S NOTEBOOK
Managing the drone revolution

LETTER TO THE EDITOR
Another option for low-cost access

IN BRIEF
Reducing aircraft separation; ExoMars launch date

INTERNATIONAL BEAT
France’s futuristic airliner; carbon nanotubes; maritime patrol aircraft

THE VIEW FROM HERE
21st century spacesuits

ENGINEERING NOTEBOOK
Powering the fighter jets of the future

OUT OF THE PAST

CAREER OPPORTUNITIES

FEATURES

CLOSE ENCOUNTERS OF THE DRONE KIND
The FAA, aircraft manufacturers and engine builders know what can happen when birds strike airliners. But the experts are less sure about risks posed by the growing legions of drones.

by Michael Peck

MARS VIA THE MOON
Experts want the next U.S. president to incorporate the moon into the country’s Mars exploration plans.

by Debra Werner

VIEWPOINT: MASTERING COMPLEXITY
Systems engineering practices won’t be adequate for a future of ever more complex systems. Lessons from the software industry can help aerospace engineers manage complexity.

by Dianne J. DeTurris and Steven J. D’Urso

BULLETIN

AIAA Meeting Schedule B2
AIAA News B5
AIAA Courses and Training Program B16

ON THE COVER
Photo illustration by Jane Fitzgerald
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
Letter to the Editor

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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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, MADESTRO, 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 uncertainty 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. Anatoly Zak agzak@russianspaceweb.com

Schiaparelli, the ExoMars entry, descent and landing demonstator module (foreground) is shown next to the Trace Gas Orbiter. A possible funding shortfall is threatening ExoMars’ 2018 launch date.
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-hyp 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.
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 station-keeping 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 includes 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.

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 Kozio, 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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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.

“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.

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 be reluctant to chance...
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.

Five decades ago, the first spacewalks thrilled the public and nearly killed two pioneers of extravehicular 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, to-
day’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.

**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-
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 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.
**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 space-suit. 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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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-
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 & Whit-
ney 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.

**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.

Keith Button
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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
michael.peck1@gmail.com
@Mipeck1

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.
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.
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

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**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.
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.
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

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Percentage of total</th>
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<tbody>
<tr>
<td>1. Windshield</td>
<td>20,302</td>
<td>16 percent</td>
</tr>
<tr>
<td>2. Nose</td>
<td>17,654</td>
<td>14 percent</td>
</tr>
<tr>
<td>3. Wing/rotor</td>
<td>16,743</td>
<td>14 percent</td>
</tr>
<tr>
<td>4. Engine(s)</td>
<td>15,814</td>
<td>13 percent</td>
</tr>
<tr>
<td>5. Radome</td>
<td>15,415</td>
<td>13 percent</td>
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### Aircraft components damaged

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<th>Number of cases</th>
<th>Percentage of total</th>
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<tr>
<td>1. Engine(s)</td>
<td>4,321</td>
<td>29 percent</td>
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<tr>
<td>2. Wing/rotor</td>
<td>3,508</td>
<td>24 percent</td>
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<tr>
<td>3. Radome</td>
<td>1,433</td>
<td>10 percent</td>
</tr>
<tr>
<td>4. Other</td>
<td>1,156</td>
<td>8 percent</td>
</tr>
<tr>
<td>5. Windshield</td>
<td>926</td>
<td>6 percent</td>
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The identity of the bird species or species group is known in about half of the strikes.

### Strikes by bird species

<table>
<thead>
<tr>
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<th>Number of cases</th>
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<tr>
<td>1. Mourning dove</td>
<td>6,124</td>
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<tr>
<td>2. American kestrel</td>
<td>3,593</td>
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<tr>
<td>3. Killdeer</td>
<td>3,369</td>
</tr>
<tr>
<td>4. European starling</td>
<td>3,348</td>
</tr>
<tr>
<td>5. Barn swallow</td>
<td>2,863</td>
</tr>
</tbody>
</table>


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.
“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.

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. Ben Iannotta contributed to this article.
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.
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
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.

... 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. 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
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 a 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 propel-lant 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.

“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
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.
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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.

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...
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...
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 unpredictable 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.

