Aerospace Engineering/**2024**

UPDATE

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80
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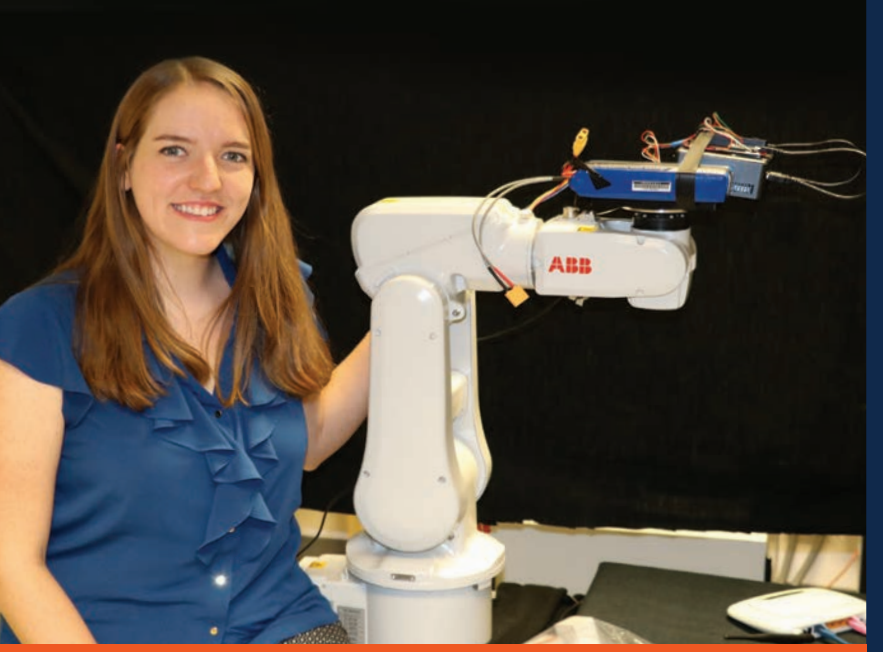


Illinois team wins OpenCV AI first prize

A team led by AE PhD student **Holly Dinkel** won first prize in the Core Track of an OpenCV AI Competition. Their software called COCOpen produces image data used to train models for identifying and outlining specific objects in a scene which could contain multiple objects of the same category.

In the example use-case in their code repository, they generated images which contain multiple objects of the wire and ethernet device categories. These synthetic images can be used to train a deep learning model to detect categories of objects on new images which the model has never seen before.

Automated creation and labeling of these training images significantly reduce the time and expense associated with this process. The code can be used in a variety of applications such as manufacturing, logistics, autonomous driving, and domestic services.

Other team members were undergrads in computer science, electrical and computer engineering, and AE's **Harry Zhao**, BS '23.

"Although COCOpen as a product came together in the course of a few weeks, it represents two years of effort researching problems in computer vision," Dinkel said. "It was successful because we adopted an attitude of trying things, of jumping into the sand box and building something from nothing."

The Illinois team was advised by AE's **Tim Bretl** and by NASA's Brian Coltin and Trey Smith.

Aerodynamics students share in **Illini Motorsports win**

Six AE students brought their best to the Illini Motorsports aerodynamics team, helping secure first place in the North American Formula SAE competition and third place ranking in the world.

Aerodynamics Team Lead **Sid Sudhir** said the philosophy for this year was to focus on properly testing the aerodynamics package and building up a large team of young engineering students.

"I made it a priority this year to recruit hard and put more effort into assigning responsibility and empowering team members to get more deeply involved on the team. With more great members, we can continue to attack more problems and improve as a team," he said.

Other AE team members included undergrads **Anthony Sanguinetti, Anirudh Vishneek, Arif Mahmudi, Patrick Swiatek,** and **Jacopo D'Amato**.

"A large project this year was adjusting our computational fluid dynamics setup to correlate data from the Stellantis wind tunnel test," Sudhir said. "It was a great exercise for all of us to more deeply understand our simulations and their strengths."

In tests at World Wide Technology Raceway in St. Louis, the team learned key information about reliability and vehicle performance.

"We received a lot of driver feedback about aero balance which gave us some confidence that we were headed in the right direction."

CREDIT: SAM LEE

Sid Sudhir holds a smoke machine to create a smoke trace to help visualize the flow over different surfaces of the car.

Greetings

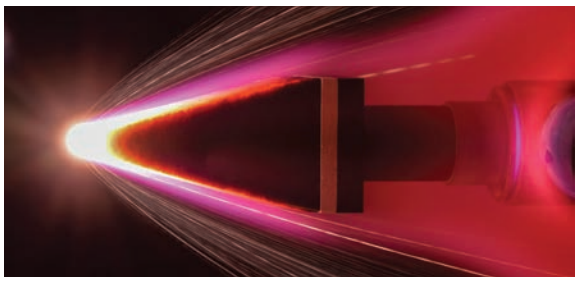
For both efficiency and for the environment, sustainability has become a top priority across aerospace.

This issue features a section on our leadership efforts in sustainable aviation, covering our research, activities of our alums and a student competition team, and interactions with our sponsors.

This year—our 80th as a department!—is marked by growth of students and faculty; see the inside back cover for introductions of four of our newest members.

As always, we are finding new ways to **elevate society** and **create wonder**. Please enjoy reading about them here.

Jonathan B. Freund
Donald Biggar Willett Professor and Head



On the cover: PhD student **Benjamin Ringel** observed spalling particles during thermal protection system experiments in the Plasmatron X facility at Illinois. The work appears in "Quantification of spalling particles for carbon thermal protection system materials in supersonic air and nitrogen plasma," by Ringel, **Henry Boesch**, **Sreevishnu Oruganti**, **Lorenzo Capponi**, **Laura Villafañe**, and **Francesco Panerai** in the AIAA SCITECH 2024 Forum. The image received 2nd place in the 2024 Image of Research competition.

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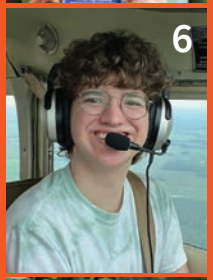

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Aadhy Parthasarathy, PhD '23, and Theresa Saxton-Fox in the Aerodynamics Research Laboratory.

New boundary layer identified

In an experiment on how turbulent boundary layers respond to acceleration in the flow around them, AE's **Theresa Saxton-Fox** and her former student **Aadhy Parthasarathy**, PhD '23, observed an unexpected internal boundary layer.

"Not only were we able to identify a new internal boundary layer, but we were able to systematically track its height so we can understand its growth rate. We also noticed it only formed if our pressure gradient, our acceleration, was sufficiently strong. There was a threshold under which we didn't see this phenomenon occurring. This was something that wasn't known before," said Saxton-Fox.

When designing a new vehicle, it is crucial to know how boundary layers will respond to the vehicle's shape, as the response changes the forces on the vehicle. Current computer models of how boundary layers respond to curvature don't get it right, making the design process challenging, expensive, and risky.

"We can't predict ahead of time how the flow will behave with complex geometries so we looked at a number of different acceleration profiles to get a sense for not just one configuration, but 22 different shapes," she said.

Identifying this new boundary layer is important because it will help in understanding complicated aerodynamics physics. The type of acceleration profiles generated in the study were analogous to those found in flow over airfoils and in converging /diverging nozzles.

"When the flow doesn't follow a geometry and ignores what we asked it to do, it causes a lot of big problems such as stall. Now that we've seen the presence of an internal layer and how the flow separates, it can help in modeling flows and in vehicle designs."

The research is funded by an Office of Naval Research Young Investigator Program award.

"A family of adverse pressure gradient turbulent boundary layers with upstream favourable pressure gradients," is published by Cambridge University.

