FALL 2019 | THE A. JAMES CLARK SCHOOL OF ENGINEERING

AEROCONTACT

AEROSPACE ENGINEERING AT MARYLAND

Special Delivery

How drone technology could transport organs directly from the donor hospital to the recipient hospital

Chairman's Corner

Celebrating Our History

As the A. James Clark School of Engineering celebrates the 125th anniversary of engineering education at the University of Maryland, the Department of Aerospace Engineering has much to celebrate as well. This issue of *AeroContact* recognizes three vital components of the department's history as well as more recent innovations that keep us at the forefront of research and education.

It is hard to believe the pace at which unmanned aerial vehicles (UAVs) are developing and the myriad purposes they can serve to improve lives. In this issue's cover story, you will read how UAVs are saving lives and how a collaboration among very different areas in the University System of Maryland led to a lifesaving endeavor that holds promise for organ transportation worldwide.

The department is also taking a leading role in the development of electric-powered vertical takeoff and landing aircraft (eVTOL), which hold great potential for improving transportation, particularly in urban areas, by shortening commuter times, overflying road traffic congestion, and reaching people where they are. Led largely by Associate Professor Anubhav Datta, the department has undertaken several federally funded projects, drawing on multidisciplinary resources across the university, to advance eVTOL flight.

The department would not be one of the most prestigious in the country if not for the solid foundation on which it was built. Among its many innovations, the department may be most recognized for three very different, yet related, initiatives covered in this issue. You can read more about the Alfred Gessow Rotorcraft Center, the Glenn L. Martin Wind Tunnel, and the Space Systems Laboratory.

The accolades and awards continue to pour in to our faculty members, and our students continue to earn scholarships, fellowships, and awards both individually and in team competitions. Our alumni continue to demonstrate exceptional levels of generosity and of achievement as they move through their careers. In sum, the department is flying high on all counts. We look forward to hearing about your connections and achievements in the months to come.

Norman M. Wereley
MINTA MARTIN PROFESSOR AND CHAIR
DEPARTMENT OF AEROSPACE ENGINEERING

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Please send letters to the editor and alumni notes to aero-comms@umd.edu.

Special Delivery

In 2018, a human organ was transported by an unmanned aerial vehicle (UAV), popularly known as a drone, for the very first time. University of Maryland researchers conducted the test flight with an off-the-shelf hexacopter, albeit outfitted with a special container to carry its special cargo.

Nearly a year later, the UAV that delivered a viable, donated kidney to a patient whose life depended on it is heralded as anything but average.

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To create a machine worthy of the groundbreaking three-mile flight on the night of April 19, a team of UMD engineers worked over the course of two and a half years to design and build an automated vehicle and system for the task. Yet when they first got the call about whether such a flight was possible, two of the project's leaders had very different initial reactions.

"Yes," said Matthew Scassero, director of UMD's Unmanned Aircraft Systems (UAS) Test Site.

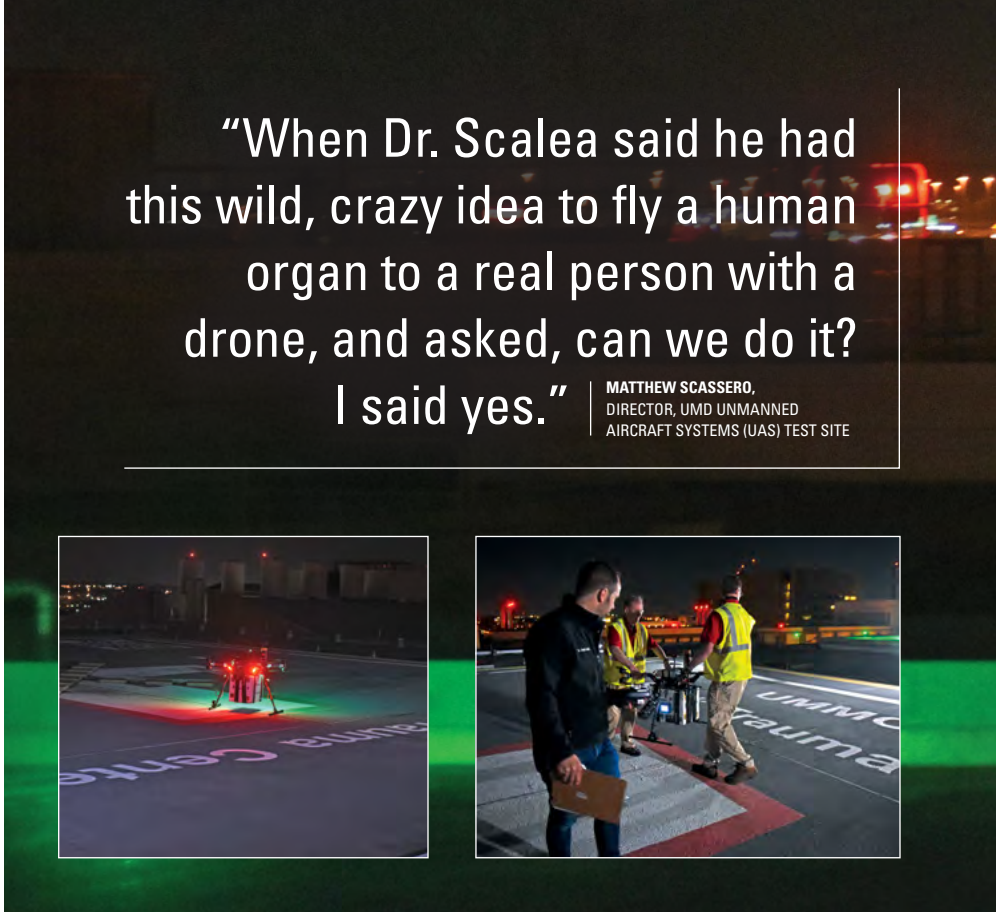
"No," shot back Tony Pucciarella, the Test Site's director of operations at the time.

This yin-yang response—unbridled enthusiasm for pushing the innovation envelope complemented by a careful and methodical pumping of the brakes—is characteristic of the Test Site's work. Though they laugh now when recalling that moment, both men acknowledge that it is exactly this kind of chiaroscuro that is critical to their success.

"My job is to be visionary, to blaze trails, to be the first to do things," Scassero says. "But we need to get there responsibly."

"Initially saying 'no' is to get the time we need to make it all right—and move forward from there to 'yes,'" explains Pucciarella. "This was a was a high-risk operation."

Pucciarella's push-back stemmed from the fact that conventional UAVs are essentially bundles of failures waiting to happen. If any one component falters—motor, rotor, guidance system, power controls—the aircraft is doomed. And, lacking wings, a drone's descent isn't a graceful glide to terra firma; it's a catastrophic plunge to earth.



"When Dr. Scalea said he had this wild, crazy idea to fly a human organ to a real person with a drone, and asked, can we do it? I said yes."

MATTHEW SCASSERO, DIRECTOR, UMD UNMANNED AIRCRAFT SYSTEMS (UAS) TEST SITE

So when Dr. Joseph Scalea called about delivering a live human organ to a living human patient, the Test Site team had their work cut out for them.

Scalea, an assistant professor at the University of Maryland School of Medicine, had read about the Test Site's successful 2016 experiment to deliver a cache of medical supplies via automated aircraft across the Chesapeake Bay. He wondered if something similar could be done with a donated organ.

"The transport of organs takes too long, is too expensive, and is unsafe," Scalea says. "I do not accept that that's the best we can do. Technology like drones could enable us to transport organs directly from the donor hospital to the recipient hospital."

Kidneys were the obvious organ with which to attempt such a feat: of the 124,000 people currently on the national organ waiting list, just over 103,000 need a kidney. Yet in 2018, only 21,167 people waiting for a kidney received one.

Time is of the essence: every hour that a donated kidney is on ice increases the risk for transplant complications. And new federal regulations mandating changes in the organ-matching system has boosted the average distance some donated kidneys must travel to reach a patient—more than 700 miles—which means that an increasing number of organs are transplanted after 24 hours.

Yet moving organs from donor to recipient remains the single most unpredictable variable in the entire process. Delays in commercial air schedules, costly plane and helicopter charters, traffic jams on roads, and even periodic crashes of transport vehicles mean that an estimated 20 percent of donated kidneys must be discarded every year.

PHOTOS: MARK TESKE

Department Chair and Minta Martin Professor Norman Wereley connected Scalea to the Test Site team after Scalea found him through an internet search.

"The delivery of pizzas and burritos never seemed a compelling enough reason to have the Federal Aviation Administration modify rules to allow unmanned systems," Wereley says. "But when Joe called to talk about getting organs delivered as quickly as possible after donation—well, that's a pretty compelling reason."