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.
The AIAA Defense and Security Forum (AIAA DEFENSE 2016) brings together the contractor, acquisition, and R&D communities for classified and unclassified discussions of critical technical, programmatic, and policy topics in a SECRET/U.S. ONLY unbiased, nonpartisan environment. More than 200 experts will present the latest innovative technological breakthroughs that will integrate with current and next-generation defense systems.

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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. 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. 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. 5 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. 2 The X-15 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.

75 Years Ago, November 1940

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

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.

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5) Contact information for at least three professional references

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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/).

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CHAIR OF AEROSPACE ENGINEERING

The Department of Aerospace Engineering at San Diego State University is seeking a visionary and strategic leader in the field of aerospace engineering and invites applications for the Chair of Aerospace Engineering. Applicants must hold an earned Ph.D. in Aerospace Engineering or a closely related discipline. The applicant must have a distinguished record of accomplishments in aerospace engineering education and research, and an outstanding record of scholarly publications and funded research. The applicant must qualify for appointment at the rank of Professor. Aerospace Engineering is one of four departments in the College of Engineering at San Diego State University. The department has nationally and internationally recognized research programs in aerodynamics, fluid mechanics, and structures. A comprehensive aero lab consisting of a mid-size (4.75 by 2.7 feet) low speed wind tunnel, a supersonic wind tunnel capable of simulating supersonic flows up to Mach number 4.5, and a pressurized water tunnel equipped with the state-of-the-art flow diagnostic and pressure measurement systems are operated within the department. Several faculty in the department are also affiliated with university research centers like the Computational Science Research Center which brings together researchers from various disciplines. Graduates from the department are among top aircraft designers in the nation. The department actively engages undergraduate students in faculty research and promotes extra-curricular professional activities as evident in championships and top positions in the AIAA Design Build and Fly competition in recent years. The department offers Bachelors, Masters and Doctoral degree programs. The ABET-accredited Bachelors degree in Aerospace Engineering is one of seven such Bachelors degrees offered in the College of Engineering. The College of Engineering is the fastest growing of SDSU’s seven Colleges. A new state-of-the-art Engineering and Interdisciplinary Sciences Complex is currently under construction to significantly expand and enhance facilities in the College. Over 95,000 square feet of new space will be added. This will facilitate collaboration between engineers and scientists and promote real-world applications of research discoveries.

The city of San Diego enjoys a mild climate year-round and is a family-friendly urban environment. The metropolitan area is the hub of several leading industries, including major defense contractors and aerospace companies, and it offers extensive opportunities for developing industrial research partnerships. The faculty in the department are actively involved in collaborative research with local industry.

San Diego State University is a large, diverse, urban university and Hispanic-Serving Institution with a commitment to diversity, equity, and inclusive excellence. Our campus community is diverse in many ways, including race, religion, color, sex, age, disability, marital status, sexual orientation, gender identity and expression, national origin, pregnancy, medical condition, and covered veteran status. We strive to build and sustain a welcoming environment for all. SDSU is seeking applicants with demonstrated experience in and/or commitment to teaching and working effectively with individuals from diverse backgrounds and members of underrepresented groups. For more information about the department, college, and university, please visit http://aerospace.sdsu.edu, http://engineering.sdsu.edu, and http://www.sdsu.edu.

Review of applications will begin in December 2015 and will continue until the position is filled. Nominations are accepted. Applicants should submit curriculum vitae, statement of research interests (3 page limit), statement of teaching interests (2 page limit), a vision statement (2 page limit), and complete contact information for at least three professional references via Interfolio at http://apply.interfolio.com/31864.

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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.

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 are 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
Tenure Track Position
In Aerospace Engineering

The Department of Mechanical, Aerospace and Biomedical Engineering (MABE) at the University of Tennessee is seeking an exceptionally qualified candidate with expertise in an area of aerospace engineering for the appointment to the position of Assistant Professor. All outstanding candidates with a strong background in fundamental science and engineering relevant to aerospace engineering will be considered. Candidates applying for this position are expected to have a strong commitment to teaching excellence at both the undergraduate and graduate levels, demonstrate research capabilities that will enable the development of robust externally funded research programs, and produce archival publications in leading scholarly journals. A Ph.D. in Aerospace Engineering or a related field of engineering is required. It is highly desirable for the candidate to have an undergraduate degree from an aerospace engineering program. Primary consideration will be given to those with undergraduate teaching capabilities and interests in the following areas: astronautics, compressible flow, orbital mechanics, space vehicle design, hypersonics, and other space-focused areas.