Unique collaboration brings West Point to Illinois

Now in its second year, the unique collaboration AE's **Laura Villafañe Roca** developed with Professor Andrew Banko at the United States Military Academy at West Point again brought cadets to campus.

As part of their senior design project West Point cadets come to U of I with their adviser Banko to conduct magnetic resonance imaging experiments. They work together with Illinois students—**Tuhin Bandopadhyay** leading the effort—with help from Brad Sutton, Aaron Anderson, and others at the Biomedical Imaging Center and Beckman Institute.

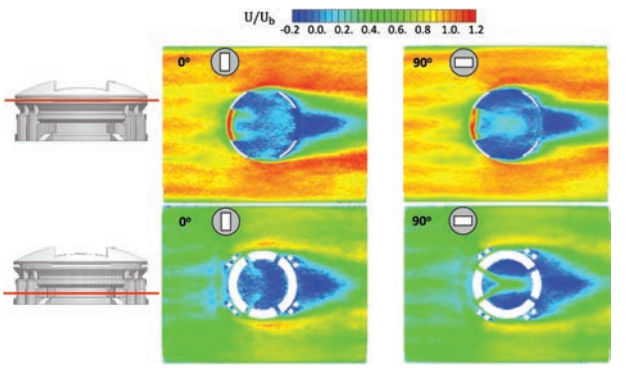
"The cadets learned how the three-dimensional flow moves within and around the structures to understand the transport of potential contaminants," Villafañe said. "Classical measurement techniques are not well suited to study complex 3D and internal flows. MRI, not requiring any optical or probe access, is an excellent candidate to cover this gap."

Instead of a wind tunnel, they use a water channel. In place of a human or animal, the MRI bed holds the water channel with the scaled model under study in it. The MRI scans produce detailed 3D data of the flow velocity outside and within the model structures.

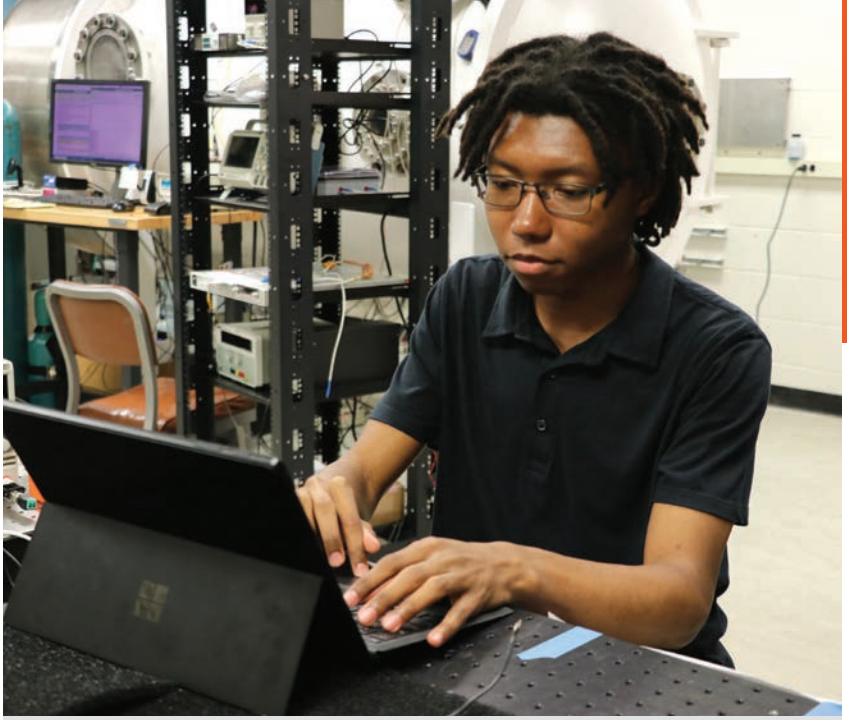
"Combining 3D velocity fields and 3D concentration maps we can get a full picture of how contaminants are mixed, where they reach and stagnate," she said.

Villafañe routinely measures turbulent flows and particle dynamics in flows using laser-based diagnostics in dedicated facilities.

"Developing new measurement techniques, or as in this case, extending the field MRI applications to fluid mechanics in engineering and environmental settings, are exciting new challenges. We are just starting to scratch the surface of all we can achieve using MRI to study complex flow problems."



Streamwise velocity contours at two elevations above the stadium floor and for two stadium orientations relative to the prevailing wind direction, in collaboration with West Point researchers and capstone design team.



Transfer student begins with **summer fellowship**

After two years at Harold Washington and Wilbur Wright City Colleges in Chicago, **Dumisani Rashid** transferred to U of I. He came to campus early for a summer research program at the Joint AdvaNced PropUlsion InStitute, also known as JANUS. He lived in a dorm for 10 weeks while working on advanced space propulsion Hall-effect plasma thrusters. The project uses a space simulation vacuum chamber to help **Joshua Rovey**'s research group and NASA develop new advanced rocket engines for deep space exploration missions to the moon, Mars, and beyond.

For one of his assignments, Rashid had to learn Blender, an animation software.

"The team needed a short animation for a conference in Michigan in July," he said. "I had to learn how to use Blender to animate a Carbon 12 back sputter effect to visualize it. I'd never been exposed to the concept of back sputter, but electricity and magnetism was one of the last classes I took before coming here for the fellowship."

Toward the end of the summer, Rashid accompanied Rovey's lab group to Michigan.

"I was in the room when Dr. Rovey showed off the Blender animation and later heard that he got comments from a few people saying it helped them grasp the concept better, which I was glad to hear."

About the entire summer Rashid said, "I felt like the work is difficult, but also within my reach, even for things I don't fully understand yet. I'm confident I can learn them."

DarkNESS passes Fermilab test

Dark matter detection took a significant step forward when Fermilab scientist Juan Estrada brought his novel Skipper detector technology to U of I to run a thermal vacuum test interfaced to its future satellite bus. The test successfully demonstrated the crucial thermal control capabilities required for the detector operation at 170 Kelvin, or -153.67 Fahrenheit.

"This test validated our detector's ability to operate under flight-like conditions but also captured cosmic rays, demonstrating our readiness to move toward a milestone test using a faint X-ray source. Milestone tests like this bring us closer to the detection of the ethereal signals of dark matter," said **Phoenix Merrick Alpine**, PhD student and lead systems engineer for the DarkNESS mission, which stands for Dark matter Nanosatellite Equipped with Skipper Sensors.

The mission has recently entered the critical design phase, Alpine said.

"In partnership with Kongsberg NanoAvionics, the focus now shifts toward bringing the thermal control system to flight configuration. This thermal control system is a characteristic feature of the DarkNESS satellite, which is responsible for maintaining the detector's operational temperature in the space environment," Alpine said.

The DarkNESS mission was selected by Firefly's DREAM 2.0 initiative for a launch opportunity targeted for October 2025. DarkNESS will go into a near polar orbit where it will collect X-ray data emanating from Sagittarius A*, the black hole at the center of the Milky Way.

Members of the DarkNESS team left to right: AE undergrads Niharika Navin and Evan Lee, AE PhD student Phoenix Merrick Alpine, and Fermilab interns Terry Kim, and Santiago Perez, who is a PhD student in physics at Universidad de Buenos Aires. Not pictured, AE undergrad Aalia Angirish.

Marty Bathgate:
Pilot, undergrad researcher, optimist

As is true of most 2024 graduates, **Marty Bathgate** finished high school in the first months of the pandemic and began college with online learning and multiple COVID tests each week.

"It made it hard to meet people and it was stressful to be constantly worried about getting sick," they said. "But the tests were a good excuse to get out of the dorm."

That positive attitude is apparent in the way they approach life—recognizing the people who influenced them as well as the happy accidents that brought them to Illinois, opened doors to undergraduate research, and gave them a clear career path.