No stone was left unturned in the process that culminated in the flight. Every last piece of the vehicle was selected for its reliability and robustness, every possible route to failure analyzed and accounted for.

Scassero, Pucciarella, and numerous others at the Test Site, including project engineer Luan Duong, set about addressing as many of the conventional UAV single-point failures as possible—which, on an average quad- or hexacopter-style drone, is in the neighborhood of 40 different components. Including all the moving parts, Test Site engineers scrutinized power distribution, communications systems, and central computer and navigation systems, striving to use only the best commercially available drone components.

Among other redundant safety features, the final design of the 50-pound UAV boasted eight rotors (two could fail and the vehicle would still fly), a parachute, a backup battery, and a mesh network radio system able to automatically select the best communications connections at any point along the flight path.

In addition to coordinating participation between multiple City of Baltimore agencies and partners for the flight itself, Scassero and Pucciarella say the project also offered an opportunity to contribute to the ongoing conversation about how UAVs will one day be integrated into the national airspace.

This particular UAV worked without a hitch for its mission, as it was designed specifically for this job. In the future, it's possible that each type of organ will require a different kind of aircraft. And the UAS Test Site will be working over the next several years to develop a corridor network for UAVs that may one day be used for even more organ deliveries.

"We've overcome the hurdle of whether this is possible," says Charlie Alexander, president of the Living Legacy Foundation of Maryland, the organ procurement organization that partnered with the University of Maryland on the project. "We flew a three-mile mission in nine minutes. We want to fly 100-mile missions in a matter of minutes or hours."

"When Dr. Scalea said he had this wild, crazy idea to fly a human organ to a real person with a drone, and asked, can we do it? I said yes," Scassero adds. "Looking 10, 20, 30 years into the future—I can see it easily, in a heartbeat. Autonomous aircraft is the way we're going to transport organs for transplant someday.

"Let us be the ones who build the bridge to make it happen."

A LEADER IN URBAN AIR MOBILITY

Need a ride to the airport? In the not-so-distant future, you may be calling an air taxi to deliver you in minutes to your destination. All-electric and hybrid electric-powered vertical takeoff and landing aircraft (eVTOL) could represent the future of urban air mobility (UAM), and the Clark School's Department of Aerospace Engineering is playing a major role in their development.

The department's efforts are led largely by Associate Professor Anubhav Datta, who is the inaugural chair of the eVTOL Technical Committee of the Vertical Flight Society (VFS), along with Professor James Baeder and Assistant Professor Mumu Xu.

The VFS initiated the Transformative Vertical Flight Workshops (now the Annual eVTOL Symposiums) and their working groups managed by the NASA Aeronautics Research Institute (NARI). The initial workshop, held in 2014, was the first public gathering of the nascent eVTOL industry and brought together pioneers who believed electric propulsion had a future. Datta, who co-authored the first peer-reviewed paper on eVTOL and attended that workshop, was among those who foresaw the potential growth of the field. He was also the inaugural chair of the NARI working group on intra-city UAM, which produced a comprehensive report on the status of the technology in 2018.

To fulfill its potential, a concerted and coordinated approach is needed between government, industry, and academia for eVTOL and UAM infrastructure, according to Datta. "eVOTL are not toys or small-scale drones," he says. "Transporting people requires aircraft of an entirely different scale in size, safety, and reliability." Datta cites the principal barriers as the weight of electric power, operating infrastructure, and uncertain noise metrics (how quiet is quiet enough?).

"Offering one of the three Vertical Lift Rotorcraft Centers of Excellence in the United States, the department is well positioned to produce research and students steeped in the understanding of eVTOL as much as helicopters," says Mike Hirschberg, executive director of the VFS (formerly the American Helicopter Society).

Hirschberg predicts an eVTOL revolution, with the greatest demand in urban areas where eVTOL aircraft will be used to shorten commuter times and overfly road congestion. "We could be moving from thousands of helicopters in the air to tens of thousands of eVTOLs worldwide," says Hirschberg.

The opportunity to educate generations of eVTOL engineers is what attracted Datta to UMD from the U.S. Army Aviation Development Directorate at NASA Ames Research Center. "If

we don't train the right engineers now, we cannot expand in the future," says Datta, who created the inaugural course in this field, now offered at the Annual Forum of the VFS—the world's premier conference on vertical lift aircraft.

The department's eVTOL research program began in 2016. Currently four doctoral students are working on different aspects of eVTOL, from hydrogen fuel cells to hybrid-electric power to fundamental aeromechanics of electric flight. In addition, Baeder and his students are investigating noise and how to cancel noise, while Xu and her students focus on autonomy and urban airspace operations.

In work funded by the U.S. Army Research Laboratory, Ph.D. student Brent Mills is studying a new engine-generator-driven propulsion system that transmits and controls power to distributed rotors individually for trim and maneuvering flight without a mechanical transmission. Independent control of fuel rate and generator voltage are essential for the efficient operation of the devices.

In a project funded jointly by the Army, Navy, and NASA, researchers in the department are studying how to combine unpressurized hydrogen fuel cells with batteries to take advantage of the high energy of hydrogen storage and eliminate the bottleneck of batteries. The requirements for fast-charging batteries that sustain high power are critical in eVTOL; batteries developed for consumer electronics cannot simply be stacked together.

In addition, every graduate student is developing mathematical models as well as building hardware to test and validate these models. Once matured, the data and models are transferred to NASA for insertion into NASA Design Analysis of Rotorcraft software, widely used by the Department of Defense and U.S. industry.

"It is certainly an exciting time to be a member of the aerospace community," says Department of Aerospace Engineering Board of Visitors member Chris Van Buiten, vice president of Sikorsky Innovations. "Emerging opportunities will take an entrepreneurial spirit, technical expertise, and a global mindset to make them a reality—which are all qualities found within the UMD community."

Fellow board member Matt Hutchison, senior vice president of operations at Aurora Flight Sciences, a Boeing company, agrees. "The department is doubling down on the future by building the talent pipeline with the workforce-ready skills needed to be competitive in aerospace today." Hutchison notes that Boeing is reimagining the future of flight and mobility to address the growing challenges of sustainable, economical, and accessible modes of transportation as well as the related infrastructure.

Datta emphasizes the need for a multidisciplinary approach that considers more than traditional aeromechanics and noise and broadens the design space to include real-time human-machine interface, artificial intelligence for autonomy of flight and safety in failure, new and novel power systems, as well as infrastructure for vertiport. "We have the students and the resources on campus to do all of that."

TESTING THE NEXUS

The Alfred Gessow Rotorcraft Center is widely acknowledged throughout the helicopter industry as a leading center of rotorcraft education and research. Its reputation led to discussions between department faculty and senior management at Bell Labs in summer 2018 about the possibility of testing the Bell Nexus, an eVTOL aircraft, in the Glenn L. Martin Wind Tunnel. Preparations began months in advance to ensure testing equipment matched the company's needs.

Four months of testing were overseen by Bell Lab's Innovation group and J. Scott Drennan ('93), vice president of engineering innovation at Bell. The Nexus is being designed to operate as both a piloted and autonomous aircraft. It will be piloted when it enters the air taxi service in mid-2020, which Bell believes is essential to help develop the new air taxi market. The Nexus will transition to fully autonomous once the technology proves itself.

"The Wind Tunnel is focused on trying to develop specifications required to produce a usable product; this has been our lifeblood for 70 years," says Wind Tunnel Director Jewel Barlow (right). "Our measurements will help define the efficiencies the vehicle exhibits in flight operation and will measure stability and control. Data we collect help identify deficiencies and modifications that can be made to address them."

Barlow notes that while travel occurs daily in helicopters, the infrastructure to land a helicopter in many different places does not exist. Expanding the capabilities of urban air vehicles to operate in a much larger set of locations will make them more broadly accessible for a diverse population.

"We are very pleased to be involved with the Nexus program and eager to be involved in similar programs with other innovators in the industry," adds Barlow. "Our expertise makes us uniquely capable to support developments in the urban air mobility area."

DEPARTMENT JOINS CELEBRATION OF CLARK SCHOOL'S 125TH ANNIVERSARY

A. James Clark School of Engineering 125 Years 1894 2019

As the A. James Clark School of Engineering celebrates its 125th anniversary, the department recognizes its contributions to the school and to the field of flight. From Glenn L. Martin's vision for the department in 1944 to the first delivery of a human organ for transplant by an unmanned aircraft, the department's benefactors, faculty, staff, and students have achieved amazing accomplishments. Fueled by this passion, the department has earned a reputation for conducting cutting-edge research, developing new technology, and preparing the next generation of leaders in aerospace engineering. Three of the most notable innovations through the years are the Alfred Gessow Rotorcraft Center, the Glenn L. Martin Wind Tunnel, and the Space Systems Laboratory.

