**MARYLAND** AEROSPACE ENGINEERING | **FALL 2022**

# **AERO**CONTACT

# Ingenuity and Beyond

UMD researchers have been a driving force in the development of the Mars helicopter—and the story's just begun.

**DEAR FRIENDS,**

I would like to begin by expressing my deep appreciation to UMD's Clark School of Engineering and Dean Samuel Graham, Jr. for selecting me as chair. It is an incredible privilege to serve the department in this capacity. Aerospace Engineering at UMD has won national and international renown for our pioneering research, and we continue to educate and train successive generations of aerospace engineers. Though much has been accomplished, new horizons lie ahead, and we are determined to keep the momentum going!

In this issue of *AeroContact*, we take an in-depth look at UMD's ongoing role in supporting one of the great space exploration stories of our time: the successful achievement of powered flight on a planet other than Earth. When the Ingenuity helicopter lifted off in 2019, it provided the ultimate "proof of concept" for a design first put forward by UMD students nearly two decades previously. Key figures involved in the earlier design—notably, former graduate student and current UMD aerospace engineering professor Anubhav Datta—would then go on to assist NASA and its partners as they developed the craft that became known as Ingenuity.

And the story doesn't end there. As NASA continues to develop the Mars rotorcraft, adding new capabilities and preparing it to eventually take on the work currently done by Curiosity, the Mars Rover. Datta and the UMD team are contributing their expertise and resources. New facilities at Maryland Engineering, particularly the E.A. Fernandez IDEA (Innovate, Design, and Engineer for America) Factory, are boosting our capacity to support the endeavor.

UMD's Ingenuity-related research, significant as it is, represents only one facet of the work being done at the Alfred Gessow Rotorcraft Center, one of only three such centers at state universities nationwide. This year, it celebrates 40 years of service to the rotorcraft community, and as the industry increasingly transitions towards utilization of unmanned and autonomous systems, the expertise and training it provides remains as crucial as ever. As center director Inderjit Chopra notes, "this is a field that never hovers in one place for long."

In addition to Ingenuity and the Gessow Center, this issue also highlights other important research taking place at UMD aerospace engineering, including the AI and Autonomy for Multi-Agent Systems (ArtIAMAS) project being led by Professor Derek Paley. This ambitious, multi-institutional endeavor aims at nothing less than major transformations in the field of autonomy. Many of our most accomplished faculty, in both engineering and computer science, are involved in this project, together with colleagues at the Army Research Lab (ARL) and the University of Maryland, Baltimore County (UMBC).

We also congratulate Associate Professor Christoph Brehm, a recent addition to the faculty at UMD Aero, on winning an NSF CAREER Award that will support his groundbreaking studies of boundary-layer transitions between laminar and turbulent flow.

This issue also showcases the accomplishments of our students, both as individuals and as members of project and competition teams. Our department is in some ways unique, in that students not only have had abundant opportunities to be involved in hands-on research, but in many cases have spearheaded innovations of lasting significance. That was true of the student team that drew up the Mars helicopter designs that influenced Ingenuity. And it is equally true of such recent projects as Crimson Spin, in which a team of students successfully realized a concept first thought up by Leonardo da Vinci many centuries ago.

I hope you enjoy this update on the vibrant world of ideas and experimentation that is aerospace engineering at Maryland.

Best regards,

Alison Flatau
PROFESSOR AND CHAIR
DEPARTMENT OF AEROSPACE ENGINEERING

SPECIAL SECTION



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

# Ingenuity and Beyond

## As NASA eyes upgrades to the history-making Mars Helicopter, UMD researchers continue to play a pivotal role.

Anubhav Datta was waiting to catch a train in New York's Penn Station when the news came.

"It was in late June of 2015 that I received a call from Dr. Wayne Johnson of NASA Ames, who informed me that planning was underway at the Jet Propulsion Laboratory (JPL) to build a helicopter for the Mars 2020 mission, and that there was an opportunity to be involved," Datta recalls. "AeroVironment would be building the aircraft and JPL would be testing it in their 25-ft Space Simulator the following year. It was important to establish quickly a fundamental understanding of the rotor dynamic loading, blade stresses and stability characteristics, and the critical operating conditions that would be encountered on Mars."

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IMAGES: NASA

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**The MARV design team comprised of an outstanding selection of graduate students,** many of whom are now recognized leaders in the rotary-wing community, Datta notes, while some have gone on to success in other fields. Dr. Beatrice Roget and Dr. Jay Sitaraman are now at the U.S. Army Aviation Development Directorate at NASA Ames, while Dr. Lin Liu, Dr. Jinsong Bao, and Daniel Griffiths are at Sikorsky-Lockheed Martin. Olivier Gamard was at Hélicoptères Guimbal in France before moving on to other endeavors. Greg Pugliese moved to international relations and works at a strategic think-tank in Washington, D.C.

Roget and Bao studied with Inder Chopra, Liu with Darryll Pines, Griffiths and Pugliese with Gordon Leishman, and Sitaraman with James Baeder.

Back row: Beatrice Roget, Daniel Griffiths, Dr. V.T. Nagaraj, Prof. Tishchenko (Mil Design Bereau, Moscow), Olivier Gamard, Greg Pugliese, Jinsong Bao

Front row: Jaina Sitaraman, Lin liu, Anubhav Datta

**The UMD students' design was part of a prestigious annual competition** that continues to this day, with a different challenge posed by every year. To participate, students must first take at least five graduate classes in helicopters, and then be part of a formal graduate design class, ENAE 634. The design class has been taught since 1998 by Dr. V. T. Nagaraj, one of the most renowned luminaries in the field, together with Dr. Inder Chopra, who is the director of the Alfred Gessow Rotorcraft Center (AGRC). The 2000 team also benefited from having other legendary figures as advisors, including Professor Alfred Gessow as well as Professor Marat Tishchenko of the Russian Academy of Sciences, designer of the world's largest helicopter, the 8-bladed Mil Mi-26.

An associate professor of aerospace engineering at the University of Maryland, Datta has been involved with the topic since his days as a graduate student, when he led a UMD graduate team that, in 2000, drew up plans for a design they named the Martian Autonomous Rotary-wing Vehicle (MARV). It sounded like science-fiction at the time.

Their design, which featured two-bladed coaxial counter-rotating rotors mounted on a square, symmetric fuselage, established the feasibility of a Mars helicopter, and provided a blueprint for its design. It won them first place in the American Helicopter Society's (now known as the Vertical Flight Society) international graduate design competition, which was sponsored by Sikorsky and NASA.

The students demonstrated that blade loading—a parameter crucial for rotary-wing flight—could be achieved satisfactorily on Mars, if certain guidelines for maximizing the blade Reynolds number were followed, and that a two-bladed coaxial counter-rotating system would be ideal. Their work was published in the *AIAA Journal of Aircraft*[1] and then quickly forgotten. "There was no momentum to make it real," Datta said. "The scale of enterprise needed to put a helicopter on a Mars mission meant only NASA JPL could make it happen."

Anubhav Datta

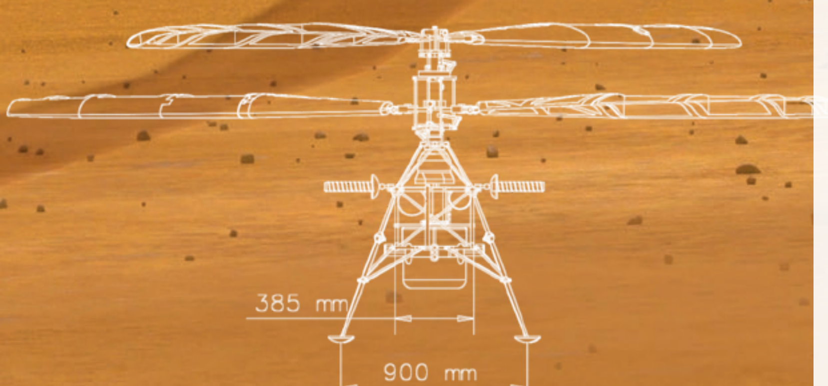
In general, Datta recalls, "the head count of people interested in the topic was low. Apart from Larry Young at NASA Ames Research Center, who has been the chief proponent of the topic since 1999 (and an architect of the AHS Design) and his followers there, and researchers at Maryland, who kept at it sporadically after the design, there were no serious takers."

## From Vision to Reality

By 2015, however, all that had changed. Not only was NASA JPL designing a helicopter bound for the Red Planet, but it would incorporate key aspects of the UMD students' work.

Indeed, the helicopter that lifted off from the surface of Mars on April 19, 2022, achieving the first-ever powered flight on another planet, bore a striking resemblance to MARV—notably, both designs featured two-bladed coaxial counter-rotating rotors on a square fuselage. The actual helicopter was 1/3.7-scale smaller in dimensions and had a hinge-less hub to conform to certain control bandwidth requirements discovered by JPL. Advances in lightweight electric motors allowed two independent rotor drives and independent swash-plates replacing the more complex inter-connecting linkages designed in MARV. There was no payload except for a camera.

[1] Vol. 40, No. 3 (May-June 2003)



# The Mars Helicopter: Ingenuity

The rotorcraft known as the "Mars Helicopter Scout," later as "Mars Helicopter Technology Demonstrator," and ultimately as Ingenuity was conceived and developed by NASA JPL and AeroVironment starting around 2014.