Bathgate said the primary reason they chose to study at U of I was a fluke.

"I signed up for a summer camp in mechanical engineering, but that camp was filled so they put me in aerospace. I came and had the best week ever."

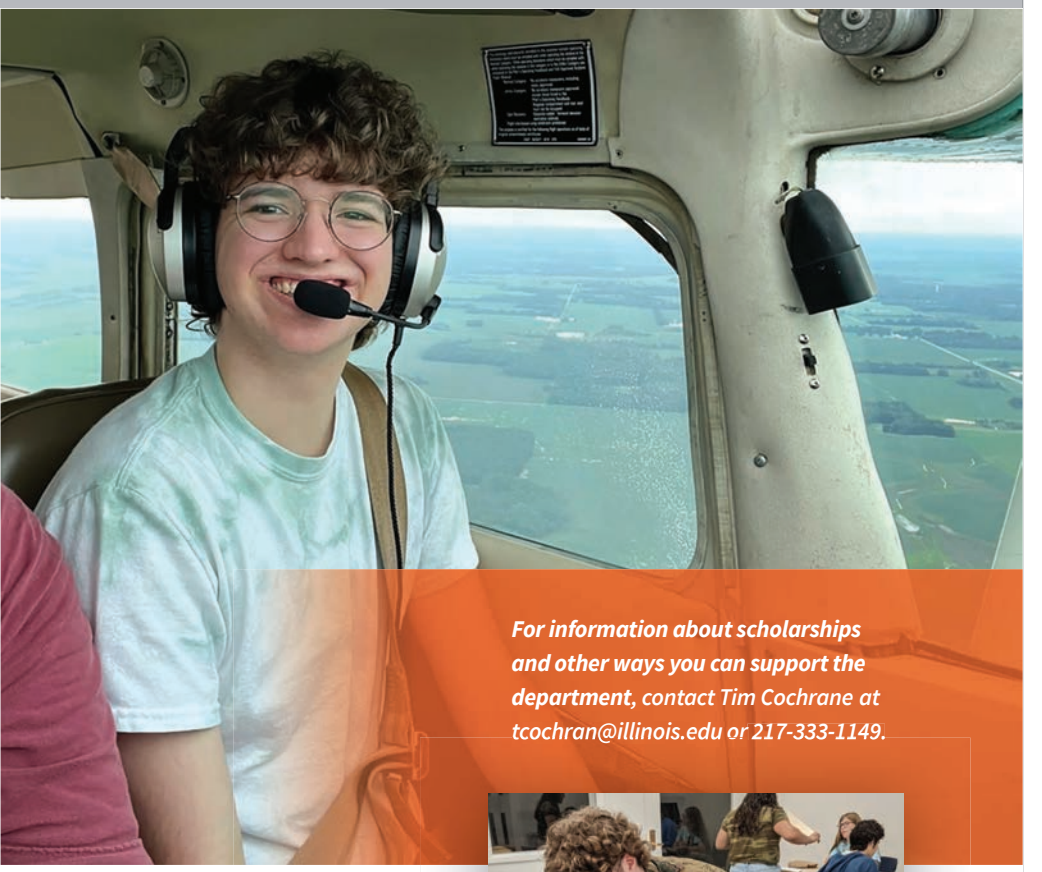
That summer, Bathgate got a job at the local airport and their pilot's license.

The camp is also where they met AE's **Brian Woodard**, who introduced them to the NASA Space Grant Undergraduate Research Opportunity Program—a summer job where they reduced and analyzed results and created presentations of an extensive set of wind tunnel tests on swept wing icing.

"I started to notice the quality of Marty's work," Woodard said. "Their final presentation exhibited an understanding of our research, the motivation, methods, and important results in a way I have seldom seen even from much more advanced graduate students. In fact, we used Marty's presentation as the basis for a presentation to introduce our research and the initial results to a group of Boeing engineers."

This past year, their work in UROP earned them an Engineering Visionary Scholarship, presented in the spirit of the late **Scott R. White**'s deep commitment to providing opportunities for undergraduate research.

"I'm extremely grateful for the scholarship," Bathgate said. "I can focus more on my schooling and buy my textbooks instead of just renting. Getting paid for UROP was very helpful but getting to do research with Dr. Woodard is very beneficial for me."



For information about scholarships and other ways you can support the department, contact Tim Cochrane at tcochran@illinois.edu or 217-333-1149.

Above, Marty Bathgate during a flight lesson. Right, Bathgate assists a student at a recent summer camp.

Bathgate's positive spin on life helps them downplay overcoming personal challenges. They said they had some health issues and two major surgeries, one that caused them to miss two weeks of class.

"I had to find ways to communicate with professors and work with them to catch up with what I missed. Luckily, because of Covid, a lot of professors had prerecorded lectures from when everything was online. Everybody was very helpful."

Bathgate was an undergraduate course assistant and supported the aerospace summer camp dedicated to encouraging gender equity in engineering.

"Working with Dr. Woodard at the summer camp was a full-circle experience for me," Bathgate said. "I learned I actually enjoy teaching and sharing my passion for aerospace with others."

Bathgate is conducting research with **Phillip Ansell** toward a master's degree at Illinois and a career in academia.

Derek Smith: The Idea Guy

Derek Smith, BS '91, making a comment at an Aerospace Engineering Alumni Board meeting with Chris Raymond, BS '86.

The image above is from the early '90s: Derek Smith, left, with his coworker Bob Davis in the striped shirt, and members of the band The Misfits, who had just signed with Geffen Records, one of Smith's first clients.

With clients such as Netscape, Toshiba, 20th Century Fox Film, and Meta Platforms (formerly Facebook), **Derek Smith** has taken a career path most people would describe as non-traditional for an aerospace engineer.

Smith was born in Chicago, attended elementary school through junior high in Washington, D.C. —which included numerous visits to the National Air and Space Museum—then returned to Chicago for high school where he was accepted into the Academy at Lincoln Park High School.

When the time came to look at colleges, U of I was on his list, but so were MIT and Stanford. Because several U of I professors graduated from MIT and Stanford, Smith surmised he'd get an exceptional education at Illinois.

After earning his BS in aerospace with a minor in economics in 1991, Smith immediately began working on an MBA at Tulane University. During a summer internship in Chicago with tax company Arthur Anderson, he learned Fortran and Pascal and took classes in liberal arts subjects at Truman Community College.

"I'd leave my internship and hop on the train to go learn about architecture and art history. I wanted the binary ones and zeros from engineering, but I also wanted to understand the shades of gray from liberal arts," he said.

With his MBA in hand, he took a job consulting in California and began building out a new clientele in the entertainment sector.

Smith soon became seen as someone at the intersection of content and technology to solve logistical problems. Soon he was spending 90 percent of his time launching new digital products in London, Brazil, and India.

As a new husband and parent, Smith wanted to be closer to home, so he left consulting and took a job as studio executive at 20th Century Fox Film, where he was eventually put in charge of finding ways to apply emerging technologies and processes to the work of the studio.

The first year, Smith saved the studio $45 million and $35 million the second.

"The studio was making thousands of copies of films every week and shipping them to screens. I eliminated that entire process by digitizing it. After that, I was known as the idea guy."

After 10 years, he returned to consult entertainment companies at PwC with clients such as Warner Brothers, MGM Studios, and Lionsgate. PwC's desire to develop more clientele in technology led to Smith's global technology work with Meta and HP.

Smith described how his foundation in engineering plays a role in consulting.

"There's a certain scrappiness that I love about aerospace engineers, like when the Apollo 13 astronauts were stuck and the engineers back in Houston sat around a table with all the stuff the astronauts had available to them and said, we have to figure this out. That's consulting."

Smith has served on the department's alumni board since 2021. He said he saw it as one way to give back, as well as an opportunity to bring diversity to the board—not just in ethnicity, race, and gender. Smith's alternative aerospace career brings diversity in thinking.