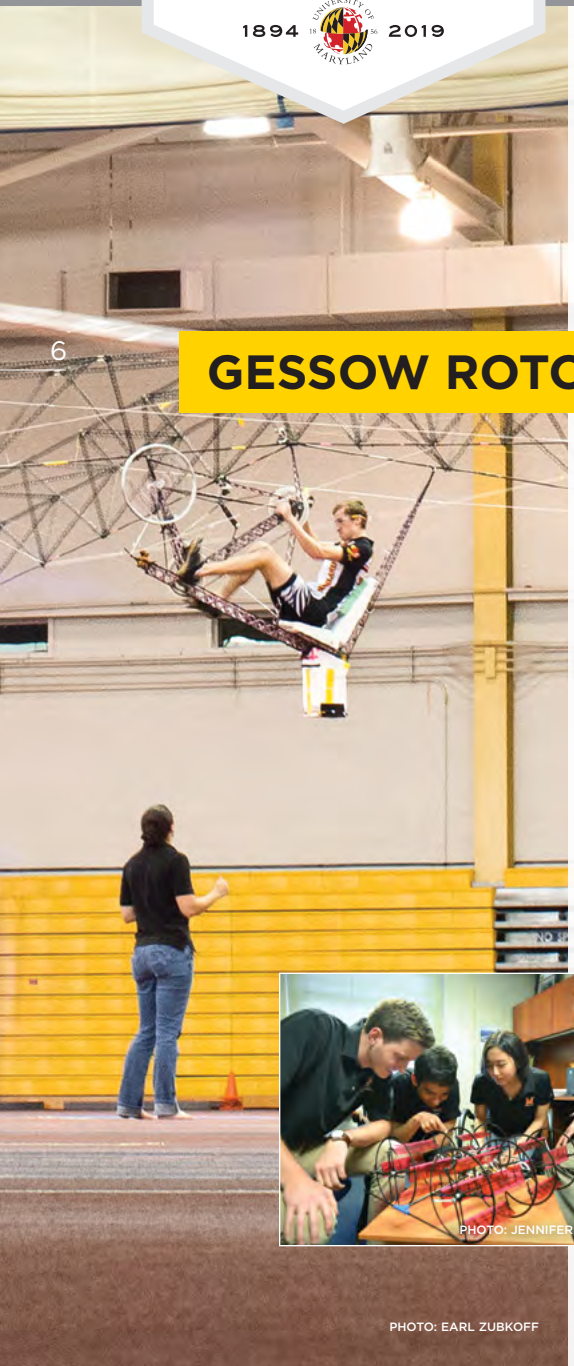


PHOTO: EARL ZUBKOFF

GESSOW ROTORCRAFT CENTER

In 1982, the department founded the Center for Rotorcraft Education and Research (later renamed the Alfred Gessow Rotorcraft Center) to advance helicopter technology. One of only three rotorcraft centers in the country, the center has contributed substantially to the field of rotorcraft engineering and is nationally and internationally recognized as one of the preeminent rotorcraft centers in the world. A U.S Army Center of Excellence of Helicopter Technology, the center is the two-time recipient of the American Helicopter Society Glover Bell Award for fostering, and experimentation in, helicopter development.

An active crash protection system developed by a team from Boeing, the Army Aviation Technology Directorate, and the Alfred Gessow Rotorcraft Center's Smart Structures Laboratory, headed by Department Chair Norman Wereley, was awarded the 2011 Harry T. Jensen Award by the American Helicopter Society (AHS). The team's work made significant contributions to helicopter crash safety and survivability. The center was officially redesignated as a Vertical Lift Rotorcraft Center of Excellence by the Vertical Flight Foundation in 2012. That same year, a team from the center made history by developing a cyclocopter that performed both a piloted and autonomous stable flight in hover. The cyclocopter was also the smallest model known to have achieved flight. By 2014, the UMD team successfully demonstrated the first-ever stable flight of a twin-rotor cyclocopter.

PHOTO: JENNIFER FIGGINS ROOKS

In recent years, graduate and undergraduate aerospace engineering students took big steps toward the Sikorsky Prize, a $250,000 award established by AHS in 1980. To win the prize, a team must build a helicopter powered solely by human energy that can fly for 60 seconds, reach a height of three meters, and hover within a 10-by-10 meter square. The UMD Gamera helicopter team was recognized by the American Helicopter Museum and Education Center in 2011 for its contribution to furthering rotary wing aviation. By 2014, the Gamera team had achieved a flight time of 97 seconds and was named as a finalist for one of engineering's highest honors, the Collier Trophy. Though the Gamera team ultimately was not the first to achieve the required criteria, the team was formally recognized in 2014 by the Sikorsky Aircraft Corporation with a trophy and a $50,000 award for its advancements in helicopter innovation.

PHOTO: BRIAN SCHNEIDER

GLENN L. MARTIN WIND TUNNEL

The Glenn L. Martin Wind Tunnel (GLMWT), a low-speed (or subsonic) wind tunnel designed for aerodynamic and hydrodynamic research and development, was built in 1950 as part of a four-building construction boom funded by Glenn L. Martin. It is one of only a dozen low-speed wind tunnels in the United States and the second largest wind tunnel at a university.

At almost eight-feet tall and 11-feet long, it is large enough to test electric vehicles, helicopters, boats, and even building structures. It has been the test site for almost all of the Ford Motor Company's scale models, including the Ford GT40 and the original Ford Taurus.

The GLMWT was in heavy demand by the aerospace industry during the 1950s and most of the 1960s. Development tests were conducted for signature aircraft of the period and many experimental configurations that did not achieve production. The GLMWT was the primary test facility for parachutes used in deployment of ordnance of various types by the U.S. Navy and for submarine tests. One of the largest aerodynamic test series for Class 8 trucks was conducted in the tunnel in 1953 and 1954, and a number of standard features of truck trailers were based on those tests. The shape of the Ford racing car that won the 24 Hours of Le Mans in 1965, 1966, and 1967 was fine-tuned in the GLMWT.

More recently, tests of unmanned aircraft are conducted there. It has been tapped for sports aerodynamic testing, like cycling and speed skaters; animal studies, like the feasibility of tracking devices on birds and the evolution of the flying squirrel; and weather, replicating hurricane conditions to test the integrity of building materials, bridges, roofing systems, and radar antennas. In the 1990s, the tunnel was instrumental in reducing NASCAR driver injuries from vehicles going airborne at high speeds. Tunnel researchers worked with Ford to create a roof spoiler that is now a NASCAR safety requirement.

SPACE SYSTEMS LABORATORY

During the 1990s, the department expanded its educational offerings to include astronautical offerings with the addition of Professor Dave Akin and the Space Systems Laboratory (SSL) from the Massachusetts Institute of Technology. The work of the SSL is centered around the Neutral Buoyancy Research Facility, which is the only such facility housed at a university in the United States. Used for both undergraduate and graduate research, the 50-foot diameter, 25-foot deep water tank is used to simulate the microgravity environment of space. With this facility, the Space Systems Laboratory distinguished itself as a nationally recognized leader in astronautics, making significant contributions to the study of robotics for use in an outer space environment. Research emphasizes space robotics, human factors, applications of artificial intelligence, and the underlying fundamentals of space simulation. Current projects include the MX suits, simplified spacesuits for use in extravehicular activity research. The cornerstone of the lab's robotic research is Ranger, a series of robotics specifically designed to study satellite servicing.

In 2015, a group of aerospace engineering students won the Revolutionary Aerospace Systems Concepts–Academic Linkages (RASC-AL) Exploration Robo-Ops Competition, placing first for the seventh time at the RASC-AL Student Design Competition. RASC-AL is a NASA-sponsored university-level, full mission architecture engineering design competition. SSL Director Dave Akin has mentored Maryland students to participate in NASA design competitions since he began his career at the university.

PHOTO: JOHN CONSOLI

PHOTO: NASA-BILL STAFFORD

A Generous Thank You to a Longtime Mentor

Jim Rand with his children.

GIFT DOUBLES THE IMPACT OF ROBERT M. RIVELLO SCHOLARSHIP

Two years ago, a serious medical diagnosis led Jim Rand ('61, M.S. '63, Ph.D. '67) to reflect on his long career and many remarkable successes in aerospace engineering. He thought back to whom he wanted to thank—and how.