Datta, then at the U.S. Army Aviation Development Directorate at NASA Ames Research Center, was recruited as an AeroVironment contractor responsible for predicting accurately its rotor dynamic characteristics and the blade stresses needed for safety of flight. Datta recalls, "my Army supervisor and mentor, Dr. Roger Strawn, enthusiastically permitted me to participate, without him it would not have been possible. He knew my history with Mars helicopters, and had one of his own. He had in fact supported the first computational fluid dynamic analysis for Mars, carried out by Kelly Corfeld and Prof. Lyle Long of Penn State for a rotor prototype tested at Ames following the UMD design.

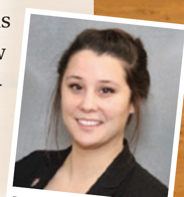
The stakes could hardly be higher. "The Mars Helicopter would be the first attempt at controlled flight outside Earth, a major milestone in aeronautics and planetary exploration, if successful," Datta said. "It could not break apart on Mars, nor during testing at the JPL 25-ft Space Simulator. The unusual aircraft needed an unusual software to predict its stresses accurately, in one shot, with no margin for trial and error."


William Staruk Ph.D. '17

Once again, UMD graduate students would play a pivotal role. William Staruk and Elizabeth Ward, both in the doctoral program at Maryland, were spearheading a joint effort by the university and the U.S. Army to develop software—eventually known as X3D—that would be capable of predicting stresses on unusual helicopter rotors, based on a digital description of the rotors' geometry and material plies. "Only one person—William Staruk—could build the models we needed at the time," Datta said. Staruk worked at a computer in Datta's UMD office, clocking in late hours and knowing only that the work was of national importance.

"I still remember the day I was asked by Dr. Datta to do some rotor blade structural modeling for Mars Ingenuity," Staruk said. "He couldn't tell me what the blades were for, but when I saw the unique shape of the blades I guessed it might be related to the Mars development program. The blade structure was quite unlike a typical helicopter and required the unique tools being developed jointly by UMD and the U.S. Army for analysis."

"When, months later, I found out that those were the actual Ingenuity blades I was ecstatic! Knowing that I had contributed my tiny bit of work to the program made watching the launch even more exciting. Most aerospace engineers have to choose between the two domains, air or space, and I consider myself very fortunate to have had the opportunity to contribute on both fronts," he said.


Elizabeth Ward Ph.D. '17

Recollects Ward: "At the time I had no idea what kind of impact our work would have. My specific project was exciting and I was able to show, at least analytically, how tailoring materials could significantly affect rotor performance, but it had not ever been put into practice. I remember Will [Staruk] disappearing to work on a special project with no indication of what it was. I can't describe how exciting it was when I finally heard that the work was for Ingenuity. I knew that our work had the potential for great impact, but figured that was a ways down the road. To see it happen, and so soon, is a testament to the incredible work that UMD students and faculty can produce."

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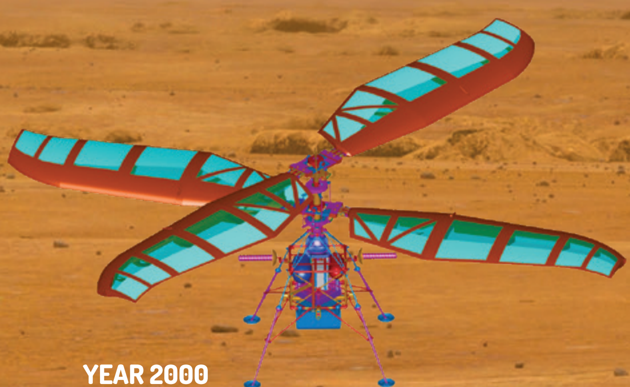

**YEAR 2000**

**Martian Autonomous Rotory-wing Vehicle (MARV)**

UNIVERSITY OF MARYLAND

NASA / SIKORSKY / VFS WINNING DESIGN 2000

BLADE SPAN: **4.3 m**
MASS: **50 kg**
ENDURANCE: **39 minutes**
GUST REJECTION: **7 m/sec**
FLIGHT RANGE: **Up to 25 km**
FLIGHT ALTITUDE: **Up to 100 m**

**YEAR 2020**

**Ingenuity**

NASA / AEROVIRONMENT

MARS 2020 MISSION

BLADE SPAN: **1.2 m**
MASS: **1.8 kg**
ENDURANCE: **90 seconds**
GUST REJECTION: **10 m/sec**
FLIGHT RANGE: **Up to 300 m**
FLIGHT ALTITUDE: **Up to 5 m**

## From MARV to Ingenuity: A 20-Year Journey*

*Source: Vertical Flight Society, *Vertilite*, May-June 2021

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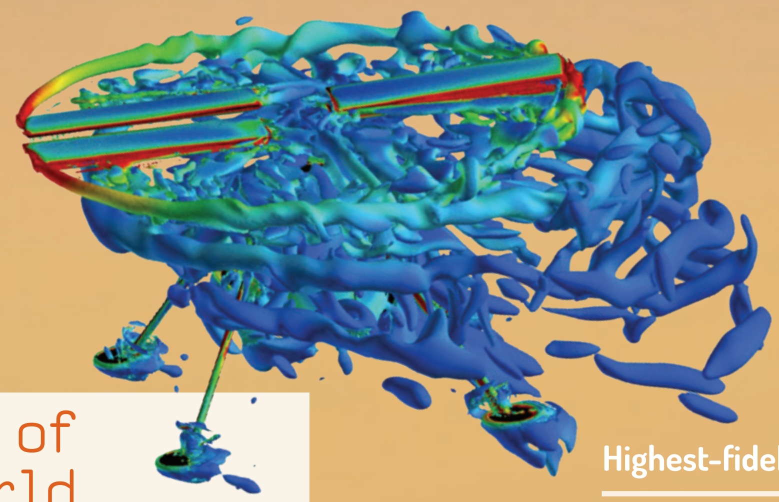


## Highest-fidelity simulation

Escobar's CFD/CA coupled simulation with with DOD CFD and UMD rotor Comprehensive Analysis. CFD/CA is the highest-fidelity simulation tool in the US.

# The Physics of an Alien World

Understanding the nature of the engineering challenge involved in flying on Mars requires some familiarity with the atmospheric conditions that prevail on the red planet. These are very different from what we are used to on Earth.

Even though gravity on Mars is only 37% that of Earth, the Mars atmosphere, consisting primarily of carbon dioxide, is about 100 times thinner than that of Earth: in effect, when a helicopter is on the Martian surface, it's already at the Earth equivalent of 90,000 feet up. Atmospheric viscosity and density are both low, affecting the ability to achieve and sustain lift. Because Mars is also very cold, the speed of sound is only about 70% of that on Earth. Thus, shocks and compressibility are encountered earlier, and prevent the rotors from simply being turned faster. Mars also differs in a number of other ways that can have an indirect bearing on flight, including extreme temperatures, strong gusts, lack of effective cooling, and rugged terrain. Designs can vary significantly depending on the landing site and time of the day.

Eric Greenbaum; M.S. student working on Flight Dynamics on Mars

"The low Martian density presents two challenges: generating lift and (specifically for rotorcraft) low aerodynamic damping," said Eric Greenbaum, an M.S. student at the AGRC. "When you decrease the density as much as you do from Earth to Mars, that aerodynamic damping—which is usually around 50%—decreases in orders of magnitude to 1-2% or so. This presents very interesting flight dynamics and flight control challenges, which in turn, affect the design of the entire aircraft, because those effects propagate from the blades to the rotor through the hub and into the fuselage to impact rigid body dynamics."

The Reynolds number, or the ratio of flow inertia to viscosity, becomes significant in a way that is seldom true for large aircraft on Earth. Perhaps most important, given the conditions, is lightness. A helicopter designed for Mars has to be incredibly light, with rotor blades thinner than paper, its blades designed to have just the right chord, and rotor spin at just the right speed, to maintain precise control of the Reynolds number.

There are many advantages, too. Low density means low drag, so the airframe does not have to be particularly aerodynamic in shape. Hence the square-shaped fuselage, which provides extra room for scientific instruments. "We have to think about flight in a different way when we are talking about Mars," Datta said. "Not just out-of-the-box, but out-of-the-planet thinking."

For example, he notes, "two major technical challenges of any new helicopter development on Earth are vibration and noise. Not on Mars. Tip vortices that produce vibration dissipate faster at a low Reynolds number and there is nobody to complain about noise. A clever design leverages the opportunities on Mars, rather than just trying to fight the obvious barriers."

Much of UMD's Mars-related research work has thus been concerned with designing blades that are both uncommonly thin and sufficiently strong. This cannot be achieved easily through trial and error, even with a pressure chamber at hand that can approximate Martian conditions. It requires, instead, an approach based on mathematics and on the fundamentals of physics.


## Ingenuity helicopter team wins Howard Hughes Award

The University of Maryland (UMD) and other organizations involved in development of Ingenuity, the Mars helicopter, received the Vertical Flight Society's (VFS) Howard Hughes award earlier this year in recognition of their achievement. The award was presented formally at the 78th annual Forum and Technology Display on May 12 in Fort Worth, Texas.