The University of Tennessee, Knoxville (UTK), a Carnegie Research I institution, is the state's comprehensive, land grant, research institution. The College of Engineering is undergoing a period of substantial growth in both physical infrastructure and research expenditures as it seeks to become a Top-25 ranked Public Institution. More information regarding the Department may be found at http://www.engr.utk.edu/mabe/.

Review of applications will begin January 1, 2016, and will continue until the position is filled. The anticipated start date of the new position is August 1, 2016. Salary is commensurate with the position and experience of the applicant, and highly competitive with Top-25 institutions. Applications should include (1) a concise letter of intent outlining the applicant’s research and teaching goals and objectives; (2) a comprehensive curriculum vitae; (3) a statement of research and teaching interests; and (4) the names, addresses and telephone numbers of at least five references. All documents should be combined into a single PDF file. The preferred method of application or nomination is by email to aesearch2015@utk.edu. As an alternative, materials may be mailed directly to:

Dr. J.I. Frankel, Professor
Search Chair, Aerospace Engineering
Department of Mechanical, Aerospace and Biomedical Engineering
402 Dougherty Engineering Building
University of Tennessee, Knoxville
Knoxville, TN 37996-2210

The University of Tennessee, Knoxville does not discriminate on the basis of race, sex, color religion, national origin, age, disability, or veteran status in provision of education programs and services or employment opportunities and benefits. This policy extends to both employment and admission to the University.

The University does not discriminate on the basis of race, sex, or disability in the education programs and activities pursuant to the requirements of Title VI of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Section 504 of the Rehabilitation Act of 1973, and the American Disabilities Act (ADA) of 1990.
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 Department of Engineering Mechanics anticipates filling an Assistant Professor position beginning June 27, 2016. Desired experience includes mechanics of materials, aerospace structures, finite element analysis, fatigue and fracture, composite materials, structural dynamics, and experimental mechanics. The initial appointment will be for three years and successive reappointments of up to four years are possible. Responsibilities include teaching undergraduate core and majors’ mechanical engineering courses to officer candidates and fulfilling departmental duties. The selected candidate will participate in academic advising, mentoring, accreditation reviews, and directing research in mechanical engineering.

An earned doctoral degree in Engineering Mechanics or Mechanical, Aeronautical, or Astronautical Engineering focused in structural mechanics with demonstrated expertise is required by the time of application. Essential qualities include integrity, industry, cooperation, initiative, and breadth of intellectual interests. Successful candidates will have a strong commitment to undergraduate teaching.

The United States Air Force Academy is located just north of Colorado Springs, Colorado. It is an undergraduate institution that awards the Bachelor of Science degree as part of its mission to educate, train, and inspire men and women to become officers of character, motivated to lead in the United States Air Force and in service to our nation. The student body consists of approximately 4,000 men and women representing every state and several foreign countries. The curriculum includes core academic and professional courses and 27 disciplinary and interdisciplinary majors.

Requirements: Candidates must be a U.S. citizen. The selected candidate must complete a security investigation. Failure to meet the requirements of the investigation will be grounds for termination.

To Apply: Applications must be received by November 30, 2015. Go to www.usajobs.gov. Search for #16-10DFEM in the “Keyword” box, or type in “USAF Academy” in the “Location” box. Click “Search,” then scroll down until you locate this position.

The U.S. Air Force Academy is an Equal Opportunity Employer.
Tenure-Track Faculty Positions in Mechanical Engineering

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.

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 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
**Department of Aerospace Engineering**  
**Unmanned Aerial Systems**

The Department of Aerospace Engineering at Iowa State University ([www.aere.iastate.edu](http://www.aere.iastate.edu)) invites applicants for a faculty position in the area of unmanned aerial systems. The search is focused at the Assistant and Associate Professor level, however, exceptional candidates at the rank of Full Professor may also be considered. We seek outstanding individuals with strong interest in the broad area of unmanned aerial systems (UAS). Research areas of interest include, but are not limited to, autonomy and intelligent systems, crop monitoring, and remote sensing and data management. The ideal candidate would develop a funded research program focusing on agricultural applications of UAS, including field operations in close collaboration with the College of Agriculture and Life Sciences (CALS).