One of those people was Robert "Bob" Rivello ('43, M.S. '48, mechanical engineering), who taught Rand and many other aerospace engineering students before he passed away in 1991; his wife, Marcelle O'Shaughnessy Rivello ('43, psychology), passed away in 1997. "Bob Rivello stood out," says Rand, "as the one individual who helped me learn how to be an engineer, supported me in all my research, and was generally someone I looked up to."

In gratitude to his mentor, Rand has made a generous gift to the Clark School to support the Robert M. Rivello Scholarship. His contribution doubles the amount of the endowed fund—and its impact on current and future students. Presented first in 2005, the annual award goes to a junior-level aerospace engineering student who has attained the highest overall academic average. The 2018–2019 recipient was Justin Lidard.

"Dr. Rand's philanthropy demonstrates the importance of the faculty-student relationship and how far-reaching the positive outcomes of mentorship can be," says Department Chair and Minta Martin Professor Norman Wereley. "Endowed scholarships like this one are part of the permanent history of the department and will support deserving students for generations. We are so grateful Dr. Rand chose to honor Bob Rivello's legacy by elevating this fund to a level of real prestige in the department."

Rivello joined the department's teaching staff in 1946 after serving in the U.S. Air Force in World War II. A lover of flight, Rivello found a second love—teaching—at Maryland. He was instrumental in setting Rand on a path to becoming one of the department's most accomplished graduates and a fellow of the American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers, and American Society for Engineering Education.

But first, as with many engineering problems, Rand had to fail. He laughs about it now, looking back at his initial unsuccessful start at UMD. "I just wasn't ready for more school right after high school," he recalls. He left the university after his freshman year to join the Air Force. During the four-year "breather," he married his first wife, Deanne Marie, and had his first of six children. When Rand returned to college, Rivello was on the reinstatement committee that let him back in. Matured and motivated, Rand finished engineering coursework for his bachelor's degree in three years. For a year after graduation, he worked at UMD as an aeronautical engineering instructor and then as a research engineer for the U.S. Naval Ordnance Laboratory while he continued to take courses at UMD toward his master's degree and doctorate.

Robert "Bob" Rivello

After completing his education at UMD, Rand moved his family to Texas, where he would serve as a professor of aerospace engineering at Texas A&M University for 12 years. He taught courses on aircraft structures, using notes from his former teacher's courses, and even modeled his teaching style on Rivello's. "He taught me that before you try and solve a problem, you have to find the cause of it," Rand remembers.

One particular engineering problem Rand watched Rivello solve was related to the installation of a 21,000-pound replica of a blue whale at the Smithsonian's National Museum of Natural History. Rivello was tasked with doing the stress tests for the display that became an icon at the Washington, D.C., museum. "You use your talent wherever you can; Bob Rivello was a prime example of that," says Rand.

Through his research, Rand became known for his analysis of high-altitude scientific balloons like those used by atmospheric physicists to send telescopes above the atmosphere to study outer space. He continued this research at the Southwest Research Institute before he was recruited as president and CEO of Winzen International. "These balloons are some of the largest aerospace structures ever built, and they were built by my company, by my people," Rand says proudly. He and his wife of 45 years, Patricia, currently reside in San Antonio.

Back at UMD, Rivello spent 45 years teaching future aerospace engineers. His son, Dave Rivello ('77, law enforcement), remembers hanging out in his father's office. "Students always had positive things to say about my father," he recalls. That his former student had such a favorable impression of his father was not surprising. That Rand remembered his father with such a generous scholarship gift was the best kind of surprise.

"We have a lot of Terrapin blood in the family," says Dave, whose son John ('12, criminology and criminal justice), makes three generations of Rivello Terps. "My siblings and I contribute to the scholarship in our father's name every year, but this gift takes it to another level," he says. "Dad would be extremely humbled and deeply touched."

Are you looking to honor a faculty member who made an impact on a student, past or present? Learn more by contacting Almarie Wood at aiwood@umd.edu or 301-405-9836.

Scholarships Broaden Opportunities for Students

AEROSPACE ENGINEERING BOARD OF VISITORS SCHOLARSHIP

Established in 1995, the Department of Aerospace Engineering Board of Visitors (ABOV) is composed of leaders from industry, government, and academia committed to the advancement of the department. Current members of the ABOV have made financial commitments to endow this scholarship to support the education of students of merit in aerospace engineering.

ALEXANDER BROWN MEMORIAL GRADUATE AWARD

This fund, named in honor of graduate student Alexander "Alex" Nicholas Brown ('08, M.S. '10), supports graduate students who embody Alex's fearless pursuit of innovation, superior leadership, and persistent drive. Brown was pursuing his Ph.D. in aerospace engineering at UMD. Through the fund, the department provides support for students pursuing graduate degrees within the department.

JOHN ANDERSON SCHOLARSHIP IN AEROSPACE ENGINEERING FOR UNDERGRADUATE STUDENTS

This endowed fund, named in honor of Professor Emeritus in Aerospace Engineering John D. Anderson, Jr., encourages a motivated undergraduate student to pursue experiential research each summer. These opportunities foster deep learning and greatly enhance students' preparation for careers in industry and academia.

MARY AND TOM SNITCH ENDOWED UNDERGRADUATE SCHOLARSHIP

Mrs. Mary Snitch and Tom Snitch established the Mary and Tom Snitch Endowed Undergraduate Scholarship in May 2011. This merit-based scholarship supports undergraduates in aerospace engineering with a preference for students participating in the Women in Aeronautics and Astronautics Student Chapter. Mary, a senior manager at Lockheed Martin, has served as a past national president for the ARCS Foundation. She also served on the board of directors for the American Institute for Aeronautics and Astronautics, the Ron Brown Foundation, and the Department of Aerospace Engineering Board of Visitors.

LOCKHEED MARTIN GIFT SUPPORTS RESEARCH, STEM EDUCATION

A three-year, $3 million gift to the Clark School from Lockheed Martin will fund aerospace research while increasing opportunities for women and underrepresented minorities in science, technology, engineering, and math (STEM) fields.

The gift deepens a strategic partnership established in 2010 and renewed last year between the UMD and the Bethesda-based global security and aerospace firm. Lockheed Martin's association with UMD dates back to 1944, when co-founder Glenn L. Martin funded four buildings, including the wind tunnel and classroom building that bear his name.

The new grant will fund vertical takeoff and landing research conducted at the university's rotorcraft lab in the E.A. Fernandez IDEA Factory, scheduled to open in 2021, and high-speed flight experiments up to Mach 8, or 6,000 mph, at the school's new hypersonic wind tunnel. It will also underwrite programs overseen by the Clark School's Center for Minorities in Science and Engineering and Women in Engineering Program that aim to boost the enrollment of women and underrepresented minorities in STEM disciplines.

Today, Lockheed Martin employs over 600 UMD graduates holding nearly 700 degrees, and it has a formal collaboration agreement in place with the school to research, develop, and design advanced technology systems, products, and services.

PHOTO: ALISON HARBAUGH

Girls learn engineering basics at a 2019 Clark School summer camp. The gift from Lockheed Martin will, in part, support STEM education for women and underrepresented minorities.

>> LEARN MORE, VISIT go.umd.edu/lm

Surf's Up: Clark Fellow Studies Shock Wave Surfing

Cole Sousa ('18) describes himself as "a man of many dedications." His commitment to his academic studies and career paid off last year when Sousa was named a Clark Doctoral Fellow, one of the most prestigious honors a Clark School student can receive.

Sousa takes the role seriously. "It is an honor to be called a Clark Fellow for the entirety of my program," explains Sousa. "The fellowship has allowed me to create a head space to concentrate on coursework and worry less about finances." He is particularly appreciative of the travel stipend to attend conferences that would otherwise be unaffordable. "I also look forward to the special events, like coffee hours and receptions, to connect with other fellows, talk to faculty members, and discuss research experiences."

The goal of the Clark Doctoral Fellows Program is to substantially increase the number of graduate fellows in the Clark School, supporting 30 first-year doctoral students each year in their research. The program is funded by a transformative investment of nearly $220 million from the A. James & Alice B. Clark Foundation.

Sousa attributes his academic success to his participation in the university's and the department's undergraduate honors programs. "I am in this field primarily because of the Aerospace Engineering Honors Program," he explains. "In that program, you are required to work with a faculty advisor on a research project."

That is when Sousa began his long-term research partnership with Associate Professor Stuart Laurence, mapping and analyzing the trajectories of free-flying objects interacting with planar shockwaves in hypersonic airflow (exceeding up to six times the speed of sound). He was looking for insight into the forces and behaviors these fragments experience after separating from a vehicle at various flight conditions. As a fellow, he is continuing his work with Laurence, developing a computational model to calculate the forces of the spherical fragments and their trajectories in space. His findings could help protect equipment and promote a greater understanding of the forces these fragments experience.