> “A clever design leverages the opportunities on Mars, rather than just trying to fight the obvious barriers.”

# After Ingenuity

While the Mars rotorcraft has secured its place in the annals of science, the story is only beginning. NASA has its sights set on designing a next-generation rotorcraft that will not only be able to fly, but carry out science experiments, ultimately perhaps taking on much of the work now being done by rovers, like Curiosity and Perseverance.

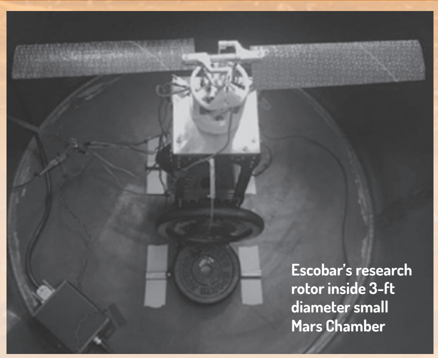
And it continues to leverage UMD’s expertise to help make this happen.

The Mars Helicopter is a small 1.8 kg rotorcraft. A larger, more capable rotorcraft is needed to carry out science missions in the future. For that purpose, the rotor and the aircraft must be optimized skillfully to take advantage of Martian aeromechanics. High-fidelity software is needed to produce an innovative design for these aircraft. Basic research data is needed to validate and calibrate inventions.

Daniel Escobar, who joined the Alfred Gessow Rotorcraft Center in 2016, set about filling in some of the major research gaps as part of his Ph.D. dissertation at Maryland. Among other contributions, he synthesized his own rotor Comprehensive Analysis (CA) and coupled it with AGRC in-house Computational Fluid Dynamics (CFD) software developed by Prof. James Baeder and his students to reveal some of the remarkable flow features and load patterns on Mars for the first time. Since there was no flight test data to validate his results, he fabricated and tested rotor blades in a small 3-feet diameter Mars chamber in-house to collect hover data. By comparing theory with experiments, Escobar confirmed that non-smooth, sharp-edged, ultra-thin surfaces might be better suited for Mars than regular airfoils.

Daniel Escobar Ph.D. ’20, Clark Fellow

Escobar completed his Ph.D. in 2020 and is now at the U.S. Army Aviation Directorate at NASA Ames.



Escobar’s research rotor inside 3-ft diameter small Mars Chamber

## Next-generation Mars rotor blades

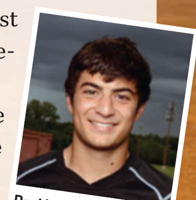
An illustration of a blade’s internal structure. The skin and spar are made of different types of carbon fiber, the foam core is rohacell foam, and the root insert is made of aluminum.

IMAGE: RAVI LUMBA/ALFRED GESSOW ROTORCRAFT CENTER


Building off the work of Staruk and Ward, meanwhile, a newer generation of graduate students—including Cheng Chi, Ravi Lumba, and Mrinal Patil (all 2022 Ph.D. graduates)—has expanded the capabilities of the X3D program. Using parallel computing on UMD’s supercomputer cluster, the program can now analyze thousands of potential geometries in a few hours to down-select the best aeromechanical solution with integrated structures, aerodynamics, and controls.

Cheng Chi Ph.D. ’22

Notes Lumba: “With the solver, you put in the parameters—atmospheric density, how fast the rotor is going to be spinning, how the aerodynamics are distributed across the blade. It then models the blade being rotated, and calculates the stresses and strains throughout the system.”



Ravi Lumba Ph.D. ’22, NSF Fellow

Meanwhile, current UMD Ph.D. student and Clark Fellow, Victoria Britcher is developing ways to equip future rotorcraft with the computer vision capabilities needed to successfully, and autonomously, navigate an alien world. To carry out compelling science, a Mars helicopter will have to ultimately interrogate cliffs, fly into caves, follow rugged terrain, and land on unprepared sites on its own, and perhaps return samples to the rover. Britcher’s goal is to develop vision algorithms that would recognize 3D features and make intelligent decisions on where to land, when, how, what to interrogate, and when needed, what to pick up.

Victoria Britcher current Ph.D. student, Clark Fellow

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“This is an emerging field of the future. It has blurred the distinction between space and aeronautics.”

# Only the Beginning

A vision for the future can be found in a NASA technical memorandum (NASA/TM 2020-220485), “Mars Science Helicopter Conceptual Design,” which was published in March 2020. A follow-up project called ROAMX at the NASA Ames Research Center, led by Haley Cummings aims to convert the vision to reality. Datta notes: “Ms. Cummings and her team at NASA Ames are designing, fabricating, and preparing to test the next-generation optimized rotor system that will pave the way for increased payload, speed, and range. Cheng and Ravi are both playing a key role in this project. That program is also supporting our graduate students.”

Report co-author Cheng Chi, who graduated with his doctoral degree in May 2022 after extensive work related to Mars rotorcraft, explains the process. “NASA provides us with a target aerodynamic shape—the dream shape, so to speak—and we have to create the structural design to support that shape with minimum weight and maximum stiffness in a manner that can be fabricated,” he said. “We design the internal structure using our unique X3D solver but also bring to bear our in-house expertise on Mach-scale fabrication and testing. The design is not on paper, but is fabrication ready.”

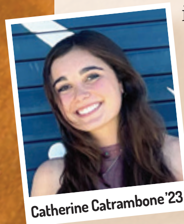
“We’re looking for the weight—is it light enough?—and we look for strains and stresses to determine if it will break during rotation. Also, very importantly, we identify the natural frequencies of the rotating blades, because we want to prevent resonance,” he said. “We also have a unique vacuum chamber facility where pure natural frequencies can actually be measured.”


Past, present, and future researchers of Mars aeromechanics: Larry Young (NASA Ames), Cheng Chi, Ravi Lumba, Nubhav Datta (UMD), Haley Cummings (NASA Ames), William Staruk (Joby), Lin Liu (Sikorsky), and Wayne Johnson (NASA Ames); VFS Annual Forum and Technology Display 2022.

To achieve its objectives, the upgraded craft must reflect new advances in lightness, speed, and efficiency—a tall order, given how lightweight Ingenuity already is. Once again, the focus is on blades, Lumba explains. “We can achieve significant weight savings by using unconventional materials, such as carbon fiber and composites, and leveraging the advantages on Mars, including no noise or vibration concerns,” he said.

“But we also have to make sure they are structurally sound. They’re incredibly thin, even more so than the blades being used on Ingenuity now, and based on what we have learned from NASA and UMD research since, are likely to have sharp edges.”

Catherine Catrambone, an aerospace engineering undergraduate, and Logan Swaisgood, who completed his bachelor’s in May and entered the Ph.D. program this fall, have been making important contributions as well, including by testing the material properties of the composite materials being used for the blades, and preparing for serious research in future. As their mentor Lumba notes, “the specs provided by the manufacturer aren’t always on target, and with a mission like this one, the numbers must be precise. NASA sends us what are termed ‘coupons’ of composite materials; and by measuring the strains on each coupon, their ply properties can be measured.” Catrambone spent the summer of 2022 at NASA Ames Research Center as an intern in the Aeromechanics Branch under the supervision of Ms. Haley Cummings.



Catherine Catrambone ’23

Logan Swaisgood ’22

Further testing capabilities are in store. In May, Maryland Engineering launched the brand-new E.A. Fernandez IDEA Factory, the first-ever building on UMD to be constructed entirely with private financing. Among other facilities, the building will house a pressure chamber, large enough to test completed blades, as well as a computer-vision laboratory with a motion platform to develop truly autonomous landing capabilities.

“This is an emerging field of the future,” Datta said. “It has blurred the distinction between space and aeronautics. Because of our long track record in creating and nurturing this field, we are now well-poised to be the leader. There are barriers to be broken before rotorcraft becomes ubiquitous as a compelling science platform on Mars or act as astronaut agents in the future. Our task is to do the hard research work that is needed to break those barriers.”

# ALFRED GESSOW ROTORCRAFT CENTER:
## 40 YEARS OF PREPARING FUTURE ENGINEERS

**THE UMD-BASED ROTORCRAFT CENTER OF EXCELLENCE HAS BEEN TRAINING INDUSTRY GAME-CHANGERS SINCE 1982. WITH THE EVTOL REVOLUTION IN PROGRESS, THE MOMENTUM IS SET TO CONTINUE.**

From the Gamera human-powered helicopter to Ingenuity, some of the most striking achievements in the world of rotorcraft have involved students and faculty at UMD's Alfred Gessow Rotorcraft Center (AGRC), which marks its 40th anniversary this year.

One of three university-based Vertical Lift Rotorcraft Centers for Excellence, the others being at Georgia Tech and Penn State, AGRC helps meet the rotorcraft industry's need for skilled engineers and creative thinkers, providing research and training opportunities to more than 50 graduate students annually, as well as 30-40 undergraduates.

"We need to increase the number of trained rotorcraft engineers in this country," said Inderjit Chopra, who has directed the center since its establishment in 1982. "If the United States is to retain leadership in the field, we must ensure that the pipeline is there. At UMD, we're doing our part."