An earned Ph.D. or equivalent terminal degree in Aerospace Engineering or a closely related field is required at the start date of employment. Candidates at the level of Associate or Full Professor must demonstrate a strong record as evidenced by a quality research program, publications, professional recognition, and scholarly impact. Candidates are required to have credentials commensurate with teaching undergraduate and graduate classes in engineering.

Iowa State University is classified as a Carnegie Foundation Doctoral/Research University-Extensive, a member of the Association of American Universities (AAU), and ranked by *U.S. News & World Report* as one of the top public universities in the nation. Over 34,000 students are enrolled, and served by over 6,100 faculty and staff ([www.iastate.edu](http://www.iastate.edu)).

To apply for this position, please go to [www.iastatejobs.com](http://www.iastatejobs.com), click on "Search Jobs", search for posting number: 500160 and then click on "Apply for this Job" to complete the employment application. Guaranteed consideration date is 11/30/2015.

Iowa State University is an Equal Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, age, religion, sex, sexual orientation, gender identity, genetic information, national origin, marital status, disability, or protected veteran status, and will not be discriminated against. Inquiries can be directed to the Director of Equal Opportunity, 3350 Beardshear Hall, (515) 294-7612.

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**THE AIAA SUGGESTION PROGRAM**

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

**Annalisa Weigel**  
VP Member Services  
1801 Alexander Bell Drive, Suite 500  
Reston, VA 20191-4344

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**AEROSPACE ENGINEERING AND MECHANICS UNIVERSITY OF MINNESOTA**

The Department of Aerospace Engineering and Mechanics seeks to fill faculty positions in aerospace systems. Applications are invited in all areas of aerospace systems, particularly those that complement current research activities in the department. These research activities include but are not limited to mathematical modeling of aerospace vehicles or systems; control system analysis and design; state estimation; multi-sensor fusion; and guidance, navigation and control of aircraft, spacecraft and autonomous aerial vehicles. The department has close ties with other departments and on-campus multidisciplinary centers and strong access to experimental and computational facilities. Information about the department is available at [http://www.aem.umn.edu/](http://www.aem.umn.edu/)

The successful candidate will participate in all aspects of the Department's mission, including teaching undergraduate and graduate courses in aerospace engineering mechanics and aerospace systems; supervision of undergraduate and graduate students; service responsibilities; and developing an independent, externally funded research program.

Applicants must have an earned doctorate in a related field by the date of appointment. The intent is to hire at the assistant professor rank. However, exceptional applicants may be considered for appointment at the rank of associate professor with or without tenure. It is anticipated that the appointment will begin Fall 2016.

To apply for this position, candidates must go to [http://www1.umn.edu/ohr/employment/index.html](http://www1.umn.edu/ohr/employment/index.html) and search for Job ID no.: 304466; key word search: Aerospace or visit: [http://z.umn.edu/z97](http://z.umn.edu/z97)

*If searching for the Job ID no. or key word, it may be necessary to broaden the "Jobs Posted Within" range.*

Please attach your: 1) cover letter, 2) detailed resume, 3) names and contact information of three references, and 4) a statement of teaching and research interests as one PDF.

**Application Deadline:** The initial screening of applications will begin on December 1, 2015; applications will be accepted until the position is filled.

*The University of Minnesota is an equal opportunity educator and employer.*
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www.aiaa.org/you
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.