Sousa's major research interest is a phenomenon called shock wave surfing, which looks at the two supersonic flows on either side of a shock wave and analyzes their forces on fragments. "A fragment can oscillate inside and outside the shock wave and surf the wave," explains Sousa, who cites the significance of the catastrophic breaking of fragments, such as what occurred with the Space Shuttle Columbia in 2003, when the shuttle disintegrated and caused the deaths of seven astronauts. "The shuttle's external tank was shedding, and it broke off and punctured the wing. My work may be able to shed light on ways to address this type of fragmentation."

Sousa anticipates another milestone in his academic career in the coming months. "My advisor is submitting a paper to the *Journal of Fluid Mechanics*, one of the most prestigious journals in the field," says Sousa. "I am excited about the possibility of publishing my first paper as a first author. It is a real resume booster and hopefully is the first of many papers."

While Sousa can envision himself as an academician, he feels a stint working in industry would make him a more well-rounded aeronautical engineer and researcher. "I feel it is important to know how to apply your research and what you have learned in the classroom. Then I may think about teaching in a university."

IT TAKES A SWARM

THE POWER OF GROUP THINK

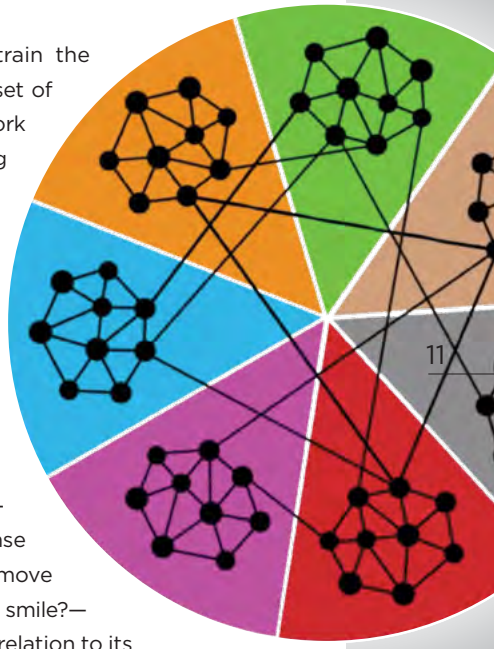
If two heads are better than one, imagine the impact of hundreds of brains. Recognizing there is power in numbers, Assistant Professor Michael Otte wirelessly connects a large number of robots—or artificial "brains"—into a single, complex computational entity; roboticists call it a swarm. He trains them to connect, communicate by sharing data to form a picture of their entire environment, and collectively figure out how to respond to the environment.

To help his robots pool resources to solve a common problem, Otte has created a process by which hundreds of individual robots merge their computing power to become a single, albeit distributed, computer. The swarms can be particularly valuable in facing unknown challenges such as assessing risk and response needs as part of a search-and-rescue mission after a catastrophic natural disaster.

His research is inspired, in part, by the so-called swarm intelligence of self-organized biological systems such as colonies of ants or bees. Individual ants, for example, are simple organisms capable of simple tasks. One ant searches for food; another ant lays eggs; another builds walls made of soil. Many ants together, however, form complex social networks that can perform complex tasks for the collective good.

Otte is driven by an inquisitiveness that combines inspiration from insect colonies with the challenge of making science fiction a reality. "The concept of a 'group mind,' in which multiple consciousnesses are linked into a single intelligence, has been a plot device in science fiction literature since at least the 1930 novel *Last and First Men*," says Otte, who joined the full-time faculty in 2018 after serving as an adjunct faculty in the Office of Advanced Engineering Education and as a visiting assistant professor in the department. "I wanted to see if I could successfully apply that concept of a group mind in robotic swarms."

In a peer-reviewed paper published in *The International Journal of Robotics Research*, Otte describes how he trained a legion of Kilobots—a simple robotic platform that clocks in at only 3.3 centimeters tall. While a single Kilobot has but a single light sensor capable of discerning only a single light value, a swarm of Kilobots can combine their sensor data to "see" across their entire environment. Each robot communicates wirelessly with its neighbors, bouncing infrared signals off the ground and up to other nearby robots. This connection forms an artificial neural network, which the swarm uses to detect and recognize images created by projected visible light. The resulting computational entity is called an artificial group mind. The group mind then figures out what is happening in the environment and the appropriate behavioral response. For example, the group mind can be trained to recognize a projected peace symbol or biohazard symbol. If the group mind recognizes a peace symbol, it responds by creating a smiley face. If a biohazard symbol is recognized, the swarm is trained to create a frowning face.



The algorithm Otte used to train the Kilobot swarm is a tried-and-true set of rules used in artificial neural network research. What's new and interesting about his work is that the algorithm was modified to be successfully applied across a distributed swarm of many robots connected by a wireless network.

This capability is especially useful for groups in which different robots are programmed to perform different actions. Each robot is location-dependent, meaning its role in the collective response behavior—i.e., does an individual move to form part of an eye or part of the smile?—is determined by where it starts in relation to its neighbors. If a robot falls too far behind its neighbor in training, it could compromise the response action, which is defined by the coordinated movement of the whole. In other words, one rogue robot could spoil the swarm.

"We need all of the neurons in the entire brain to learn as a group. In a sense, the robotic swarm is only as strong as the weakest individual. By waiting for individual robots who have dropped messages due to the unreliability of wireless networks, the swarm learns more efficiently, making it stronger in the long run," says Otte.

ILLUSTRATION COURTESY: MICHAEL OTTE

Pines Elected to NAE

PHOTO: MIKE MORGAN

Clark School Dean and Nariman Farvardin Professor Darryll Pines has been elected to the 2019 class of the National Academy of Engineering (NAE), among the highest distinctions in the engineering profession. Pines was cited for "inspirational leadership and contributions to engineering education excellence in the United States." He joins 21 other Clark School-affiliated faculty who have been inducted into NAE, including UMD Regents Professor C.D. "Dan" Mote, Jr., former UMD president and former NAE president. Pines is the second Clark School dean to be elected to NAE, joining Professor Emeritus of Mechanical Engineering and former Dean George Dieter.

As dean of the engineering school, Pines has led the development and implementation of a strategy to improve teaching in fundamental undergraduate courses and raise student retention, achieve success in national and international student competitions, place new emphasis on service learning and grand societal challenges, promote STEM education among high school students, increase the impact of research programs, and expand philanthropic contributions to the school.

Pines was instrumental in securing a $219.5 million investment—among the largest gifts ever to a public university—from the A. James & Alice B. Clark Foundation. *Building Together: An Investment for Maryland* is funding need-based scholarships campus-wide, as well as graduate fellowships, faculty positions, infrastructure, and other initiatives. Pines's belief in the value of an inclusive and diverse community has underpinned his work. He served as director of the Alfred P. Sloan Doctoral Scholars Program and presently serves as secretary of the Board of Directors for the National GEM Consortium Fellowship Program. The percentage of women and underrepresented minorities in the UMD engineering undergraduate student body has grown to 25 and 16 percent, respectively, during his tenure as dean. According to *Diverse Issues in Higher Education*, the Clark School ranks among the top 10 engineering schools in conferring the most B.S., M.S., and Ph.D. degrees to African-American students.

AIAA RECOGNIZES FACULTY ACHIEVEMENTS

Three faculty members were recognized for their outstanding contributions during the annual American Institute of Aeronautics and Astronautics (AIAA) National Capital Section Honors and Awards Banquet held in May.

PINES HONORED WITH INAUGURAL PIERS SELLERS AWARD

Clark School Dean and Nariman Farvardin Professor of Aerospace Engineering

DARRYLL PINES was recognized for his work as principal investigator on a National Science Foundation-funded pilot program, entitled Engineering For US All (E4USA), a first-of-its-kind nationwide pre-college course on engineering principles and design. The course is intended to eventually provide the equivalent of placement credit for an introductory college course.

MAQBOOL WINS YOUNG SCIENTIST OF THE YEAR AWARD

DAANISH MAQBOOL, a lecturer and researcher at UMD and CEO of North American Wave Engine Corporation (NAWEC), has been awarded the 2019 Hal Andrews Young Engineer/Scientist of the Year Award, which recognizes a single significant professional accomplishment or longer-term outstanding career leadership/accomplishment in the technical disciplines of aeronautics and astronautics. NAWEC is a start-up company that has designed and developed a jet engine without any moving parts to deliver unparalleled levels of fuel efficiency and weight- and cost-savings to a rapidly growing unmanned aerial vehicle market and the broader aerospace sector.