The AGRC's primary mission is to educate students and prepare them for impactful roles in the rotorcraft industry, Chopra said. "But we also have a mission to support the industry directly with pioneering research," he added. "Since the research focus provides hands-on experience for our students, and our students contribute to the advancement of research, these are really two sides of the same coin."

Visit the AGRC's facilities on campus and you'll see students in action, creating scaled rotor models and then testing their performance characteristics on hover tower and in vacuum chambers, as well as in the Glenn L. Martin Wind Tunnel. In the coming years, the existing facilities will be supplemented by new ones housed in the IDEA Factory, the brand-new, state-of-the-art engineering building that opened its doors in 2022.

You might also encounter them hard at work on the next exciting breakthrough. Just this past school year, for instance, a student team succeeded in designing a flyable machine that uses an "aerial screw"—a concept first proposed by Leonardo da Vinci, and long thought merely fanciful—to achieve lift. In another recent example, students affiliated with the center developed a hybrid vehicle that takes off vertically but becomes a biplane while in flight. U.S. and world records achieved by the UMD-built Gamera human-powered helicopters still stand, including the as-yet-unsurpassed flight duration record of 97 seconds, as well as the U.S. record for longest human-powered flight achieved by a female pilot.

Named after former UMD chair of aerospace engineering Alfred Gessow (1922-2002), whose work helped establish precise methods of rotor analysis, the AGRC was established with support from the Army Research Office and later the U.S. Army, Navy, and NASA. Its core program covers aerodynamics, dynamics, flight dynamics, computational fluid dynamics, acoustics, transmissions and drivetrains, electric VTOL, composite, and advanced designs. In addition, the center has contributed greatly to research on "smart structures," including rotors that are controllable with next-generation actuators; and micro aerial vehicles, including rotor-based and flapping-wing-based, semi-autonomous, palm-sized vehicles.

Faculty currently affiliated with the center include Distinguished University Professor Inderjit Chopra, Langley Professor James Baeder, Associate Professor Anubhav Datta, Professor Roberto Celi, Igor Sikorsky Professor Olivier Bauchau, Minta Martin Professor Norman Wereley, Assistant Professor Umberto Saetti and Research Scientist V. T. Nagaraj. UMD President Darryll J. Pines, who began his career at UMD as an aerospace engineering professor with focus on rotorcraft, is also on the AGRC faculty.

Faculty at the center have led highly competitive MURIs, one 10-year Micro Autonomous System Technology Collaborative Technology Alliance grant, and three major DARPA programs. AGRC faculty and students have published more than 1,000 papers in leading national and international conferences and more than 500 papers in peer reviewed journals. More than 200 Ph.D. and 350 M.S. degrees have been awarded. Nine AGRC alumni have received the prestigious VFS (Vertical Flight Society) Bagnoud Vertical Flight Awards, 13 have become Technical Fellows of the VFS, and 29 are now faculty members at leading institutions and invigorating rotorcraft education worldwide.

Another key component of the education is the emphasis on rotorcraft design and practical application of textbook learning. In each of the past 24 years, a team of graduate students has assembled a design for the VFS International Design Competition; 22 out of 24 years, the team won first place.

"This is a field that never hovers in one place for long, and the pace of change is set to accelerate," Chopra said. "Major companies are already investing heavily in technologies related to electric vertical takeoff and landing (eVTOL) vehicles, and that trend is set to continue in the coming years. We help solve the technology barrier problems, speedily transfer technology, and the skilled personnel that will help advance this technological revolution."

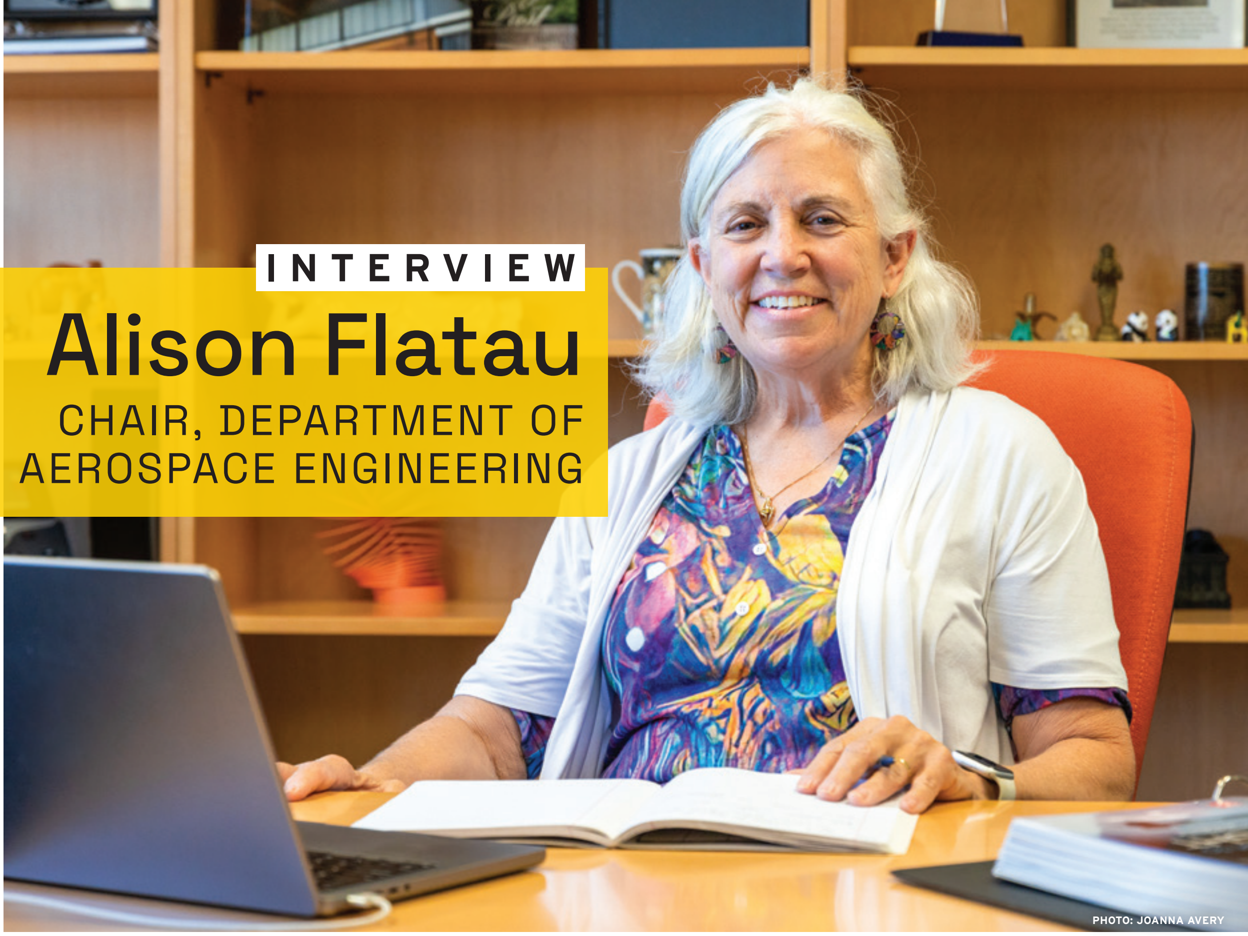


PHOTO: JOANNA AVERY

INTERVIEW

# Alison Flatau

## CHAIR, DEPARTMENT OF AEROSPACE ENGINEERING

UMD Aerospace Engineering Professor Alison Flatau became chair of the department on August 1. She had previously served as interim chair. In announcing her selection, Maryland Engineering's Dean Samuel Graham, Jr. noted Flatau's many contributions to the aerospace community. "We've found an experienced and nationally recognized leader for our aerospace engineering department—and found her right here at the Clark School," Graham said.

Flatau's teaching and research interests focus on smart materials and structures, with an emphasis on magnetostrictive actuator and sensor technologies. She was principal investigator on an Office of Naval Research Multi-Institutional University Research Initiative (MURI) grant supporting magnetostrictive alloy research, which made important contributions to the Department of Defense and the aerospace industry.

Her honors include a Clark School Faculty Service Award, Women in Aerospace Engineering Educator of the Year Award, SPIE Smart Structures and Materials Lifetime Achievement Award, and an ASME Adaptive Structures and Materials Systems Prize. She is a Fellow of the American Society of Mechanical Engineers and the American Institute of Aeronautics and Astronautics, and in 2018 was an IEEE Distinguished Lecturer.

Dr. Flatau holds a B.S. in Chemical Engineering from the University of Connecticut; and a M.S. and Ph.D. in Mechanical Engineering from the University of Utah.

**WHAT DO YOU SEE AS THE DISTINCTIVE STRENGTHS OF THE AEROSPACE ENGINEERING DEPARTMENT AT UMD?**

First and foremost are our internationally recognized faculty, whose impact is seen not only in the research they produce, but also in the success of our graduate students. We also host unique facilities, including the Neutral Buoyancy Research Facility, the High Speed Aerodynamics and Propulsion Laboratory, the Glenn L. Martin Wind Tunnel, and the UMD UAS Research and Operations Center. With the opening of the new IDEA Factory on campus, we'll have additional facilities to support rotorcraft research and robotics. Numerous faculty members have won highly competitive Defense University Research Instrumentation Program (DURIP) grants that provide support for establishing and maintaining such facilities. Location is a major plus for us—we're in near proximity to NASA, the Army Research Lab, and to facilities such as Tunnel 9, as well as research hubs like the Johns Hopkins University Applied Physics Lab. Our proximity to key labs, agencies, organization, and companies opens up internship and employment opportunities for our students, and it also connects us with lecturers who bring hands-on aerospace engineering experience into the classroom.