AIAA Directory

**NOVEMBER 2015**

AIAA Meeting Schedule B2
AIAA News B5
AIAA Courses and Training Program B16

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†

† 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.
<table>
<thead>
<tr>
<th>DATE</th>
<th>MEETING</th>
<th>LOCATION</th>
<th>ABSTRACT DEADLINE</th>
</tr>
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<tbody>
<tr>
<td>11–14 Nov†</td>
<td>31st Annual Meeting of the American Society for Gravitational and Space Research (ASGSR)</td>
<td>Alexandria, VA (Contact: Cindy Martin-Brennan, 703.392.0272, <a href="mailto:executive_director@asgsr.org">executive_director@asgsr.org</a>, <a href="http://www.asgsr.org">www.asgsr.org</a>)</td>
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<td>2–3 Jan</td>
<td>2nd AIAA CFD Aerelastic Prediction Workshop</td>
<td>San Diego, CA</td>
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<td>2–3 Jan</td>
<td>Guidance of Unmanned Aerial Vehicles</td>
<td>San Diego, CA</td>
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<td>Systems Requirements Engineering</td>
<td>San Diego, CA</td>
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<td>3 Jan</td>
<td>Structural Dynamics of Rocket Engines Tutorial</td>
<td>San Diego, CA</td>
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<td>4 Jan</td>
<td>AIAA Associate Fellows Recognition Ceremony and Dinner</td>
<td>San Diego, CA</td>
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<td>4–8 Jan</td>
<td>AIAA SciTech 2016 (AIAA Science and Technology Forum and Exposition)</td>
<td>San Diego, CA</td>
<td>2 Jun 15</td>
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<td>24th AIAA/AHS Adaptive Structures Conference</td>
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<td>54th AIAA Aerospace Sciences Meeting</td>
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<td>AIAA Atmospheric Flight Mechanics Conference</td>
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<td>15th Dynamics Specialists Conference</td>
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<td>AIAA Guidance, Navigation, and Control Conference</td>
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<td>AIAA Information Systems—Infotech@Aerospace Conference</td>
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<td>AIAA Modeling and Simulation Technologies Conference</td>
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<td>18th AIAA Non-Deterministic Approaches Conference</td>
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<td>57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference</td>
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<td>9th Symposium on Space Resource Utilization</td>
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<td>3rd AIAA Spacecraft Structures Conference</td>
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<td>34th Wind Energy Symposium</td>
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<td>25-28 Jan†</td>
<td>Annual Reliability and Maintainability Symposium (RAMS)</td>
<td>Tucson, AZ (Contact: Sean Carter, <a href="mailto:seancarter67@gmail.com">seancarter67@gmail.com</a>, <a href="http://www.rams.org">www.rams.org</a>)</td>
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<td>14–18 Feb†</td>
<td>26th AAS/AIAA Space Flight Mechanics Meeting</td>
<td>Napa, CA (Contact: Ryan Russell, 512.471.4190, <a href="mailto:ryan.russell@utexas.edu">ryan.russell@utexas.edu</a>, <a href="http://www.space-flight.org/docs/2016_winter/2016_winter.html">www.space-flight.org/docs/2016_winter/2016_winter.html</a>)</td>
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<td>8–10 Mar</td>
<td>AIAA DEFENSE 2016 (AIAA Defense and Security Forum)</td>
<td>Laurel, MD</td>
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<td>AIAA Strategic and Tactical Missile Systems Conference</td>
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<td>5–12 Mar†</td>
<td>2016 IEEE Aerospace Conference</td>
<td>Big Sky, MT (Contact: Erik Nilsen, 818.354.4441, <a href="mailto:Erik.n.nilsen@jpl.nasa.gov">Erik.n.nilsen@jpl.nasa.gov</a>, <a href="http://www.aeroconf.org">www.aeroconf.org</a>)</td>
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<td>19–21 Apr†</td>
<td>16th Integrated Communications and Surveillance (ICNS) Conference</td>
<td>Herndon, VA (Contact: Denise Ponchak, 216.433.3465, <a href="mailto:denise.s.ponchak@nasa.gov">denise.s.ponchak@nasa.gov</a>, <a href="http://i-cns.org">http://i-cns.org</a>)</td>