PUCCIARELLA RECEIVES ENGINEER OF THE YEAR AWARD

ANTHONY PUCCIARELLA, director of operations for the UMD Unmanned Aircraft Systems (UAS) Test Site, was honored with the Engineer of the Year Award, which recognizes a recent individual contribution to the application of scientific and mathematical principles leading to a significant accomplishment or event worthy of AIAA's national or international recognition. Pucciarella was a member of the UAS Transport Team that recently took part in the successful first flight of an unmanned aircraft delivering a donor kidney to surgeons at the University of Maryland Medical Center in Baltimore for successful transplantation into a patient with kidney failure.

Four Faculty Promotions

ANUBHAV DATTA (M.S. '02, Ph.D. '04) has been promoted to the rank of associate professor. Datta's research interests include electronic vertical takeoff and landing aircraft and electric aviation, scalable 3D structures for computational aeromechanics, wind-tunnel testing of high-speed tiltrotors, and Mars rotorcraft.

RAYMOND SEDWICK has been promoted to the rank of professor. Sedwick pursues research in space power and propulsion technologies, applications of plasmas, and orbital debris. He founded the UMD Center for Orbital Debris Education and Research.

STUART LAURENCE has been promoted to the rank of associate professor. Laurence's research focuses on many aspects of high-speed flows, including hypersonic aerodynamics and aerothermodynamics, boundary-layer transition, and supersonic combustion and propulsion.

ANDREW BECNEL has been promoted to the rank of senior lecturer. Becnel conducts research on smart composite material and advanced manufacturing of smart structures and functionalized materials and their applications for improving human-device interfaces.

AIR FORCE ASSOCIATION HONORS LEWIS

Professor Emeritus **MARK LEWIS** received the 2018 Theodore von Karman Award, presented by the Air Force Association. The award recognizes the most outstanding contribution to national defense in the fields of science and engineering. Lewis was recognized for his contributions as the longest-serving chief scientist in the history of the Air Force, national leadership in promoting basic research, and contributions and influence in the fields of propulsion and hypersonics.

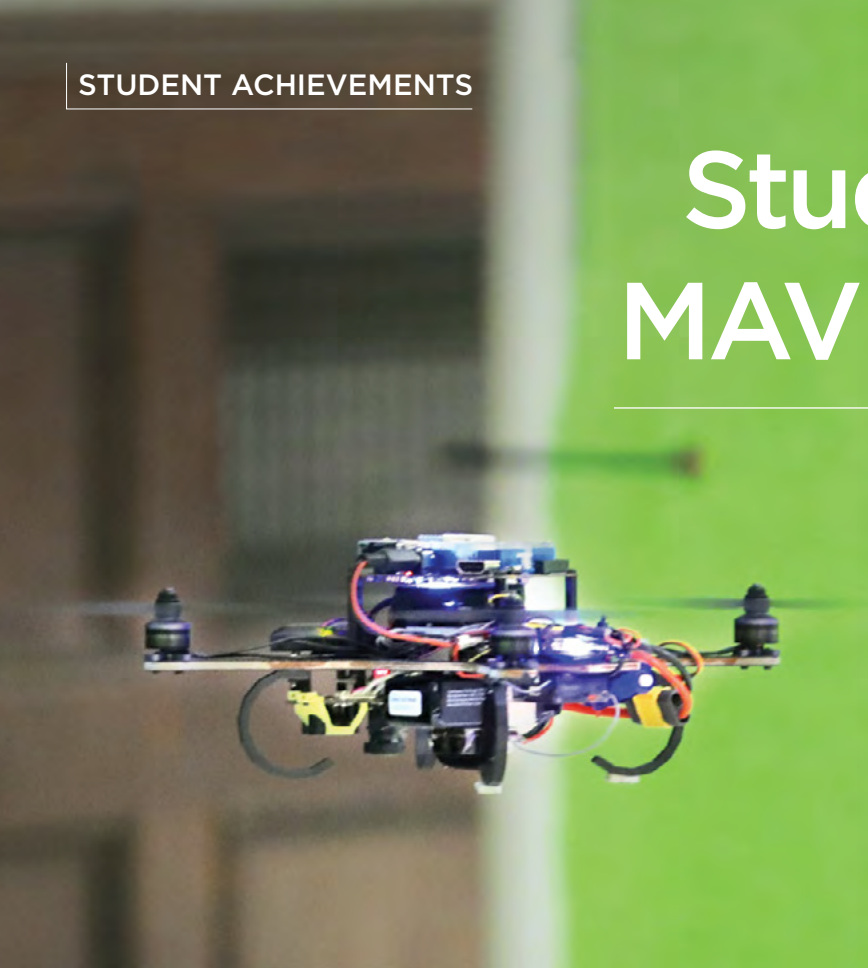
AKIN RECEIVES RASC-AL AWARD

Associate Professor **DAVE AKIN** received the Pioneering Exceptional Achievement Concept Honor Award from Revolutionary Aerospace Systems Concepts-Academic Linkages, a university-level engineering design and technology demonstration content managed by the National Institute of Aerospace.

HARTZELL SELECTED FOR NASA MISSION

Assistant Professor **CHRISTINE HARTZELL** is the mission scientist for one of three finalist missions selected by NASA for future small satellites. Janus: Reconnaissance Missions to Binary Asteroids will study the formation and evolutionary implications for small "rubble pile" asteroids and build an accurate model of two binary asteroid bodies. The three missions will contribute to NASA's goal of understanding our solar system's content, origin, and evolution.

Students Sweep MAV Competition



Department of Aerospace Engineering student teams took first place in the manual and autonomous categories of the Seventh Annual Micro Air Vehicle Student Challenge, held at the Vertical Flight Society Annual Forum in Philadelphia in May. This electric-powered vertical takeoff and landing micro air vehicle (MAV) competition encourages student interest in autonomous/unmanned aircraft technology as well as small air vehicle design and fabrication.

The winning Clark School entry in the Manual Flight category was piloted by freshman students in the university's First-Year Innovation and Research Experience (FIRE)

TECHNOLOGY LEADER OF TOMORROW

Adam Boro has been named among the 2019 "Tomorrow's Technology Leaders: The 20 Twenties" by the Aviation Week Network in collaboration with the American Institute of Aeronautics and Astronautics (AIAA). The award recognizes top students in engineering, math, science, and technology from across the country and globe on the basis of their academic performance, civic contribution, and research or design project. Since its inception in 2013, 13 UMD students and alumni have been recognized.

Boro, a senior who is majoring in aerospace engineering, is a member of the Aerospace Honors Program and the Science, Discovery and the Universe Program of College Park Scholars. He is an active member of UMD's student chapter of AIAA, serves as fundraising chair of the Delta Sigma Phi fraternity, and is active with the Terrapin Trail Club. Boro has served in leadership positions for UMD's Gamera (human-powered helicopter) project, completed an Alexander R. Norris Space View Internship with AIAA, and interned under the Jacobs Test Operations and Support Contract at NASA's Kennedy Space Center. Boro is conducting space exploration research at NASA's Goddard Space Flight Center under the satellite servicing division.

Autonomous Unmanned Systems Stream (AUS Stream). They were advised by Assistant Clinical Professor Derrick Yeo and Distinguished University Professor Inderjit Chopra.

The FIRE program provides freshmen with authentic research experiences, broad mentorship, and degree credits to enhance their academic success and personal development while building community and professional opportunities. Students in the AUS Stream address research challenges in autonomous vehicle mission planning, platform-level sense and avoidance capabilities, cooperative control of multiple autonomous vehicles, and interactions between humans and autonomous systems.

The winner in the Fully Autonomous category was the Autonomous Micro Air Vehicle (AMAV) Team, advised by Postdoctoral Researcher Artur Wolek and Professor Derek Paley, who also is the faculty director of the FIRE AUS Stream. The AMAV team consists of undergraduate and graduate students in the Master of Engineering in Robotics program.

PHOTO: WARREN LIEBMANN

Vertical Flight Foundation Scholarship Winners

Six students have received scholarships from the Vertical Flight Foundation (VFF), the philanthropic arm of the Vertical Flight Society (VFS), for 2019. VFF scholarships are awarded to the world's most talented college engineering students interested in vertical flight. UMD awardees include:

DANIEL ESCOBAR
Geoff Byham Scholarship

In his graduate studies, Escobar began an autonomous drone project for the VFS Autonomous Micro-Aerial Vehicle Challenge, but has recently shifted his focus to the Mars helicopter.