Our department has also been a leader both nationally and on campus when it comes to fostering diversity in engineering as evidenced by the success of programs such as the Junior Endeavor Transfer program and organizations such as Women in Aeronautics and Astronautics.

**WHAT ARE SOME OF YOUR MAIN OBJECTIVES AND PRIORITIES AS AE CHAIR?**

Student success is front and center in all that we do, and my main objective is to make sure this continues. We endeavor to provide our students with an education that prepares them for successful careers at all levels in the aerospace field, including leadership roles. To accomplish this, we offer them an academic environment in which they can tap their inner creativity in ways that have an impact, because that's how innovation happens. We've seen it, for example, in the da Vinci-inspired aerial screw designed by one of our student teams—it takes creativity not only to think of an idea like that, but to follow it through to completion. In short, students come first. When we do right by our students, we also do right by our stakeholders, whether in government or in industry.

Our priorities in hiring, curriculum development, and other areas reflect this overarching goal of fostering student success. We plan to increase the number of faculty and graduate students involved in space-related research, and also broaden our space systems curriculum, because we're seeing a large increase in the number of undergraduates pursuing the space track. We also plan to reinforce our capabilities in areas such as hypersonics and low-speed aerodynamics, which have been among our strengths historically. Another key priority is creating additional opportunities for students—both undergraduate and graduate—to participate in national design competitions; we hope to provide new opportunities for mentorship in design and other areas.

**WHAT DO YOU SEE AS SOME OF THE MAJOR EMERGING TRENDS IN THE AEROSPACE ENGINEERING FIELD? HOW IS THE FIELD CHANGING, AND HOW IS THE AE DEPARTMENT AT UMD RESPONDING TO THESE CHANGES?**

We are seeing enormous technical advances and growth in activities related to space, hypersonics, and autonomy. These are creating new opportunities and challenges for our faculty and students. For example, in the past, the industry consisted mainly of NASA contractors and satellite companies that relied on NASA to get them into space. But now, everyone has their own vehicles, and we've been seeing explosive growth in the number of space-related private companies. It's going to be a major area of growth for the conceivable future. The commercialization of space has been a major driver of the increased enrollments we've been seeing in aerospace engineering.

Another important development is increased federal support—and increased business and entrepreneurial activity—in areas such as urban air mobility and electric aviation. Go back a few years and there were very few jobs in those fields. Now there's a real and growing demand.

**HOW ARE AEROSPACE ENGINEERS AT UMD HELPING TO ADDRESS THE GRAND CHALLENGES OF OUR TIME?**

One of the National Academy of Engineering's Grand Challenges is to "engineer the tools of scientific discovery." Ingenuity, the Mars rotorcraft, is an inspiring example. Powered flight allows us to learn much more about Mars than was possible before and may shed new light on whether life exists, or has existed, on our neighbor planet. And the blades used on Ingenuity were analyzed here at UMD, by our faculty and students. You can come to UMD as an undergraduate student and make a real contribution to space exploration—how cool is that?

Aerospace engineers also provide the tools and technologies needed to better understand our own planet, including the hazards of climate change. Climatologists rely on sea ice data gathered by orbiting satellites in order to make projections. We also have students and faculty who work with underwater robots that can help scientists gain a clearer picture of oceanic ecosystems.

As aerospace engineers devise new approaches to propulsion, their findings may offer clues to addressing our energy problems here on Earth. UMD aerospace engineering alumnus Ajay Kothari (Ph.D., '79), for instance, has been exploring the potential of thorium-based systems that could provide a major boost to space exploration—and it could also offer a radiation-free alternative to nuclear energy. The possibilities are astonishing.

**OUTSIDE OF YOUR PROFESSIONAL LIFE, WHAT ARE SOME OF YOUR INTERESTS?**

Enjoying time with family and friends, playing with my dog, golf, bird watching, reading a good book, and spending summers in Vermont!

## FACULTY PROMOTIONS

**CHRISTOPH BREHM** has been promoted from Assistant to Associate Professor.

**PINO MARTIN** has been promoted to Professor.

**HUAN "MUMU" XU** has been promoted to Associate Professor

## Saetti joins UMD Aerospace Engineering faculty

Umberto Saetti has been appointed assistant professor at the UMD aerospace engineering department. He had previously served as a visiting professor in the department, and as assistant professor at Auburn University.

Saetti's research focuses on modeling, simulation, order reduction, and control of high-order models of the coupled flight dynamics, aerodynamics, and aeroacoustics of aircraft, rotorcraft, and biologically-inspired flying vehicles. These models are used for studies involving immersive simulations that make use of Extended Reality (XR), human-machine interaction, synthesis of advanced flight control laws, development of innovative pilot cueing methods, and fundamental understanding of the stability of flapping-wing flight.

He is the recipient of the 2022 Office of Naval Research Young Investigator Program (ONR YIP) award. Additionally, he received the Barnes McCormick Memorial Scholarship, awarded by the Vertical Flight Foundation (VFF) for outstanding accomplishments as a doctoral candidate in the vertical flight field.

Saetti holds a Ph.D. in Aerospace Engineering (with a minor in Computational Science), an M.Sc. in Aerospace Engineering, and an M.Sc. in Electrical Engineering from Pennsylvania State University. He received his B.Sc. in Aerospace Engineering from Politecnico di Milano, Italy. He has been a Postdoctoral Fellow in the Daniel Guggenheim School of Aerospace Engineering at Georgia Tech, and a Visiting Scholar at the U.S. Army Aviation Development Directorate at NASA Ames.

# Brehm to Conduct First-of-Kind Flow Simulations

**AN NSF CAREER GRANT WILL PROVIDE MORE THAN $500K IN FUNDING TO SUPPORT NEW RESEARCH.**

Christoph Brehm
*UMD assistant professor of aerospace engineering, is the recipient of an NSF CAREER Award.*

When designing vehicles that travel at very high speeds, engineers must be able to predict how flow fields interact with vehicle surfaces. Particularly critical is the transition between two kinds of flow regimes: laminar, in which the flow moves in orderly, parallel lines, and turbulent, characterized by chaotic movement in many directions.

Turbulent flow causes surface friction and heat transfer to increase, creating conditions that can lead to degraded performance or even structural failure.

But predicting when and how the transition occurs is difficult, says Dr. Christoph Brehm, assistant professor of aerospace engineering and recipient of a recently announced NSF CAREER grant—considered one of the most prestigious awards available to early-career researchers. Many parameters are involved, including geometry, flow conditions, external disturbance, and the surface texture; moreover, the conditions in which the phenomena occur are nearly impossible to reproduce in a lab.

With $515K in NSF support over five years, Brehm aims to address current gaps in the research concerning flow-surface interactions.

More specifically, his research focuses on how certain surface types—particularly ablative surfaces, which are rough and evolve over time—interact with transitional flows. As part of his research, Brehm will be performing the first-ever simulations of transitional flow interacting with ablative surfaces at the hypersonic boundary layer—that is, the region of airflow that is closest to the surface.

"We want to obtain a fundamental understanding of how realistic non-smooth surfaces affect all stages of the laminar-to-turbulent transition process," Brehm said. "This has significance to everything from cruise missiles to spacecraft reentry."

*"THIS HAS SIGNIFICANCE TO EVERYTHING FROM CRUISE MISSILES TO SPACECRAFT REENTRY."*

Advanced computing promises to yield breakthroughs that have hitherto proved elusive due to the inherent limitations of experimental research, Brehm said.

"That's why it is so important for us to have powerful computational resources," he said. "We can only make real progress in this area through computation and simulation. Even with a large amount of funding for experimental testing facilities, it's next to impossible to reproduce the conditions of re-entry into the Earth's atmosphere, of free flight, or of Mars entry."

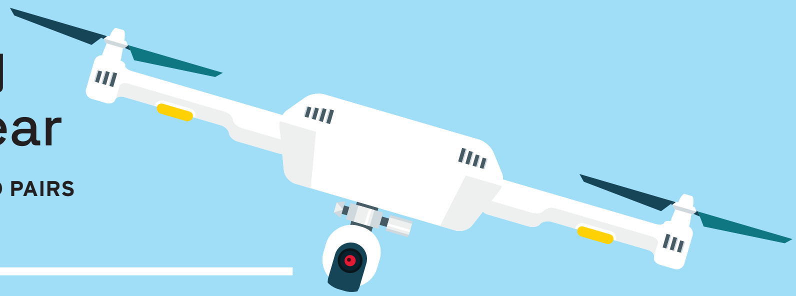
While Brehm will have access to NASA and NSF computing resources, the upcoming Zaratan supercomputing cluster at UMD will be the mainstay of his CAREER grant research. "Having this cluster available is a tremendous asset," he said. "We can run our code right away and effectively debug newly developed capabilities, as opposed to waiting a week or more for time on a system that's being shared by many institutions."