When spacecraft **need servicing on orbit**

If your car breaks down, you can take it to any number of places for repair. Developing a model for how spacecraft can be similarly serviced while on orbit is the work of a team of researchers at Georgia Tech and U of I. They are working along with industry partner Redwire Space to tackle various aspects of the challenge.

"There is a pressing need to accurately assess the remaining useful life of thrusters with the most up-to-date telemetry data to decide how many more times we can refuel the spacecraft or whether we need a repair service, if that is an option," said AE's **Joshua Rovey**.

"My primary responsibility on the project is to address the challenge of spacecraft health monitoring and prediction, particularly for the thrusters, to guide informed logistics decisions. We are investigating intelligent estimation and sensing techniques to enable accurate in-flight assessment of the remaining useful life of thrusters."

Rovey said it will include a new adaptive AI-based thruster prognostic framework that leverages both physics-based simulation/experimental data and in-flight telemetry data effectively for remaining useful life prediction for operational thrusters, as well as new sensor technologies guided by the proposed prognostic framework for enhanced remaining useful life prediction for future thrusters.

Advancing Technologies for Logistics Architectures in Space is funded by the Air force Research Laboratory/Air Force Office of Scientific Research Space University Research Initiative. Co-investigators on the project from Illinois are Pingfeng Wang and Girish Krishnan. The project is led by Georgia Tech's Koki Ho.

New facility on in-space manufacturing and testing

Students and researchers will be able to fabricate and test advanced structures in a facility that simulates the harsh environmental conditions of space, funded by U of I and the Defense University Research Instrumentation Program.

The facility will simulate the extreme thermal-vacuum conditions of outer space and other environmental stressors like solar radiation and atomic oxygen. The mechanical testing equipment will take measurements during the exposure of materials and structures to these harsh conditions. The unique 3D printer will bring new research opportunities in the additive manufacturing of composite structures under external conditions, as opposed to the shielded environments in space stations.

According to AE's **Xin Ning**, a thermal-vacuum chamber with such an extensive range of capabilities is rare for a university.

"This will make it one of the few facilities, if not the only one, at a US university dedicated to both research and research-related education on space structures and materials, as well as the in-space servicing, assembly, and manufacturing of space structures," Ning said.

The long-range goal is to manufacture large parts and repair spacecraft in flight, rather than having to launch another rocket with what's needed.

"This area of research is in its infancy, but there is a rapidly growing interest in enabling space assets to overcome the limitations of rockets and making spacecraft on-site with in-space servicing, assembly, and manufacturing.

"Education and workforce development are crucial," Ning emphasized. "Illinois students will graduate with relevant knowledge rather than waiting to gain it after entering the workforce."

SUSTAINABLE AVIATION AT ILLINOIS

Conversations about fostering sustainability across the aviation sector typically focus on reducing greenhouse gas emissions and the reliance on fossil fuel resources as top priorities. Although these factors are pivotal to the creation of a green aerial transportation industry, AE at Illinois is broadening the discussion to find solutions that comprehensively address sustainability needs across the entire aviation ecosystem.

The new Center for Sustainable Aviation is taking a systems-level approach to the problems we must solve. One strategy is expanding the scope of sustainable aviation by leveraging expertise from a broad range of disciplines in academia, industry, and government.

Through this effort, we want to set a place at the table for engineers, social scientists, economists, chemists, environmental strategists, farmers, policy decision makers, and others.

Sustainable aviation is not just an environmental or natural resources concern. At Illinois, we are adopting a multidisciplinary mindset to address this global problem as we work to share science-based advice and educate the next generation of thought leaders to achieve sustainable aviation.

University of Illinois Urbana-Champaign

What would it take for **Chicago's O'Hare International Airport to run on hydrogen?**

Manufacturing hydrogen so it can be used in aircraft produces significant greenhouse gas emissions when using today's standard production methods. To study the problem more, **Phillip Ansell** conducted a case study using the electrolyzed hydrogen fuel needs of Chicago's O'Hare International Airport with today's electric grid mix.

"What I learned from this study is we need to make investments in facilities and infrastructure, because today's electric grid won't be acceptable. This is a gut check for the aviation community," Ansell said.

Hydrogen is attractive because it only produces water vapor emissions when utilized on an aircraft. But that perspective doesn't include all of the energy needs throughout the fuel's life cycle.

"Because our current grid is not fully renewable, we see negative environmental impacts if grid-sourced electrolytic hydrogen were used for aviation today. But this shouldn't stop us from the significant promise that hydrogen has for the future sustainability of aviation. Rather, this effort principally points to the need to resolve how sectors outside of the aviation ecosystem impact the progress made in the sustainability of air transportation."

According to Ansell, the development of a fully renewable electrical grid in the US by 2035 is technically and socially viable. The cost of renewable electricity generation has also dropped precipitously in the past two decades.

"If a fully renewable grid becomes a reality, electrolyzed hydrogen can serve as a compelling zero-emissions solution for aviation," Ansell said. "I believe we have all the technologies we need and enough money to do it," Ansell said. "It's a question of allocating and prioritizing."

"Electrical Grid Requirements for Sustainable Green Hydrogen Use in Aviation," is published in the *AIAA Aviation Forum.*

Sustainable energy for aviation: What are our options?

Scientists and industry leaders worldwide are looking for answers on how to make aviation sustainable by 2050 and choosing a viable sustainable fuel is a major sticking point. AE's **Phillip Ansell** took a full inventory of the options to make a data-driven assessment about how they stack up in comparison. He reviewed over 300 research projects from across different sectors, not just aerospace, to synthesize the ideas and draw conclusions to help direct the dialogue about sustainable aviation toward a permanent solution.

Ansell said several key energy carriers emerged, including bio jet fuel pathways for synthetic kerosene, power-to-liquid pathways for synthetic kerosene, liquid hydrogen, ammonia, liquid natural gas, ethanol, methanol, and battery electric systems. Ansell compared each of them to conventional fossil-derived aviation turbine fuel.

For each of the alternate fuels Ansell addressed factors such as how their material properties impact aircraft performance and fuel handling, emissions, cost and scalability, and resource and land requirements, as well as social impacts, which can be difficult to measure.

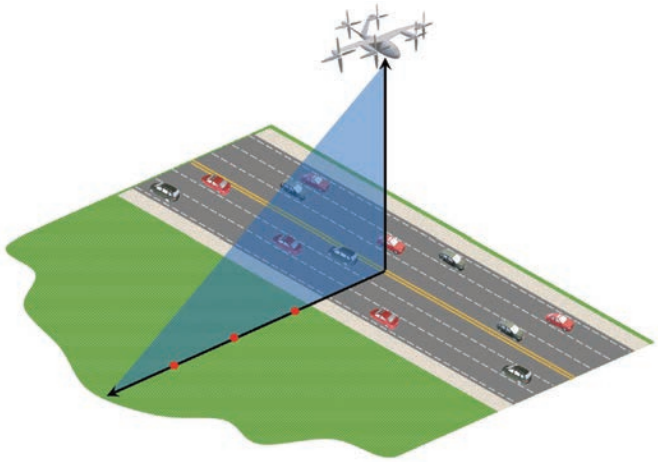
"But the choice doesn't have to be mutually exclusive," Ansell said. "For example, we can use hydrogen to produce synthetic aviation fuels like the power-to-liquid pathway or use biomass to produce hydrogen."

Ansell said he has been working with hydrogen for several years and battery/electric systems before that, so he needed to remain objective.

"About eight years ago, I realized that battery systems are a pie-in-the-sky solution. The technological challenge is insurmountable. But the technological challenges of hydrogen are very solvable. It will take a bit longer to implement at scale, but it's doable."