THOMAS HERRMANN
Robert Head Scholarship

Herrmann completed a paper on the multidisciplinary, multi-objective trim optimization for a coaxial-pusher rotorcraft configuration for the VFS 75th Annual Forum in May.

NICHOLAS REHM
Alfred Gessow Scholarship

Rehm has been studying flow-aware computational wings for small fixed-wing unmanned systems, which will augment existing avionics packages to improve an aircraft's ability to reject gusts and turbulence while in flight.

DEREK SAFIEH MATHEU
Marat Tishchenko Scholarship

Matheu is currently testing methods to aid the process of scaling the quadrotor biplane tail-sitter project.

ABHISHEK SHASTRY
Hal Andrews Scholarship

Shastry is studying rotorcraft, researching the aeromechanics and autonomy of electric vertical takeoff and landing vehicles.

FREDERICK TSAI
Bell Helicopter Vertical Flight Scholarship

Tsai is currently supporting the delivery of the Maryland Tiltrotor Rig, a design and manufacturing partnership with Calspan Systems Corporation.

Four Students Named ARCS Scholars

The Achievement Rewards for College Scientists (ARCS) Foundation Metro Washington Chapter has selected four aerospace engineering students—two undergraduates (Elizabeth McFarland and Julia Mittelstaedt) and two graduate students (Emily Fisler and Laura Paquin)—as ARCS Scholars for 2019–2020. The ARCS Foundation advances science and technology in the United States by providing financial awards to academically outstanding students studying to complete graduate degrees in science, engineering, and medical research.

ELIZABETH MCFARLAND, a previous recipient of the award, has interned and worked at the Johns Hopkins University Applied Physics Laboratory on the development of an arm-mounted robotic hand lens for future planetary landed missions. At NASA Goddard Space Flight Center, she volunteered in the satellite servicing division on collision detection compliance control.

JULIA MITTELSTAEDT, a previous award recipient, is pursuing research on swept-tip blade designs for vibration deduction on tiltrotor wings. Part of UMD's Honors College, Mittelstaedt is communications chair for Women in Aeronautics and Astronautics. She has interned at Sikorsky Aircraft Corporation, working on the CH-53K helicopter.

EMILY FISLER, a Ph.D. candidate, is pursuing research on emerging battery technology, including lightweight lithium sulfur battery design, fabrication, and scale-up for application in electric takeoff and landing aircraft. She previously received the American Helicopter Society Federal City Chapter Merit Scholarship and presented her work at the Vertical Flight Society's 75th Annual Forum in Philadelphia in May.

LAURA PAQUIN, a Ph.D. candidate, is conducting research in experimental hypersonics involving the development, calibration, and application of temperature-sensitive paint to wind-tunnel models to provide global maps of temperature and heat flux at high Mach numbers. She is a past recipient of a National Defense Science and Engineering Graduate Fellowship.

AE student scholars were recognized at the 15th Annual Honors Convocation in May 2018.

AEROS Opportunity Scholars

The Aerospace Engineering Research Opportunity Scholars (AEROS) Program was created in February 2013 to expand the mission of the John Anderson Scholarship. The program provides funding support for rising juniors and seniors interested in spending the summer working alongside faculty on scholarly research projects.

2019 AEROS Scholars

ELI ELSTEIN, SENIOR
MENTOR: Christine Hartzell
RESEARCH: Tested how meteors can compress while descending through Earth's atmosphere and created code to collect and analyze data from the experiment.

IAN MOSS, SENIOR
former AEROS Sikorsky Scholar
MENTOR: Derek Paley
RESEARCH: Improved system reliability and state estimation for the Autonomous Micro-Air Vehicle Team by exploring visual-inertial odometry.

BENJAMIN QUOCK, SENIOR
MENTOR: Christine Hartzell
RESEARCH: Integrated gecko-like adhesive material with magnetorheological fluid to create, test, and analyze robotic fingertip gripping strength for spacecraft repairing robots.

ARIQ ZUFAR, JUNIOR
MENTOR: James Baeder
RESEARCH: Built the wind turbine used in the 2017 Collegiate Wind Competition and tested its power curve and cut-in speed in order to identify possible ways to optimize its performance.

2019 Anderson Scholar

BRADY SACK, SENIOR
MENTOR: Dave Akin
RESEARCH: Explored autonomous control strategies and advanced user control interfaces in the Neutral Bouyancy Research Facility.

STUDENT HONORS AND AWARDS

STUDENTS GAIN NATIONAL RECOGNITION

Graduate Student **SAMUEL MASZKIEWICZ** has received a 2019 National Defense Science and Engineering Graduate Fellowship.

THOMAS WHALEN received a 2018 NASA Space Technology Research Fellowship for his work on "Characterization of Separation Events in High-Speed Flows."

JOSEPH BREEDEN received a 2018 Graduate Research Fellowship from the National Science Foundation.

JACOB MCCULLUM received a 2018 SMART (Science, Mathematics, and Research for Transformation) Award, part of the National Defense Education Program. More than 380 awards were made in 2018, with only seven percent to AE students nationwide.

STUDENTS EXCEL AT AIAA REGION I CONFERENCE

University of Maryland Aerospace Engineering students placed in all three categories at the annual American Institute of Aeronautics and Astronautics (AIAA) Region I Student Conference in April. The conference is an annual research competiton to give students an opportunity to have their work reviewed and critiqued by practicing professionals.

ROBERT BROWN
First Place
Masters Category

JACOB MCCULLUM
Second Place
Masters Category

From left, **ASHISH BAGAI** ('90, M.S. '92, Ph.D. '95), **LAUREN WEIST**, **CARLOS CALLEJON HIERRO**, **NARAYAN (RYAN) PILLAI**, **KAMIL PILASZEWICZ**, **JONATHAN SANDOVAL**, and **NILOY GUPTA.**
Third Place
Team Competition

2019 DEPARTMENT AND DEAN'S STUDENT RESEARCH AWARDS

Two students were among those recognized by the department and the Clark School for outstanding research:

JASON R. BURR
Department Doctoral Award
ADVISOR: Kenneth Yu
PAPER: "Fundamental Study of Rotating Detonation Combustor: Understanding Detonation Wave Propagating over Transverse Reactants Flow in Confinement"

GIRGUIS SEDKY
Clark School Master's Student Research Award
ADVISOR: Associate Professor Anya Jones
PAPER: "Lift Modeling and Regulation for a Finite Wing during Tansverse Gust Encounters"

DEPARTMENT HONORS AND AWARDS

JOSEPH BREEDEN received a Gessow Academic Achievement Award, presented to graduating seniors in the department who have attained the highest overall academic average.

JUSTIN LIDARD received the Robert M. Rivello Scholarship Award and **ZACHARY LACHANCE** was awarded the Joseph Guthrie Memorial Scholarship. Both scholarships are presented to those juniors in the department who have attained the highest overall academic average.

The American Institute of Aeronautics and Astronautics (AIAA) Outstanding Achievement Award was presented to **CASEY OHRINGER** for the most outstanding contribution through scholarship and service to the AIAA student branch and the department.

The Department of Aerospace Engineering Chair's Award was presented to **AKSHAY MENON**, who made the greatest contribution to the department through excellence in academics and outstanding service and leadership.

The Women in Aeronautics and Astronautics Award was presented to **SARAH ONIMUS** for the most outstanding contribution to the organization and the department through scholarship and service.

EYES ON THE SKIES

FOR BRADY SACK ('20), THE CLOSEST THING TO SPACE TRAVEL IS DONNING AN AIR TANK AND JUMPING INTO THE POOL OF THE NEUTRAL BUOYANCY RESEARCH FACILITY, one of four on-campus research facilities affiliated with the department's Space Systems Laboratory (SSL). "If I stretch my imagination, I almost feel like I am in space," says Sack, noting the facility is "one of the coolest labs at UMD" and one of the only such facilities located on a university campus.

Under the direction of Professor Dave Akin, SSL director, Sack has worked on a number of key research programs throughout his undergraduate career. Initially, he worked on BioBot, an autonomous portable life support system, that was funded through the 2018 NASA Innovative Advanced Concepts Phase I awards. The concept behind the BioBot is to create a robot to accompany each astronaut to transport their life support system and consumables during exploration. The astronaut would be connected to the robot via an umbilical reel, and BioBot would ultimately be able to travel anywhere the astronaut could walk.

More recently, in a project funded by NASA Goddard Space Flight Center, he is researching autonomous control for satellite servicing robots. "The idea is to launch a robot into orbit attached to an unmanned tele-operated spacecraft and maneuver it to repair a satellite," explains Sack, who worked at the Neutral Buoyancy Research Facility this summer, exploring autonomous control strategies and advanced user control interfaces.