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<td>5 May</td>
<td>Aerospace Today ... and Tomorrow—An Executive Symposium</td>
<td>Williamsburg, VA</td>
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<td>16–20 May†</td>
<td>SpaceOps 2016: 14th International Conference on Space Operations</td>
<td>Daejeon, Korea</td>
<td>30 Jul 15</td>
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<tr>
<td>30 May–1 Jun†</td>
<td>22nd AIAA/CEAS Aeroacoustics Conference</td>
<td>Lyon, France</td>
<td>9 Nov 15</td>
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<tr>
<td>30 May–1 Jun†</td>
<td>23rd Saint Petersburg International Conference on Integrated Navigation Systems</td>
<td>Saint Petersburg, Russia (Contact: Ms. M. V. Grishina, +7 812 499 8181, <a href="mailto:icins@eprib.ru">icins@eprib.ru</a>, <a href="http://www.elektropriv.sbp.ru">www.elektropriv.sbp.ru</a>)</td>
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<td>32nd AIAA Aerodynamic Measurement Technology and Ground Testing Conference</td>
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<td>34th AIAA Applied Aerodynamics Conference</td>
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<td>AIAA Atmospheric Flight Mechanics Conference</td>
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<td>8th AIAA Atmospheric and Space Environments Conference</td>
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<td>16th AIAA Aviation Technology, Integration, and Operations Conference</td>
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<td>AIAA Flight Testing Conference</td>
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<td>15 Jun</td>
<td>Aerospace Spotlight Awards Gala</td>
<td>Washington, DC</td>
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<tr>
<td>5–8 Jul†</td>
<td>ICNPA 2016 Mathematical Problems in Engineering, Aerospace and Sciences</td>
<td>University of La Rochelle, France (Contact: Prof. Seenith Sivasundaram, 386.761.9829, <a href="mailto:seenithi@gmail.com">seenithi@gmail.com</a>, <a href="http://www.icnpaa.com">www.icnpaa.com</a>)</td>
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<td>52nd AIAA/SAE/ASEE Joint Propulsion Conference</td>
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<td>14th International Energy Conversion Engineering Conference</td>
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<td>12–15 Sep</td>
<td>AIAA SPACE 2016 (AIAA Space and Astronautics Forum and Exposition)</td>
<td>Long Beach, CA</td>
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<td>Featuring: AIAA SPACE Conference</td>
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<td>AIAA/AS Astrodynamics Specialist Conference</td>
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<td>AIAA Complex Aerospace Systems Exchange</td>
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<td>25–30 Sep†</td>
<td>30th Congress of the International Council of the Aeronautical Sciences (ICAS 2016)</td>
<td>Daejeon, South Korea</td>
<td>15 Jul 15</td>
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<td>(Contact: <a href="http://www.icas.org">www.icas.org</a>)</td>
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<tr>
<td>25–30 Sep†</td>
<td>35th Digital Avionics Systems Conference</td>
<td>Sacramento, CA</td>
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<td>(Contact: Denise Ponchak, 216.433.3465, <a href="mailto:denise.s.ponchak@nasa.gov">denise.s.ponchak@nasa.gov</a>, <a href="http://www.dasconline.org">www.dasconline.org</a>)</td>
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<tr>
<td>26–30 Sep†</td>
<td>67th International Astronautical Congress</td>
<td>Guadalajara, Mexico</td>
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<td>(Contact: <a href="http://www.iafastro.org/guadalajara-to-host-iac-2016">http://www.iafastro.org/guadalajara-to-host-iac-2016</a>)</td>
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<tr>
<td>17–20 Oct†</td>
<td>22nd KA and Broadband Communications Conference and the 34th AIAA International Communications Satellite Systems Conference</td>
<td>Cleveland, OH</td>
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<td>(Contact: Chuck Cynamon, 301.820.0002, <a href="mailto:chuck.cynamon@gmail.com">chuck.cynamon@gmail.com</a>)</td>
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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.
New Release in AIAA’s Library of Flight