An educational program is planned in conjunction with Brehm's research. "We plan to set up a summer program in which high school students will have the opportunity to experiment with a user-friendly, virtual wind tunnel developed by his research team, interjecting different shapes into hypersonic flow and determining what forces are interacting with the different shapes. The students will be asked to come up with an optimal aerodynamic design meeting certain design criteria."

# ArtIAMAS:

## Game-changing autonomy research enters second year

**PROGRAM GATHERS EXPERTS FROM MULTIPLE INSTITUTIONS AND PAIRS THEM WITH STATE-OF-THE-ART AUTONOMY RESEARCH FACILITIES.**



A drone flies high over an urban environment. Below, an individual is reaching for something at his side. Is it a weapon? Or simply a cell phone?

To help train unmanned and autonomous machines to make such distinctions more accurately, UMD aerospace engineering professor Derek Paley and doctoral student Wei Cui are using Unity, a 3D development platform used widely in video gaming, to develop highly precise, responsive algorithms.

But that's not the end of the story. For added verisimilitude, the Unity simulations are supplemented by hundreds of hours' worth of real-world drone imagery. Finally, the U.S. Army Research Lab (ARL) will test the results at facilities that include the Robotics Research Collaboration Campus in Graces Quarters, Maryland.

The endeavor is one of many being conducted as part of a massive, multi-institutional program known as AI and Autonomy for Multi-Agent Systems (ArtIAMAS), with Paley as the PI. The five-year agreement, with funding up to $68 million, pools the expertise of engineers, roboticists, computer scientists, and other experts, with the aim of tackling some of the thorniest problems in AI, autonomy, and robotics research.

"What if you took all of the faculty working in AI and autonomy across two major university campuses, put all their research expertise into the toolbox, and said 'what can we build with this to address ARL's research needs?' In effect, that's what we've set out to do with ArtIAMAS," Paley said.

"The aim is to marshal a broad pool of expertise and achieve the kind of synergy that, we hope, will move the needle."

ArtIAMAS not only brings together a large pool of researchers but also gives them access to some of the best facilities available for autonomy research, including the Army Research Lab's Robotics Research Collaborative Campus (R2C2), which includes a 200-acre, reconfigurable, multiple-terrain outdoor testing laboratory just north of Baltimore for scalable AI, autonomy, and robotics research.

They also have access to the recently launched Maryland Autonomous Technology Research and Innovation Exploration (MATRIX) Lab, based at the University of Maryland System at Southern Maryland's newly-built SMART Innovation Center. The MATRIX Lab boasts an 80' by 60' open air-land lab with an amphibious pool, a hydrology lab featuring a circulating water channel with a 80 cm by 130 cm cross-section, an AR/VR capable research space, roof-top antenna farm, and outdoor ground and air vehicle testing facility.

With Paley as overall lead, specific research thrusts of the ArtIAMAS project are being headed by Jeffrey Herrmann (Department of Mechanical Engineering and Institute for Systems Research); University of Maryland Baltimore County faculty members Aryya Gangopadhyay and Nirmalya Roy; and Dinesh Manocha, Distinguished University Professor and Paul Chrisman Iribe Professor of Computer Science and Electrical and Computer Engineering at UMD.

"There's a big vision here," says Matt Scassero, who directs UMD research initiatives at the SMART Center. "Over a long period of years, UMD has been fostering autonomous research capabilities that are hard to find anywhere else. And now we're endeavoring to flex those capabilities."

"Ultimately, we want people to automatically think 'UMD' when the subject of autonomy research comes up," he said. "ArtIAMAS is one of the ways we are making that happen."

Derek Paley
*Willis H. Young, Jr. Professor of Aerospace Engineering and Director, Maryland Robotics Center*

Jeffrey Herrmann
*Professor (mechanical engineering/ISR)*

Dinesh Manocha
*Paul Chrisman Iribe Professor of Computer Science and Electrical and Computer Engineering, and Distinguished University Professor*

# Da Vinci Design Gets a New Spin

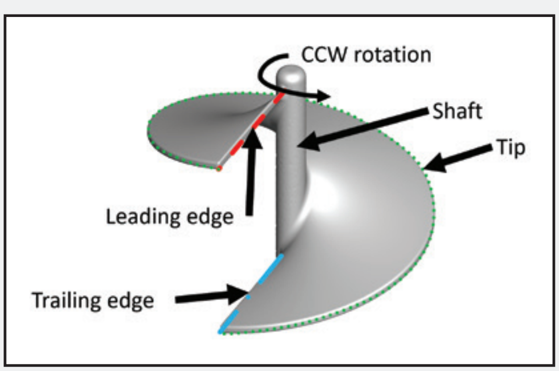
For more than 500 years, the drawings and ingenious ideas of Italian Renaissance mastermind Leonardo da Vinci have inspired generations of scientists, inventors and creative thinkers.

In a new spin on a classic da Vinci design, students from the UMD aerospace engineering department have taken one of the master's ideas, the "Aerial Screw," and developed a working prototype.

Unveiled at the Vertical Flight Society's 2022 Transformative Vertical Flight Conference—Crimson Spin, a small, unmanned aerial vehicle (UAV)—flies through the combined lift of four, whirring red spiral-shaped blades, and garnered much media attention for its unique take on da Vinci's design.

The craft was the culmination of more than two years' worth of work stemming from UMD's 2020 winning graduate entry—Elico—in the Vertical Flight Society's (VFS) 37th Annual Student Design Competition "Leonardo's Aerial Screw: 500 Years Later." The team included James Sutherland, Ehiremen Ebewele, Katie Krohmaly, Ilya Semenov, Robert Brown, Emily Fisler, Jehnae Linkins, Koushik Marepally and Austin Prete; and was supervised by Distinguished University Professor Inderjit Chopra, Senior Scientist V.T. Nagaraj and Associate Professor Anubhav Datta.

"When we first tackled this challenge as part of the Vertical Flight Society's original call for proposals, we recognized that there was a serious possibility that it just wasn't even possible to fly with an air screw," said Semenov (M.S. '20), who contributed to the preliminary experimentation to measure lift and rotor structure modeling. "The whole point of the competition was to evaluate whether this old, ancient concept could even work at all.




The team's winning design did in fact look functional—on paper and in computer simulations—but could it actually fly in reality?

"We saw some really interesting behaviors in the lift mechanisms of the air screw in our computational fluid dynamics simulations and models where we found this interesting edge vortex that would form," explained Semenov. "But with such a novel design, we couldn't be 100% sure that the phenomenon was true, so creating a working model would help us validate if that was in fact happening."

Encouraged by Chopra, master's student Austin Prete spent the next year and a half taking Elico from a theoretical working model on paper to a functional prototype.

"The first successful flight was an incredible moment," said Prete. "It took three months, just trying to get it to fly correctly."

"Just the way the air screw worked was surprising," added Sutherland, Ph.D. candidate and captain of the 2020 design team. "It's possible that the aerial screw might be less noisy, or create less downwash than a regular rotor with the same amount of thrust, but there is still a lot to learn and study before we know where it could be applied."

According to Chopra, UMD intends to continue pursuing a more detailed study on this topic. "We are exploring the possibility of sponsored work with some funding agency," he said. "The objective is to advance the aeromechanics design tools focused on the da Vinci Aerial Screw for a vertical lift system."

**IN SEARCH-AND-RESCUE MISSIONS, TIME IS OF THE ESSENCE:** a gain of minutes can mean the difference between life and death. At an inaugural National Institute of Standards and Technology (NIST) competition this summer, a team of UMD students showcased a UAV system with the potential to help personnel secure those life-saving extra minutes.

The students took first place in the event, dubbed the FIrst Responder UAS Triple Challenge 3.1: FastFind Competition. It is sponsored by NIST's Public Safety Communications Research Division's (PSCRD).

Led by Animesh Shastry, an aerospace engineering fourth-year aerospace engineering Ph.D. student, the UMD competitors—part of UMD's Autonomous Micro Air Vehicle (AMAV) Team—worked over the past year to develop custom software that not only improved their vehicle's ability to detect individuals lost in heavily forested environments, but also offered a creative open-source solution with expanded options.

"Most SAR applications are proprietary and developed in Android/iOS SDK," explained Wei Cui, a second-year aerospace engineering Ph.D. student, who led development of the software. "We created a better user interface (UI) in React, a JavaScript library, enabling our application to run on a regular laptop that offers a

# UMD Students Win Inaugural NIST UAV Challenge

bigger screen and has the power to support more sophisticated machine learning and image processing algorithms."

The team also leveraged a You Only Look Once (YOLO) classifier—a state-of-the-art deep neural network in object detection—with the goal of achieving better-than-human performance with sufficient training.

"The target locations and images are auto-saved by our application into the database in no time," Shastry said. "As far as we know, no current SAR application can achieve such efficacy. By using machine learning and computer vision algorithms we can empower first responders to detect missing personnel quickly and efficiently. Current SAR applications that run on iOS/Android do not have the computation resources to run these types of state-of-the-art algorithms."