Now in his senior year, Sack, a Presidential Scholarship recipient as well as an AEROS Scholar and Anderson Scholar, will spend much of his time with members of Team Visor as part of the Gemstone Honors Program. His team is designing an updated spacesuit visor and augmented reality system for astronauts on extravehicular activities (EVAs). Such a spacesuit would enable hands-free multitasking, enhance astronaut safety, increase efficiency, and simplify access to information and interaction with the outside environment, which could make EVAs more productive, more cost effective, and more feasible for space exploration.

> "I love the thrill of exploration, of pushing the limits of human capabilities and discovering new places."

Sack recalls he was intrigued by space as a young boy, from stargazing with siblings to watching "Star Trek" and reading *Hitchhiker's Guide to the Galaxy*. That intrigue has only intensified. "I love the thrill of exploration, of pushing the limits of human capabilities and discovering new places," he admits.

As a member of the Gamera-S Undergraduate Research Team, Sack collaborated with the controls and manufacturing teams to construct and test the world's first solar-powered helicopter. He also gained valuable experience working on the NASA Micro-g NEXT competition team to design and test an anchoring device for astronauts, participating in a competition at the Johnson Space Center in Houston where the device was tested in NASA's Neutral Buoyancy Facility.

On the ground, Sack has served as logistics chair for UMD's Relay for Life, planning and organizing the annual signature walk for the American Cancer Society, a campuswide effort that has raised nearly $50,000. "I began volunteering in high school and continue to help plan and organize the campus event," explains Sack, who celebrates survivors and remembers friends and family members lost to cancer through the event.

CREATING NOVEL ENGINE OPTIONS

WHEN SHE WAS YOUNG, SHIKHA REDHAL (M.S. '19) WAS EAGER TO LEARN MORE ABOUT THE STARS FILLING THE NIGHT SKY IN INDIA. Her father would tell her stories about Challenger Astronaut Kalpana Chawla, who attended Punjab Engineering College in Chandigarh, India—where Redhal would later earn her bachelor's degree. "This was the beginning of my interest in the science of flight, which led me to the aerospace engineering field," she recalls.

As an undergraduate, Redhal received the college's highest-ranking award for exemplary achievement along with a certificate of excellence as a member of the college's National Service Scheme. Internships at Air India and India's Defence Research and Development Organisation further whet her appetite for aerospace engineering.

"The reputation of the aerospace engineering program as one of this country's top programs and its close proximity to Washington, D.C. attracted me to the University of Maryland," says Redhal, who is the first person in her family to pursue graduate studies in the United States.

Today, Redhal is conducting research in an emerging area in the field: detonation engines. She is studying the fundamental nature of rotating detonation engines (RDE), a novel engine concept that is gaining interest from the aerospace propulsion industry, including the rocket and air-breathing propulsion community. Detonation-based engines are being considered as replacements to traditional constant pressure heat engines based on their efficiency.

Earlier this year, Redhal received a $10,000 Amelia Earhart Fellowship, joining 29 other women from 15 countries who are pursuing Ph.D./doctoral degrees in aerospace-applied sciences or engineering. Zonta International offers the fellowships to address the critical shortage of women in the field. Globally, women make up only 25 percent of the workforce in the aerospace industry, and the fellowships represent an effort to give women access to resources and leadership positions.

Redhal has developed a detonation tunnel to conduct experiments, and she is testing various injectors and different propellant combinations, including hydrogen, ethylene, and methane with oxygen. Her test bed enables her to study the complex flowfield and three-dimensional wave structure inside the injector. The outcome of her thesis will help design sub-components such as fuel injection and mixing systems, predict performance measures, and eventually help in the development of practical RDEs. It has been a busy year for the researcher, who presented her work at the American Institute of Aeronautics and Astronautics (AIAA) Science and Technology Forum, the 24th International Society of Air Breathing Engines Conference, and the AIAA Propulsion Energy Forum.

> ...Redhal is encouraging young women to consider aerospace engineering as a profession.

As the vice president of the Women in Aeronautics and Astronautics chapter at UMD, Redhal is encouraging young women to consider aerospace engineering as a profession. She is eager to contribute to the development of next-generation engines for the aerospace industry, particularly the application of RDEs for space application. "I look forward to working in industry or in national research labs and to see these technologies used in rockets and aircrafts," Redhal says.

Technical and Business Expertise Lead to Success

PHOTO: AL SANTOS

As director of Space and Missile Defense Systems for Kratos Defense and Security Solutions, Kevin M. Schoonover ('06) is doing his part to make the world a safer place. "Our unit develops launch vehicles and ballistic missile targets to test and validate the U.S. missile defense systems," explains Schoonover, the 2013 recipient of the university's Outstanding Young Alumnus Award and board member, including president, of the UMD Engineering Alumni Chapter for nearly five years.

Today, six department alumni and student interns from the aerospace program work in Schoonover's unit at Kratos, which develops and fields transformative, affordable technology, platforms, and systems for U.S. national security-related customers, allies, and commercial enterprises. "I am really proud to be a UMD graduate," says Schoonover. "The department is producing graduates who are making an impact in the field, and Dr. Wereley continues to work hard to create a good working environment for industry and government partnerships."

The former director of strategy and business development for Alliant Techsystems, Schoonover was named a "rising star in the global aerospace and defense industry" in *Aviation Week & Space Technology's* "40 Under 40." At UMD, he completed honors certifications from the Quality Enhancement Systems and Teams (QUEST) Honors Program.

Schoonover attests he is constantly impressed by graduates of the Aerospace Engineering Honors Program. "Many of our graduates hold doctorate degrees and are now in leadership positions at the Department of Defense, NASA, and other government agencies." It is not unusual for Schoonover to attend a high-level defense agency meeting and run into department alumni. "It is amazing what my former classmates have accomplished."

Following graduation from UMD, Schoonover received his MBA from the Wharton School of the University of Pennsylvania. He advises young students and alumni to be proactive and take charge of their careers. "It is difficult to work on the business side of an organization if you don't know the technical aspects of your products. When you know both, it is a real advantage in this industry."

Schoonover spends his days working with clients to execute launch vehicle campaigns that have six- to nine-month turnarounds or less. "The pace can be frenetic," Schoonover describes. "The Kratos organization has a flat and agile infrastructure. Our employees are never pigeon-holed into one area."

He is the first to admit that the excitement of a rocket launch never gets old. "I am involved with more than 10 launches a year. How cool is that?"

Tischler Receives Second Presidential Rank Award

Mark Tischler ('78, M.S. '79), a senior technologist with the Aviation and Missile Center of the U.S. Army Combat Capabilities Development Command, has been named among the recipients of one of the highest awards the president of the United States can bestow—for the second time.

Recognized as one of the Army's foremost subject matter experts in flight control technologies, Tischler was selected to receive the 2018 Distinguished Presidential Rank Award at a ceremony earlier this year. He first earned the award in 2009. The Baltimore native is one of 139 individuals across 29 agencies this year who joins the one percent of all career senior executive service members and select senior career employees to receive the honor. Tischler was inducted into the department's Academy of Distinguished Alumni in 2007.

SMARTBOLTS® INVENTOR INDUCTED INTO INNOVATION HALL OF FAME

Charles "Chuck" Popenoe ('57) was inducted into the Clark School Innovation Hall of Fame on December 6, 2018. Popenoe was recognized for inventing SmartBolts®, which remains the only technology of its kind—even after more than 50 years. SmartBolts® fasteners display actual tension with a built-in indicator that changes color as the bolt is tightened or loosened. The indicator design is reusable, so it provides value at installation and allows users to monitor fastener preload (the force applied as a result of installation) for the life of the bolt.

Popenoe worked on missile and rocket design for the U.S. Navy following graduation from UMD. In 1962, he began a 27-year career at the National Institute of Standards and Technology (NIST) as an experimental plasma physicist. After he retired from NIST, he founded Stress Indicators Inc. (now known as Industrial Indicators) to sell his SmartBolts.® Today, hundreds of thousands of SmartBolts® are used by the world's leading companies.

Chuck Popenoe and his wife, Helen, celebrate his induction into the Clark School Innovation Hall of Fame.

A. James Clark
School of Engineering

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GOLDEN TERPS

PHOTO: GREG C. FIUME

2019 CELEBRATION Francis O'Brimski ('59) shakes hands with Clark School Dean and Nariman Farvardin Professor Darryll Pines as part of the May 2019 Commencement ceremony honoring Golden Terp Engineers.

Learn more about Golden Terp Engineers at eng.umd.edu/golden-terps.

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