**Intercept 1961:**
The Birth of Soviet Missile Defense

**AVAILABLE NOW!**

Award-winning author Mike Gruntman brings us the story, a mystery even to experts, of March 4, 1961, when a Soviet guided missile performed the first nonnuclear intercept of an intermediate range ballistic missile. This early breakthrough paved the way for the emergence of a powerful missile defense complex in the Soviet Union, a major factor in the Cold War. Extremely relevant today, this book considers the “protect-or-avenge” dilemma that the U.S. and other countries still face when balancing offensive capabilities against defensive protection.

**AUTHOR:** Mike Gruntman

**AIAA MEMBER:** $29.95

**LIST:** $39.95

**PRINT ISBN:** 978-1-62410-349-0

**eISBN:** 978-1-62410-350-6

BUY IT NOW! [arc.aiaa.org/r/gruntman](arc.aiaa.org/r/gruntman)
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.
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.

AIAA Associate Fellows Recognition Ceremony and Dinner

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 triciaa@aiaa.org or 703.264.7523.

On the web, please visit www.aiaa-SciTech.org/Recognition.
## 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 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

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<td>Chair</td>
<td>Ferdinand Grosfeld</td>
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<td>RAC Representative</td>
<td>Supriya Banerjee</td>
<td>Deputy Director, Education</td>
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<td>Raymond Sedwick</td>
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AIAA Regions I–VI. Region VII territory is everything outside the U.S.

Frank Steirikin  Membership Officer  Secretary
Benjamin Mills  STEM-K-12 Officer  Technical Officer
James Burns  University Liaison Officer  Treasurer
Taylor Swanson  Deputy Director, Education
Nissa Smith  Deputy Director, Honor & Awards
Andrew Redmond  Deputy Director, Finance
Dustin Cramer  Member Officer Specialized
William Malory  Young Professional Officer

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Suresh Agarwan  Deputy Director, Education
Leo Burkardt  Deputy Director, Finance
Swarnam Geginelli  Deputy Director, Honor & Awards
Oliver Lemebrugin  Deputy Director, Membership
John Sordyl  Deputy Director, Public Policy
Robert Bruckner  Deputy Director, Technical Policy
Janice Gong  Deputy Director, Young Professionals

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Corso Padova  Chair, Honors & Awards Chair
Thomas Ramsay  Secretary, Newsletter Editor
Jolanta Janiszewska  Treasurer
Ediss Hilt  Website Editor
Thomas Ramsay  Website Editor

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Oliver Lemebrugin  Communications Officer, University Liaison Officer
Aaron Altman  Education Officer
Marc Polanka  Liaison Officer
Richard Anthony  Officer Specialized
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Michael White  Public Policy Officer
Sivaram Gogineni  RAC Representative
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Jose Camberos  University Liaison Officer
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Robert Mitchell  Young Professional Officer

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Edmond Wong  Communications Officer
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Julie Keilhenz  Treasurer
Albert Hacasz  Treasurer
Joseph Connolly  Treasurer
Jason Wolf  Treasurer
Peggy Cornell  Treasurer
Edmond Wong  Treasurer
Rogier Tokars  Treasurer

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Anand Vyas  Officer Specialized
Martin Chavensini  STEM-K-12 Officer
Jeffrey Coker  Treasurer
Patrick Satyshrsh  Website Editor
Jonathan McCabe  Young Professional Officer

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Yung-Kang Sun  Deputy Director, Education & Professional Development
Douglas Yassell  Deputy Director, Education
Mihir Faizan  Deputy Director, Finance
James Walker  Treasurer
Miramar  Treasurer
Shirley Brandt  Treasurer
Thomas Moore  Treasurer
Edgar Bering  Treasurer

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Trevor Sippel  Program Officer
Sidrith Kaminari  Secretary
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Paul Anderson  Chair
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Brian Gulliver  Chair-elect
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Onal Powell  Education Officer
Jeremiah Schneider  Honors & Awards Chair
Adrian Nangle  Newsletter Editor
Heather McKay  Treasurer
Christopher Zeller  Secretary
Tracy Copp  Treasurer
Arthur Hingerty  Treasurer
Liam Henshaw  Treasurer
Kevin Mortensen  Treasurer
Brendan Cole  Treasurer
Nicholas Zerega  Treasurer
John Reed  Treasurer
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Erik Elsnain  Vice Chair
Ivan Feir  Treasurer
Taylor Lilly  Secretary
Michael Steinleing  Treasurer
John Grace  Treasurer
Lisa Holowinski  Treasurer

St. Louis
William Alman  Chair
Daniele Brozowski  Advisor
Todd Michal  Advisor
Rudolph Yurkovich  Advisor
Karen Cooper  Career and Professional Development Officer
John Mohr  Communications Officer
Trent Duff  Education Officer
Charles Svoboda  Officer
Samuel Butler  Officer
Bradley Sexton  Other
Frank Youkhan  RAC Representative
Thomas Rehmeier  Secretary
Kyle Zimmer  STEM-K-12 Officer
Jeffrey Grear  Technical Officer
Chris Tavares  Treasurer
Robert Diniolo  Treasurer
Joseph Hendry  Website Editor

Twin Cities
Kristen Gerbner  Chair
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.