Ansell stressed it might not be a one-fuel-fits-all solution. Countries may need different strategies, different rates of implementation, and adoption of renewables, based on their own resources.

The study, "Review of sustainable energy carriers for aviation: Benefits, challenges, and future viability," appears in the journal *Progress in Aerospace Sciences.*



Studying flight paths and neighborhoods could lead to more considerate aviation

When **Matthew Clarke** overlayed flight paths in urban environments over maps showing social stratification, he noticed something significant. The flights went directly overhead low-income neighborhoods.

"I learned about an effort in Palo Alto to divert the flight path of aircraft flying from San Francisco airport over Stanford to flying over East Palo Alto—a predominately Black and Latinx community," Clarke said. "They wanted the FAA to shift that flight path and the FAA said it needs to be done equitably. We can't have all the noise going over one neighborhood."

Clarke observed a similar situation in Los Angeles.

"If you look at the LAX airport, the flightpath is just above Compton and Inglewood, which are also low-income neighborhoods."

To address the issue, Clarke said he didn't want to just model aircraft noise, which has already been done well.

"I wanted to map an urban environment, so I strategically chose flight paths that are of special interest, for example, LAX to Disney and how the communities in those paths are affected."

The study compared the noise footprints from three popular electric vertical take-off and landing vehicles: stopped-rotor aircraft, tilt-rotor aircraft, and a hexacopter.

"The results identify the hexacopter as creating the most significant noise and it is a lot louder than the highway noise, so it's going to be noticeable. However, for the other two aircraft, the highway noise is more dominant. So, if you fly over highways, you can mask the noise of these new aircraft and they won't be a disturbance."

By understanding the noise footprint, Clarke said hot spots in the Los Angeles area can be identified.

"It's an effort to be more considerate of those who live near airports or in the path of aircraft."

"An open-source framework for modeling aircraft noise in urban environments," is published in the *AIAA Aviation Forum.*

The forecast for battery life: Clear with a 45 percent chance of degradation

Rechargeable batteries have a lifespan of utility, losing their ability to hold a charge over time. AE's **Matthew Clarke** developed a model of battery degradation, then used the model to simulate four different electric vehicles in real metropolitan scenarios.

"Depending on the specific design of the aircraft—its range and battery size—its utility can fall by as much as 45 percent when operating continuously for one year," Clarke said.

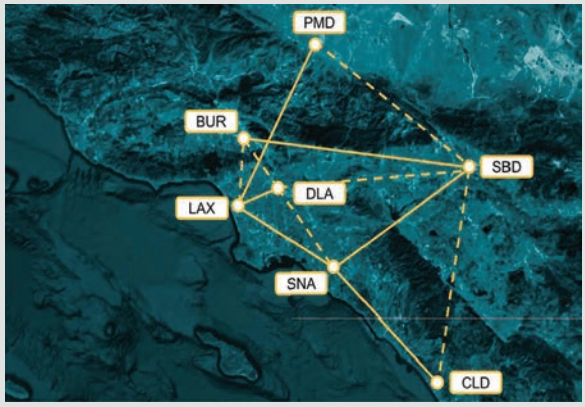
Because most of the degradation occurs when cruising, Clarke suggests the performance of the aircraft can be extended by modifying the routes over time.

"An aircraft could fly between JFK and Washington, D.C. for the first 100 days, then switch to fly a shorter distance for the next 100 days. We can change the operational envelope by changing the routes before it's necessary to completely swap out the battery. This maximizes the utility of the aircraft."

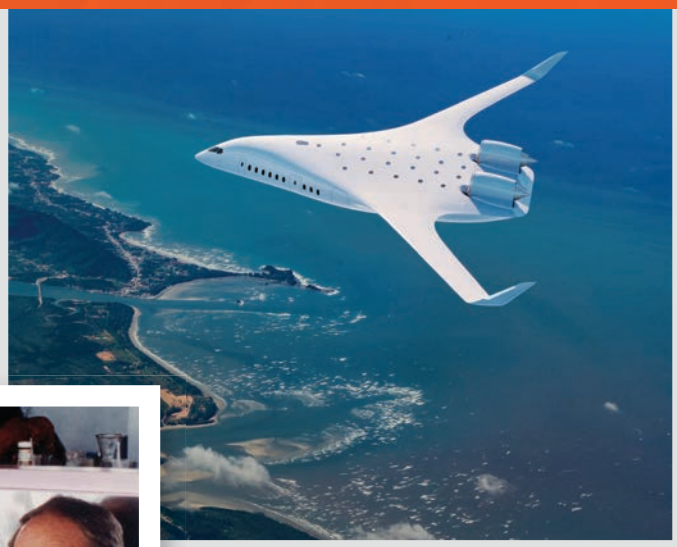
While running the simulation, Clarke discovered an angle he hadn't considered.

"Because we use atmospheric air to cool batteries, it is important to consider that the atmospheric temperature will change with the seasons. With this new understanding of battery degradation and thermal effects, we can work to design methods to cool batteries on aircraft, extending their life."

"Forecasting the Operational Lifetime of Battery-Powered Electric Aircraft," by Clarke and Juan Alonso, is published in the *Journal of Aircraft.*



Blended wing brings air travel **greater range, fuel efficiency, and comfort**



Above: Artist rendering of JetZero's blended wing body passenger airplane.

Left: Early 1990s, left to right Blaine Rawdon, Mark Page, BS '79, and Bob Liebeck, BS '61, MS '62, PhD '68, while at McDonnell-Douglas, later Boeing.

The basic design of jet airplanes has been the same for 75 years, but JetZero, a start-up founded by **Mark Page**, BS '79, is about to change that with the introduction of a blended wing body passenger jet. It promises 50 percent less fuel and 50 percent lower emissions than similar-sized, tube and wing passenger jets flying today.

The first $30K contract to study the blended wing body came from NASA administrator Dan Goldin in the early 1990s, shortly after AE alumni **Bob Liebeck** published a design for a blended wing at McDonnell-Douglas. Goldin recognized the potential for fuel savings and wanted to see more. Liebeck, Page and Blaine Rawdon worked on the design for another three years with NASA funding. Since then, NASA has invested over $1 billion into blended wing technology.

Page founded JetZero in 2021 with Tom O'Leary, a veteran executive of Tesla and BETA Technologies. Last year, the US Air Force contracted with JetZero to the tune of $235 million to build a full-size BWB demonstrator, which will take to the skies in 2027.

How does the design of the new BWB differ from the original concept?

"The original blended wing was designed for 800 passengers, double-deck cabins with lots of range," Page said. "Gate space at airports was at a premium, so the thinking was, let's make bigger airplanes. The new concept is a single deck for around 250 passengers, which will have a range of about 5,000 to 5,500 nautical miles."

The key to a single deck blended wing turned out to be the landing gear. Page figured out how to move the main gear behind the passenger cabin, which meant you didn't need a bunch of space underneath the passengers to stow the gear. A single deck minimizes the amount of empty space on the airplane and greatly reduces surface drag, making it as efficient as possible.

Page is working with Illinois' Center for Sustainable Aviation to look to the future, specifically focusing on hydrogen propulsion technology.

"With **Phil Ansell** and his team, we're researching how to make a blended wing as efficient as possible with hydrogen. Are there better places to fit the hydrogen tanks other than what we are looking at right now?"

Page realizes now why McDonnell-Douglas and Boeing didn't pursue the blended wing concept in the 90s.

"There are hard economic reasons why corporations can't implement every breakthrough. Innovations live and thrive in startups. I believe the path to future technologies is better suited to startups who can afford to take the risk. The tube and wing template is excellent. It has to be said. It really solves a bunch of problems.

"But we need to do something different; we need to change the shape to solve aviation's biggest problems. The blended wing is the way to do that, and we are bringing it to life at JetZero."