Typically, during a search for a missing person who could be anywhere within a large area, UAV flight routes are pre-programmed using "lawnmower" or "spiral" patterns. A search volunteer or ground personnel actively scans the UAV's video feed and looks for patterns or colors that contrast with the surrounding background. The process can be slow, tedious, leading to mental and physical fatigue, and increasing the risk of error "Our technology, which uses computer-assisted person identification methods, is meant to replace manual methods by being fast, accurate, easy to use and cost-effective," Shastry said

Aerospace engineering senior and pilot Qingwen Wei (second from left), recently graduated aerospace engineering B.S. student Thomas Brosh (second from right), and fourth-year aerospace engineering Ph.D. student Animesh Shastry (right), designed and tested a UAV system that could help improve Search and Rescue (SAR) operations.

To put the students' concepts to the test, NIST hosted finalists at a remote forest location in Mississippi where they held search and rescue scenarios to see how the teams' technologies fared. Although the team had spent months developing their technology in advance of competition, they also found themselves refining ideas on the fly as they learned more about the realities of SAR's operations on the ground in Mississippi.

"We discovered that focusing our search efforts around strategic terrain features such as roads, trails, and areas accessible by humans will allow us to find missing people quickly and efficiently," explained Shastry. "The technique of using terrain features wasn't a part of our original idea, but we introduced it during the competition."

Since UAVs have an average flight time of only 30 to 40 minutes, this approach helped the team enable their flights to be much more efficient during their limited flight time.

As part of their competition win, which also included a First Responder's Choice Award, the team received $60,000 in cash prizes which will help support the AMAV team as they gear up to compete in the next NIST event.

The AMAV team, which regularly completes in Design-Build-Fly competitions, is mentored by Professor Derek Paley (AE/ISR). The UAS 3.1: FastFind Competition project included three undergraduate and three graduate students.

UNDERGRADUATE STUDENT SPOTLIGHT

# Caleb Wein

**CALEB WEIN IS AN AE STUDENT, AND WHEN HE'S NOT BUSY STUDYING, HE IS AN INTERNATIONAL FIGURE SKATING COMPETITOR.**


Caleb Wein competed in the World Junior Championships in ice dance.

Caleb Wein is in his fourth year in the department of aerospace engineering (AE) at the University of Maryland (UMD), and in April he competed at the World Junior Championships international figure skating competition. As both an engineering student and a high-level athlete, Wein has to balance an education in AE alongside a rigorous practice and competition schedule. Wein notes that UMD has been particularly accommodating in allowing him the opportunity to succeed as a student and compete as a world-class ice dancer.

From a young age, Wein knew that he wanted to be an engineer. Two of his grandparents worked at NASA, and he remembers touring the facility as a young child. His fascination with AE was then confirmed when he had the opportunity to take an introductory AE course through his high school. When deciding where to pursue his aerospace engineering education, UMD was the perfect fit. Not only is the program highly ranked, but campus is located close to Wein's skating coaches and club.

"I got really lucky that UMD, with a great AE program, just happened to be fairly close to where my training base is. It's worked out really well," said Wein.

Even before Wein developed a passion for engineering, he knew that he loved to skate. He started when he was only four years old and only a few years later, he began competing. Now, Wein competes internationally in Ice Dance with his partner, Angela Ling, and the pair recently took 7th place at the World Junior Championships. Though skating and school can be difficult to balance, Wein says that they complement each other in ways one might not expect.

"There's definitely some overlap in skating and school because both require you to fully commit," said Wein. "They're opposite but complementary. AE is really technical, but there is room for some creativity. Skating is more on the artistic side of things and is really physical. Both really require you to use your brain."

Wein wants to use both skating and engineering to make a difference. He feels that he can showcase a more modern form of skating, and in doing so, make the sport more accessible.

"People definitely have a certain image in mind when they think of skating and the kind of music that's skated to," said Wein. "I feel like we can push that a little bit. I want to keep it engaging for a new audience. Skating is an art form, and art can express ideas and make meaningful statements. I want what we're doing out there to be meaningful."

Wein also feels that aerospace engineering can be extremely meaningful.

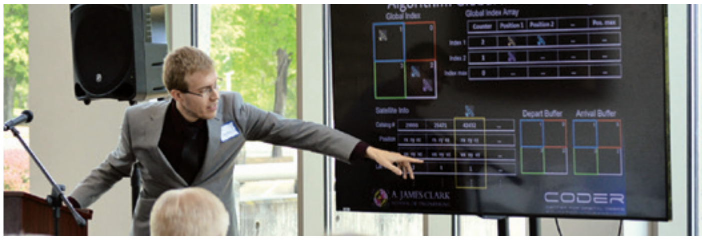
"You can change everyone's lives with AE, whether it's making it easier to travel or helping humans get off of this planet and onto another one. As an aerospace engineer, you aren't only impacting people's lives today, you also have the chance to impact the future," said Wein.

Wein is eager to continue his skating career alongside his AE education and is excited to see what the future holds.

GRADUATE STUDENT SPOTLIGHT

# Eric Frizzell

**ERIC FRIZZELL IS A NONTRADITIONAL STUDENT, AND HE'S FOUND HIS PASSION IN AEROSPACE ENGINEERING.**




*"THIS HAS BEEN ONE OF THE TIMES IN MY LIFE WHERE I'VE LEARNED THE MOST."*

Eric Frizzell first joined the department of aerospace engineering (AE) at the University of Maryland (UMD) to pursue a bachelor's degree. However, he wasn't a typical undergraduate student. In fact, Frizzell had already received a bachelor's degree in economics from the University of Michigan several years earlier. After spending some time working, he made the bold choice to switch professions and pursue AE.

Growing up, Frizzell had always been fascinated by science fiction and space. Even when he started his first undergraduate degree, he was interested in studying physics and cosmology. Frizzell eventually chose to graduate with an economics degree because he believed it was the practical thing to do at the time. However, Frizzell never forgot his passion, and he stayed attuned to what was happening in the world of space exploration.

"I was reading about what was going on with reusable rockets, and I kept thinking about how we are exploring further into the solar system," said Frizzell. "I just really wanted to be involved in that, so I decided to start over."

Frizzell was determined to attain a new undergraduate degree in AE at a top university. However, at some colleges, it can be complicated to pursue a second bachelor's degree. Thankfully, Frizzell already knew that he wanted to attend UMD, and their AE program was very accommodating. He packed up, moved across the country, and started his new educational journey in Maryland.

After completing his AE undergraduate degree, Frizzell wanted to continue conducting research, so he started graduate school at UMD. Once he started his graduate education, Frizzell was named an A. James Clark Doctoral Fellow and an NSF Graduate Research Fellow, and was awarded the Academy of Distinguished Alumni Scholarship in AE.

Now, his Ph.D. research is focused on the surface of the moon. He works with his advisor, associate professor Christine Hartzell, and her lab, the Planetary Surfaces and Spacecraft Lab, to study lunar cold spots and the density of moon dust. Frizzell explained that there's a halo around craters less than a million years old where the top layer of regolith becomes colder than background surface grains. He hypothesizes that this could be the result of a granular shock wave. He's using computer modeling to determine if this could be the case.

UMD aerospace engineering Ph.D. student Eric Frizzell scoops ice cream at the Spring 2022 Women in Aeronautics and Astronautics (WIAA) social. Frizzell's doctoral research focuses on lunar cold spots and the desity of moon dust.

PHOTO: COURTESY OF ERIC FRIZZELL

Not only has Frizzell taken advantage of the educational and research opportunities at UMD, but he's also joined several extracurricular programs. He served as a board member on the Graduate Student Advisory Committee (GSAC) and as an executive board member for Women in Aeronautics and Astronautics (WIAA). Throughout his time at UMD, Frizzell has continued to pursue new opportunities.

"This has been one of the times in my life where I've learned the most. I've met so many people from diverse backgrounds who I never would have had the chance to meet before, and I've met so many like-minded people who want to work on similar research topics," said Frizzell. "I'm glad that I took the chance and did it."

## Colby Merrill Wins SSPI Conference Award

UMD aerospace engineering graduate Colby Merrill ('22) received the "Most Innovative and Original Design" Award at the 2022 Space and Satellite Professional International (SSPI) Mid-Atlantic Chapter student research competition.

Merrill's winning presentation, "Experimental Results of Novel Gecko Skin-Inspired Lunar Dust Mitigation Technology," explored the use of a "gecko skin" adhesive roller that could remove over 98% of the lunar dust simulant from flat surfaces and spacesuit material at 1 atm.

Lunar dust posed significant challenges to previous lunar missions, and mitigating it is required for the success of future missions. As part of their research, Merrill experimented with wrapping gecko-skin adhesive, a grippy elastomer, around a household lint roller to provide a method for removing dust from surfaces with limited consumables and power.

Merrill graduated in spring 2022 and is now attending Cornell University as part of the Aerospace Engineering Ph.D. program.

## Adam Del Colliano Wins Regional AIAA Best Award Operations Paper

Department of Aerospace Engineering graduating senior Adam Del Colliano ('22) won the American Institute of Aeronautics and Astronautics' (AIAA) Aircraft Operations Technical Committee Best Aircraft Operations Paper at the AIAA 2022 Region I Student Conference with his paper, "IR Detection System for Application in Wildfire Suppression."