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.
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 Aeracoustics Best Student Paper**

**AIAA Aerodynamic Measurement Testing Best Paper**

**AIAA Aerodynamic Decelerator Systems Technology Best Student Paper**

**AIAA Aerospace Communications Best Paper**

**AIAA Aerospace Communications Best Student Paper**

**AIAA Aerospace Power Systems Best Paper**

**AIAA Aerospace Power Systems Best Student Paper**
AIAA 2014-3459, “Non-Coold Power System for Venus Lander,” Denise Salazar, The University of Texas at Austin; Geoffrey Landis, NASA Glenn Research Center; and Anthony Coloizza, 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-Calvera 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 Sáterskog, Saab; Nicola Ceresola, Alenia Aermacchi; and Ludovic Zurawski, MBDA.


**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 Mavis, Georgia Institute of Technology; Mathias Emeneth, PACE Americas Inc.; and Alexander Schneegans, PACE GmbH.

**AIAA Applied Aerodynamics Best Paper**

**AIAA Atmospheric Flight Mechanics Best Paper**

**AIAA Atmospheric Flight Mechanics Best Student Paper**

**AIAA Computational Fluid Dynamics Best Paper**

**AIAA Closure: Best Paper**

**AIAA Electric Propulsion Best Paper**
AIAA 2014-3419, “A Multi-Phase CFD Technique with Cavitation and Fluid-Structure Interaction” H. Q. Yang, CFD Research Corporation; Peter J. Dismilie, University of Cincinnati; and Gregory J. Czarnecki, Wright-Patterson Air Force Base.

**AIAA Guidance, Navigation and Control Best Student Paper**

**AIAA High Speed Air Breathing 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 Mechanics Best Paper**

**AIAA Ground Testing Best Paper**

**AIAA High Speed Air Breathing Propulsion Best Paper**

**AIAA Hybrid Rockets Best Paper**
Schlechttriem, German Aerospace Center DLR; and Elena Toson and Luigi De Luca, Politecnico di Milano.

AIAA Hybrid Rockets Best Student Paper

AIAA Hypersonic Systems and Technologies Best Paper

AIAA Intelligent Systems Best Paper

AIAA Intelligent Systems Best Student Paper

AIAA Liquid Propulsion Best Paper

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 Multidisciplinary Design Optimization Best Design Student Paper

AIAA Nuclear and Future Flight Propulsion Best Paper

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 Propellants and Combustion Best Paper

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 Haines, Massachusetts Institute of Technology

AIAA Space Architecture Best Paper

AIAA Spacecraft Structures Best Paper

AIAA Thermophysics Best Paper

AIAA/AAS Astrodynamics Specialists Best Paper

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

Collier Research HyperSizer/AIAA Structures Best Paper

Jefferson Goblet

Lockheed Martin Student Paper in Structures

Harry H. and Lois G. Hilton Student Paper in Structures

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 Mechanics and Heat Transfer, a textbook that survived three editions over a 30-year period. He served as master 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 Aerodynamics Award for major contributions to aeroacoustics 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 project or program.

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 transport 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

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

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

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

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 over-expanded 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.
CALL FOR PAPERS

Every move forward in our exploration of the world, and the universe, is enabled by new technologies coming from the researchers and engineers who will participate in the AIAA Propulsion and Energy Forum and Exposition 2016. Test your ideas, develop your skills, and build your reputation as you present your research to others from around the world.

Topics Include:

Additive Manufacturing for Propulsion Systems
Advanced Engine Control and Intelligent Systems
Advanced Propulsion Concepts
Advanced Vehicle Systems
Air Breathing Propulsion Systems Integration
Aircraft Electric Propulsion
Electric Propulsion
Electricity Delivery, Grid and Energy Storage Technologies
Energetic Components and Systems
Energy Conversion Device Technology
Energy-Efficient and Renewable Energy Technologies
Fossil-Fuel Power Technologies
Gas Turbine Engines
High Speed Air Breathing Propulsion
Hybrid Rockets

ITAR Topics
Liquid Propulsion
Nuclear and Future Flight Propulsion
Propellants and Combustion
Propulsion and Power Systems of Unmanned Systems
Propulsion Education
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