Team wins first place for hybrid-electric aircraft design

Above: Team members, front row left to right: Noor Ansari, Evher Benjamin Aponte, and Sarah Erne. Back row left to right: Hsien-Kuei Chang, Anish Joshi, Professor Jason Merret, Krishna Modi, and Stephanie Dutra.

Left: Full CAD drawing and artist rendering of the winning design

With the current fleet of 50-seat regional turboprop airplanes beginning to age, why not seize the opportunity and design their replacements with a hybrid-electric propulsion system to minimize carbon emissions? That was the 2023 challenge from AIAA's Undergraduate Team Aircraft Design Competition—a challenge which was met by an aerospace engineering senior design team from U of I and awarded with first place.

"All of the sizing work we'd done on previous class assignments were all fuel-based. Learning how to adjust the process to include batteries was a major challenge," said team lead **Stephanie Dutra**, BS '23.

The AIAA requirements also specified a minimum cruising altitude of 28,000 feet, which is higher than most turboprops on the market.

"Calculating the power needed at that altitude for a hybrid aircraft complicated sizing the propulsion system. We had to figure out how to design a conventional plane that hit all of the requirements, but then, on top of that, how to split the power and make it hybrid."

Dutra said another technical hurdle came late in the process when they decided to add a truss to support the wing, allowing the plane to have a higher aspect ratio with a longer wingspan.

"We wanted to do something unique and to challenge ourselves, but it meant a total and rapid redesign in March. We knew the truss would set us apart, but it wasn't about winning the competition for us. We wanted to produce something we were proud of and make it the best it could be."

In addition to being a truss-braced aircraft and hybrid, the winning design considered the future of autonomous flight—another aspect of AIAA's proposal. Fortunately, Dutra already had industry experience, having worked two summers on the avionics team at Collins Aerospace.

"Autothrottle function is standard in jets, but not in regional turboprops which also have condition levers for each engine. We started thinking about how to organize the power quadrant because it required additional controls due to the two electric motors onboard. We brainstormed various ways to design these controls that provisioned for future autonomous operations while also limiting an increase in pilot workload for current operations."

Senior design is a two-semester course, but the teams don't begin working on the problem until the spring. Dutra said **Jason Merret**, who teaches the class, tailors the homework assignments in the first semester to areas that are relevant to the competition.

"We had a project in the fall to research and give a presentation on electric aircraft. He integrated that into our assignments to start exposing us to the things we'd have to think about next semester."

Dutra stressed they couldn't have won without the support from Merret, the teaching assistants, and the other senior design teams.

"It was such a hard problem, and it was a huge benefit to be able to work with each other constantly, giving and getting feedback about our numbers. And even when we had very different designs, we gave each other recommendations on how to move forward and make them better."

Researching the future of **organically inspired structures and recyclable composites**

In the evolution of aerospace materials, additive manufacturing using continuous fiber allows for the creation of strong, lightweight, energy-efficient, complex designs. Researchers at U of I are changing the designs and refining the manufacturing processes while also working to make the structures recyclable.

"We can create branched structures that appear more organic," said AE's **Jeff Baur**. "For example, the hierarchical branched root and limb structure of a tree mechanically stabilizes the tree against high winds. Such a structural design would typically be too time-consuming and expensive to manufacture by traditional means. With continuous fiber additive manufacturing, there is little processing penalty for hierarchically branched structures."

Although design complexity can increase the structural efficiency of a structure it can also make it more difficult to recycle structural materials at the end of a structure's useful life.

Illinois is the lead institution in a center that is addressing fundamental scientific challenges for energy efficient manufacturing and realistic end-of-life recycling strategies for thermoset polymers and their composites. The technical challenges to recycle composites and reuse materials are significant.

"The vision is that we will have robust material with a useful life span. And when it's done, we expose it to those special conditions at which those cleavable links break apart into long chains called oligomers. The oligomers can be reactivated for repeated use as a cross-linked resin or as a starting material for another formulation."

CREDIT: CONTINUOUS COMPOSITES

CREDIT: CONTINUOUS COMPOSITES

Top: Example of a continuous fiber 3D printed rib and spar concept, with unitized structure, optimized load paths, and minimal tooling required.

Bottom: Example of a traditional rib and spar design with multi-part/joint assembly, sub-optimal load paths, and significant tooling required.

Baur said using materials for aerospace and aircraft applications may be a long way off because qualifying a new material and certifying an aerospace structural design made with new material is a lengthy and costly process.

"But we can start with other structures that don't have the extremes in environmental conditions or the same level of testing rigor and performance as aerospace structures."

Sustainable composites offer light-weight solutions, cost a consideration

A forum on materials innovation gathered experts across the spectrum of the composite community—in industry, academia, and government labs—to hear and discuss different perspectives and how they relate to the sustainability of composites.

Following invited talks from technical leaders in seven sessions which spanned energy, automotive, and aerospace sectors, **Jeff Baur** framed summary questions in terms of a SWOT analysis in which the strengths, weaknesses, opportunities, and threats of composites were assessed relative to that sub area.

Baur said some outcomes from the forum he anticipated, but others were surprising.

"Cost was the number one weakness and the number one threat in using composites to enhance sustainability, something we can't ignore," Baur said. "As a researcher, I have to consider what is driving that industrial dynamic. If the biggest barrier to adopting composites in manufacturing is cost and I don't address that, I'm not going to change the future."

Baur said because composites have to compete with lower cost materials, they have to earn their acceptance based on better performance. This includes their sustainability performance.

Cost can be related to the energy, capital equipment, and labor needed for manufacturing, the material cost, and the disposal cost.

"The number one strength for composites was their light-weight properties and the number one opportunity was for composite recycling. Both came through clearly," Baur said.

Study introduces new sustainable aviation perspective, visualization

Elias Waddington

A question posed by AE's **Phillip Ansell** in a sustainable aviation course prompted PhD student **Elias Waddington** to develop a new definition for sustainable aviation and a framework to achieve it.

"The question was, 'What does sustainability look like integrated to a system engineering process?' I couldn't stop thinking about it," Waddington said. "Industry, government, and academics have stated sustainability goals, but they aren't aligned. For some, we don't know how to achieve them. What we do have is a process, system engineering, for designing complex systems.

"I believe we must look at the challenge holistically—everything, all at once—because sustainable aviation isn't just an environmental issue. If it were, we could just stop flying. Problem solved. But that solution doesn't serve our needs for transportation and commerce."

He and Ansell ultimately developed a definition of sustainable aviation that is all-encompassing. It examines sustainable aviation as a process that connects communities, and mobilizes people, goods, and services—all while minimizing negative impacts on human health, fostering a productive quality of life, and conserving natural resources.

Waddington took their new definition of sustainable aviation and created a way to describe aircraft.

"One example is the Concorde. It was certified, built, flown, and operated. But it was prohibitively expensive to operate, leading to commercial failure. That alone indicates it is unsustainable. In addition, the high cost limited the social impact it had, not to mention the relatively high environmental impact for few passengers moved."

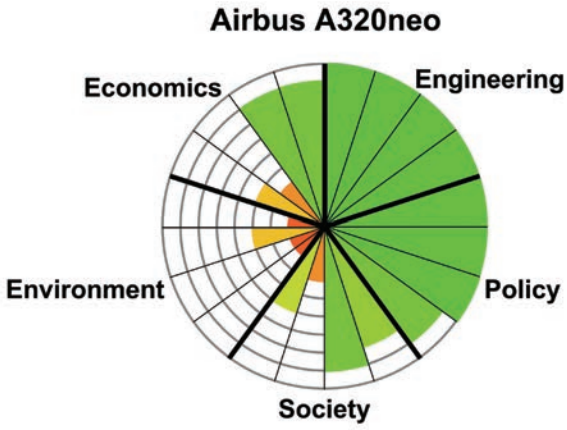
To begin the process of quantifying the sustainability of an aircraft, Waddington created a framework in which he assigned numerical values to assess vehicle system and operational performance in categories such as technology readiness, operational cost, end-of-life recyclability, and certifiability. He began by comparing the existing Airbus A320neo aircraft and the Airbus ZEROe Turbofan concept.