"This paper outlined my research using a thermal imaging camera and a LiDAR sensor to track statistics of a wildfire, specifically of the fire's front, to help more efficiently fight the fire and protect the lives of firefighters," explained Del Colliano.

AIAA holds conferences in each region for university student members at the undergraduate and graduate levels. This is the first year since the program's inception that High School Members were invited to present. The student conferences are a way for students to present their research and be judged on technical content and presentation skills by AIAA members working in the aerospace industry. Lockheed Martin was the generous sponsor of these conferences.

More than 170 papers were presented this year by university and high school students across all six regions, with over 500 students and professionals in attendance.

The first-place university student winners in each undergraduate, graduate, and team categories (listed below) are invited to attend and present their papers at the AIAA International Student Conference, to be held in conjunction with the 2023 AIAA SciTech Forum in National Harbor, Md., 23–27 January.

## Jacek Garbulinski Receives USMSC GSC Outstanding Student Award

Department of Aerospace Engineering Ph.D. student Jacek Garbulinski was recognized with an inaugural University System of Maryland Student Council (USMSC) Graduate Student Government (GSG) Outstanding Student Leader Award. Elected by the Graduate Student Government (GSG) Executive committee, award recipients are recognized for their outstanding efforts in both leadership and civic engagement.

Garbulinski is a 4th-year Ph.D. student and a Fulbright Scholar and served as Aerospace Engineering's representative for the University of Maryland's Graduate Student Government.

This year he served as the Chair of the International Student Affairs Committee and led efforts to support Ukrainian students at the University of Maryland following the country's invasion. Specifically, he helped to organize the on-campus vigil and the student-led information panel. Garbulinski has been a strong advocate for supporting the inclusion of international students from underrepresented countries at the university by organizing events that foster mutual intercultural understanding.

In his academic career, Garbulinski works with Professor Norman Wereley in the Composites Research Laboratory, where his research focuses on control and structural properties of continuum soft robots that utilize pneumatic artificial muscles.

Garbulinski is also the 2021 Alexander Brown Scholarship and Leadership Award recipient, an award based on demonstrated innovative research practices, visionary leadership, and impressive effort in his or her academic pursuits.

ALUMNI SPOTLIGHT

# A Maryland Built Lifetime

**ALUMNI CHRIS AND PATRICIA VAN BUITEN CREATE MARYLAND PROMISE SCHOLARSHIP TO GIVE BACK AND SUPPORT FUTURE STUDENT SUCCESS AT MARYLAND.**

University of Maryland alumni Chris Van Buiten ('89, aerospace engineering) and his wife Patricia ('88, recreation therapy) built more than successful careers from their education at Maryland; they built the foundation of their family and fostered a legacy of Maryland pride.

Fascinated by helicopters from a young age, and the son of an aerospace engineer at the Martin Company, Chris' decision to come to Maryland was an easy one.

"It was amazing that one of the three rotorcraft centers of excellence, the Alfred Gessow Rotorcraft Center, with a rotorcraft focused program, was right there at the University of Maryland!" said Chris, who grew up in Columbia, Md.

However, while choosing where to go was easy, paying for tuition was not, and Chris added that neither he nor Tricia came from families where paying for college was easy, so when he secured a Glenn L. Martin Scholarship, it really secured his place at Maryland and enabled him to pursue his passion.

"I came from a second-generation immigrant family," explained Tricia. "And while they worked hard and were successful, they didn't have the opportunity of a college education, and it wasn't something they expected us to do. [But when I got into Maryland] my father was so proud to have a child going to a school like the University of Maryland, the family pride was huge for a number of reasons."

After graduation Tricia received a job opportunity at Walter Reed Army Medical Center, thanks in part to an internship she secured as a UMD student. She went on to work fifteen years as a primary mental health clinician specializing in individual, family and adolescent counseling. Now she enjoys work both as a published author and a certified life coach.

Chris secured his dream job at Sikorsky, a Lockheed Martin company, where he has worked for more than thirty years pursuing his love of rotorcraft. He is currently the Vice President of Technology and Innovation and still playing key roles in advancing next-generation technology, like the recently developed Defiant X, a cutting-edge X2 Technology helicopter aimed at replacing the Blackhawk.

They both credit their time at Maryland for helping them not only enjoy successful careers, but for their family. The two met early in their college career and spent their Maryland years together tail-gating, building friendships and creating memories to last a lifetime. They went on to get married, and raised three daughters, one of whom also graduated from Maryland.

"It's incredible to reflect on how influential Maryland was on us, both professionally and personally. Those four years at Maryland created a lifetime of value that cascaded through our whole family," added Tricia. "That's part of the motivation behind this scholarship that we are so excited about. If we can help some other kids go to Maryland, and receive that experience, that is a heck of a gift! And, just maybe, they'll even be lucky enough to meet their soulmate there."

That legacy of impact is why it is so important to the Van Buitens to support future students who might not otherwise have the means to pursue their dreams. So, through the Clark Challenge for the Maryland Promise Program, they have established the Christopher and Patricia Van Buiten Maryland Promise Scholarship which will support need-based scholarships for engineering students from the local region.

"We're excited to start this scholarship to help the next generation. There's a huge spectrum of opportunities in the field that wasn't available when I started. Let them work on passenger helicopters for Mars. Wouldn't that be neat!" said Chris, adding that, "And wouldn't it be great, if thirty years from now, someone who enjoyed a scholarship, came back and told a similar story as ours."

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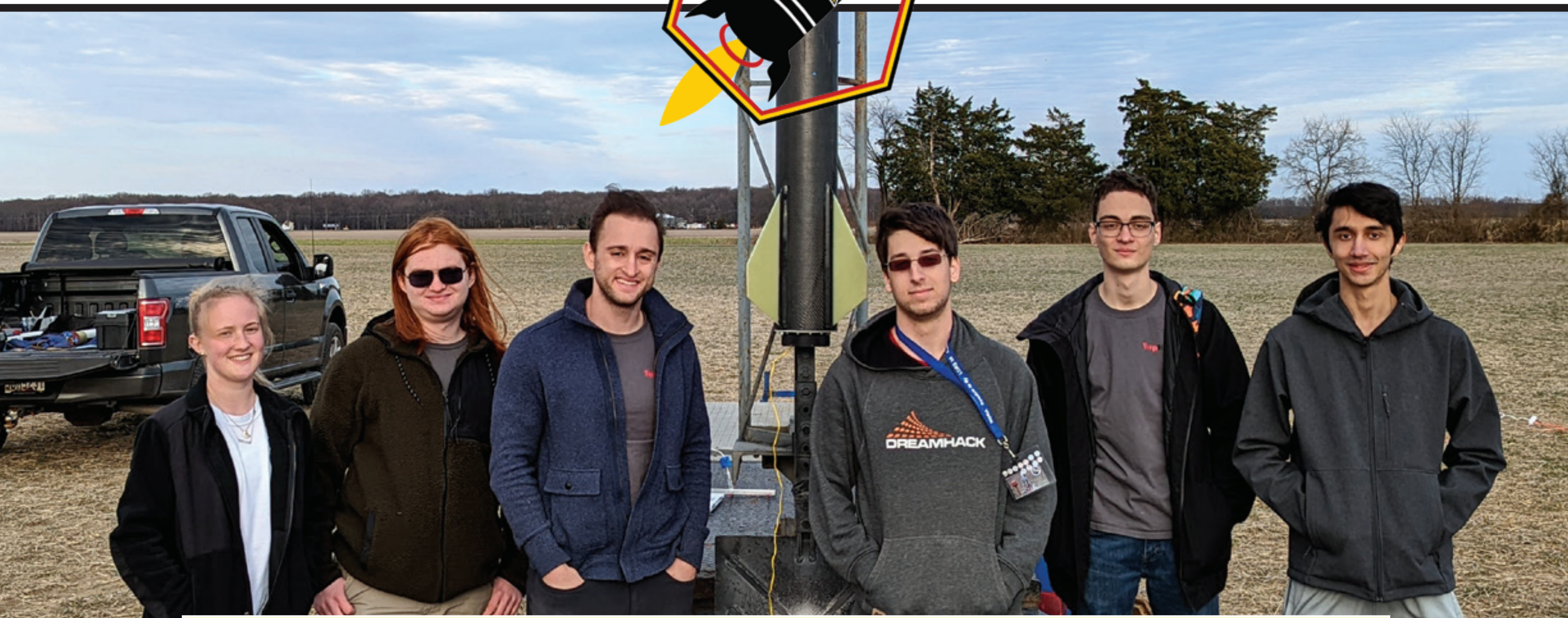


〈 PARTING SHOT 〉

## Support the University of Maryland Terrapin Rocket Team!

Terrapin Rockets is a student-run organization at the University of Maryland, comprised of cross-disciplined undergraduate and graduate students, whose members are united by a shared passion for rocketry. Our organization designs, builds, and launches high-powered rockets for competition.

The team's main focus is on The Spaceport America Cup, an international collegiate rocket competition and the world's largest rocket competition. We offer numerous technical projects and leadership opportunities. Our team takes projects through a full engineering life cycle and has complete ownership of projects. Whether a student wants to handle administrative work or gain manufacturing experience, we have a spot for everyone.

**Support Terrapin Rockets today!**
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