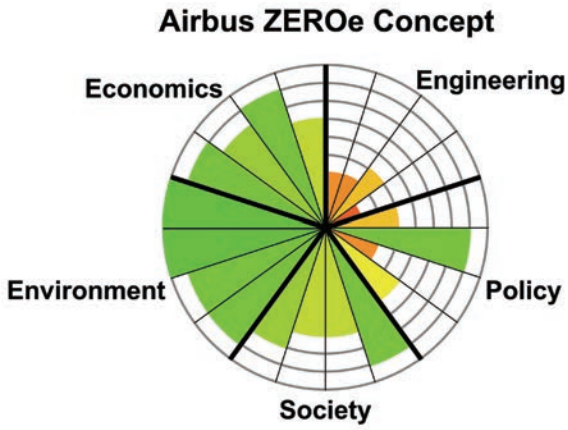
"In terms of technology readiness, if we understand the basic physics of it, it gets a one. Three means we can do it in the laboratory. Four through six means we've done it at scale and flown it at altitude. A score of 10, means it's actively in service with flight-proven hardware. So, for technology readiness, the A320 is a 10 out of 10."

The Airbus ZEROe is rated low on technology readiness, not because it doesn't show promise, but because it's still experimental. Significant technological developments will have to occur before the ZEROe can fly. But, on other environmental and societal metrics, this ZEROe architecture scored very well owing to its promising mitigation of climate impacts.

"Although preliminary, this framework provides a sustainability analysis for future air vehicles."

"A definition, conceptual framework, and pathway towards sustainable aviation," by Waddington and Phillip Ansell is published in the journal *Progress of Aerospace Science.*





The new framework estimates the sustainability of selected aircraft configurations and concepts, showing technical challenges but promising economic, environmental, and social performance. These graphics illustrate how the framework can compare the Airbus A320neo to the Airbus ZEROe Turbofan.

Government and industry support for sustainable aviation

NASA funding in two phases

In phase one of a NASA program with $6M over a three-year period, **Phillip Ansell** and his team developed new technologies and design concepts using cryogenic liquid hydrogen as an energy carrier for aircraft.

With support from an Illinois-led initiative, the Center for High-Efficiency Electrical Technologies for Aircraft was established to innovate novel power, energy, and configuration systems for a zero-emissions aviation future.

"In many ways, the hydrogen tanks and fuel management system are the heart of the airplane. The tank technology developed in CHEETA is remarkable. Not only are these systems super lightweight, but they were designed with the operating requirements of the aircraft in mind. They are robust enough to withstand the heavy-duty cycling of commercial aircraft while meeting the stringent safety requirements of certification," Ansell said.

Ansell recognized that the many constraints made the mission more challenging.

"I wanted this to be a zero emissions airplane that doesn't backpedal on capabilities while meeting the same performance characteristics of a Boeing 737-800 aircraft. This includes things like cruise speed, payload carrying capability of passengers, range, and airport compatibility."

Now, this veteran research team is working on the next phase, to develop prototypes of their designs.

Ansell said, "They'll be smaller and lower power than a full implementation but there's a lot of learning that happens in terms of what is needed to scale up for primetime and show that the paper designs and analysis are correct.

"NASA has recognized the long-term creative potential of this work. It is likely that zero-emission aircraft in the future will look quite a bit different than the prototypes we are working on, but these technologies are vital for the environmental goals set by the aviation industry."

U of I administrators, AE faculty, staff, and students met on campus with representatives from Boeing to discuss sustainable aviation research and education efforts.

Boeing backs research and education

The Boeing Company is supporting research and educational efforts at U of I to achieve a more sustainable aviation. The total $1.2M gift will provide educational support for underrepresented undergraduate and graduate students, workshops for high school teachers, and research that will lead to a net-zero emissions aviation sector by 2050.

About how the funding from Boeing will assist with student recruitment, **Phillip Ansell** said "The rates of underrepresented students entering engineering disciplines are woefully low. That's something we want to address by providing resources that will help attract them."

Ansell's new sustainable aviation course and the department's new specialized certificate in sustainable aviation are examples of Boeing's support already put into active educational efforts.

A substantial part of the funding will support the research of Phillip Ansell and **Matthew Clarke**. The projects will investigate life cycle models of pathways for aviation energy storage systems, including renewably sourced energy carriers not widely explored by the aviation industry.

"We will develop models of energy-to-propulsion processes that leverage gas turbine engine, fuel cell, electrochemical, and hybrid systems—including dual fuel solutions," Ansell said.

Clarke's aircraft design and modeling framework called RCAIDE will be further matured to integrate novel energy carriers into a baseline regional-jet platform.

"We'll also develop advanced aircraft configurations which are optimally designed to meet sustainability goals," Ansell said. "It's ambitious but vital work to help us reach a truly sustainable aviation."

New

Sustainable aviation certificate

In addition to Phillip Ansell's popular sustainable aviation course, the department is launching a specialized certificate in sustainable aviation. Earning a certificate enhances knowledge and advances careers. ***Visit AE.Illinois.edu for more information.***

NASA Pathways intern **Michaela McBride**

AE undergrad **Michaela McBride** is participating in the NASA Pathways Internship Program at the Marshall Space Flight Center.

"I have been trying to get a Pathways internship since I started college, so this is the dream of dreams," McBride said.

As an intern, McBride is part of the RS-25 engine systems team. She is learning to support tests for the Space Launch System vehicle's engines.

"The RS-25s were the space shuttle's main engines, but they're being tested so they can work on the SLS and not for the orbiter."

What she works on changes from day to day.

"The program does so many things, and this is just my first rotation," McBride said. "The cool thing about pathways is they let you move around and explore different kinds of things you can do at NASA."

The ages of the other interns McBride works with varies; some are currently sophomores in college, others are graduate students.

"For some, this is their second career. The age range is very wide."

McBride said the application process took one to two months to complete. She has two pieces of advice for students aiming for the same position she has.

"Set a challenging goal for yourself and pursue it with everything you have, because that persistence really does pay off," she said. "And do not view failure as a permanent roadblock. Think of it as an opportunity for learning and growth. I think if you can do those two things, you can be successful. Just don't give up."

Michaela McBride at the US Space and Rocket Center with a Saturn V rocket and an RS-25 engine.

Optical Navigation Engineer **Coralie Adam**

After earning her BS in 2011, **Coralie Adam** had an internship at NASA Jet Propulsion Laboratory, then began working at KinetX Aerospace where she is now the lead optical navigation engineer. In 2021, she became the deputy navigation team chief for the Lucy Mission.

Adam earned an MS in 2017 from the University of Colorado Boulder in aerospace, aeronautical and astronautical/space engineering.

How have your career goals changed over the years?

When I was 16, I set a guidepost that has helped me navigate many career decisions: to in some way contribute to expanding the collective scientific understanding of our universe, solar system, and origins. I feel so fortunate to have achieved this in many ways during the first decade of my career, and I continue to evaluate new opportunities against this guidepost.

What I love about working in planetary exploration is not only the satisfaction from helping to answer the questions we venture out seeking, but also the surprises and discoveries that lead to new questions, inspiring further scientific exploration.

What's a project you particularly enjoyed working on?

OSIRIS-REx is very near to my heart, as I've worked as the optical navigation lead since the mission was first selected by NASA in 2011. From mission development, through proximity operations and ultimately sample collection, I've learned and grown so much and worked alongside some amazing colleagues and mentors.

I was also fortunate to be involved in the scientific discovery and characterization of Bennu's active asteroid phenomenon, which was particularly rewarding because scientific exploration has always been the driving guidepost in my educational and professional trajectory.

Chris Raymond: Grainger Award for Distinguished Service

Chris Raymond, BS ’86, is executive vice president of The Boeing Company, and president and chief executive officer of Boeing Global Services, which offers solutions in fleet sustainment, parts and distribution, digital capabilities, training, engineering, and modifications, as well as cabins and interiors. Raymond has responsibility for leading Boeing’s aerospace services worldwide.

This year, Raymond received The Grainger College Alumni Award for Distinguished Service.

Prior to his newest position at Boeing, Raymond served as The Boeing Company’s first chief sustainability officer, where he was responsible for advancing the company’s approach on aerospace sustainability priorities, stakeholder-oriented engagement, reporting, and company performance.

Earlier, Raymond was vice president of Sustainability, Strategy and Corporate Development. Concurrently, Raymond was asked to lead enterprise-wide efforts to engage, inform, and seek feedback from stakeholders following the tragic accidents involving the 737 MAX airplane.

Raymond has served in leadership assignments in engineering, supply chain management, strategy, sales, program management, operations, and communications. Raymond is an associate fellow in the American Institute of Aeronautics and Astronautics, a fellow in the Royal Aeronautical Society, and serves as an advisory board member with AE’s Alumni Board. He sits on the Wolf Trap Foundation Board of Directors and is an Advocate for the International Aviation Women’s Association.

Prasun Desai: Distinguished Alumni

Prasun Desai, PhD ’05, led the 50-member NASA Langley team responsible for the entry, descent, and landing of the twin Mars rovers Spirit and Opportunity in 2000. A few years later, he left technical engineering to develop NASA’s Space Technology Mission Directorate and has since then risen to become a top administrator, managing its programs and its $1.1 billion budget.

“After the Mars landings, people all over the world asked how we accomplished it,” Desai said. “But after three Mars landings and two Earth landings, I was ready to do something different.”

For his doubly successful career, Desai received a Distinguished Alumni award.

In his present role as deputy associate administrator of NASA’s Space Technology Mission Directorate, he works with experts to define and make investments in what the next generations of space capabilities need to be developed in areas such as advanced propulsion systems, landing systems, autonomy, structures and materials, new avionics packages, mobility, and robotics. The goal of these technologies is to make future missions more capable, cost-effective, sustainable, and reliable going forward.

Desai said, “Space missions allow us to gather clues to answer fundamental questions about our place in the universe. I helped plan, design, and execute those missions in the past. Now, in this organization, I’m making them more capable so we can further probe the universe.”

Desai earned a BS in mechanical engineering from Rutgers University and an MS in astronautics from George Washington University.

Desai said the shift from technical engineering to managing programs that explore new space technologies brought him full circle.

Mohammad Naraghi: Outstanding Recent Alumni

Mohammad Naraghi, left, with Ioannis Chasiotis after the award celebration.

In 2009, **Mohammad Naraghi** earned his PhD from Illinois. His doctoral research was in nanomechanics, focusing on the utilization of MEMS devices to explore the mechanical intricacies of soft nanofibers.

He is the recipient of an Outstanding Recent Alumni award.

Following his PhD, Naraghi served as a post-doctorate research fellow at Northwestern University. In 2012, he began his academic journey as an assistant professor at Texas A&M University, rising to the rank of associate professor in 2018, and on the path to promotion to the rank of full professor in fall 2024. Additionally, he holds affiliations with the Departments of Materials Science and Engineering and Mechanical Engineering at TAMU. He is also the director of the Nanostructured Materials Lab.

"Graduates such as Professor Naraghi who lead successful careers in academia serve as inspiration to our current graduate students who are considering the pursuit of an academic career in the future," said **Ioannis Chasiotis**, who was Naraghi's PhD adviser.

Naraghi's expertise lies in high-performance lightweight nanocomposites, nanomechanics, multifunctional nanomaterials, and the application of Micro-Electro-Mechanical Systems, or MEMS, to nanomechanics.

Chasiotis said Naraghi has published 72 peer-reviewed papers, "which is an outstanding achievement for an experimentalist at his career stage."

His research receives funding from esteemed entities such as the Air Force Office of Scientific Research, Office of Naval Research, National Science Foundation, Army Research Lab, Air Force Research Lab, and Qatar National Research Funds, in addition to support from the private sector.

Dan Jensen, le t, with Harry Hilton at a dinner honoring Hilton in February 2015.

Dan Jensen: Harry Hilton Service Award

Dan Jensen, BS '88, MS '90 from Notre Dame, is the head of engineering for services at Rolls-Royce in Indianapolis. Jensen received the Harry H. Hilton Dedicated Service Award.

Being just a two-hour drive from Urbana-Champaign is a convenience for which Jensen has taken full advantage. He comes to campus frequently to meet with students and serve in a variety of capacities.

Jensen was elected to AE's Alumni Board in 2005, was vice president from 2006 to 2008, president for the following two years, and continues as a member and part of the department's inclusion, diversity, equity, and access group.

Student success has long been a passion for Jensen. Early on he joined the Student Affairs Advisory Committee, now Council, and chaired the committee from 2015 to 2017.

He has been a member of the Indianapolis Illini Club since 2013, president from 2020 to 2022, and currently serves as secretary of the group.

At the university level, Jensen has served on the U of I Alumni Association since 2018, holding positions including digital engagement committee member, external relations committee member, and the alumni and student engagement committee co-chair.

Jensen became a member of AIAA in 1985 when he was an Illinois undergrad, is now an Associate Fellow, and has served in a variety of leadership roles. This year, the AIAA Council of Directors elected him as Speaker of the Council.

Harry Hilton was a faculty member in the department beginning in 1949. When Jensen was an undergrad in the mid-80s Hilton was the department head. Although Hilton officially retired in 1990, he continued to conduct research, teach graduate courses, and actively serve the department until he passed away in March 2022.

Faculty highlights

Phillip J. Ansell (Allen Ormsbee Faculty Fellow, associate professor/PhD, University of Illinois, 2013) was inducted as an AIAA Associate Fellow and received the Rose Award for Teaching Excellence. He was a speaker and moderator for a keynote panel on sustainable aviation at the AIAA 2024 SciTech Forum. He continues to direct the Center for Sustainable Aviation and the Center for High-Efficiency Electrical Technologies for Aircraft.

Jeffrey Baur (Founder Professor/PhD, Massachusetts Institute of Technology, 1997) led the award of $3M AFOSR-sponsored Center for Resilient Multifunctional Space Structures and Surfaces through the Beckman Institute which involves five U of I PIs in aerospace, materials, and chemistry and contributed to a DARPA-sponsored joint U of I effort on low-energy manufacturing of composites in space.

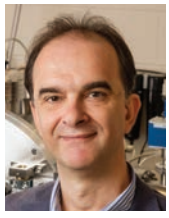
Lawrence A. Bergman (research professor, professor emeritus/PhD, Case Western Reserve University, 1980) co-authored a feature article in the journal *Nonlinear Dynamics* titled "Nonlinear targeted energy transfer: state of the art and new perspectives," with Alexander Vakakis and Alireza Mojahed from Illinois and Oleg Gendelman and Majdi Gzal from Technion – Israel Institute of Technology.

Daniel J. Bodony (Blue Waters Professor/PhD, Stanford University, 2005) is the associate dean for graduate, professional, and online programs. Bodony was elected to the President's Executive Leadership Program and started new, federally funded projects to predict hypersonic flows adjacent to compliant or ablative surfaces.

Michael B. Bragg (professor emeritus/PhD, The Ohio State University, 1981) is the executive director for The Grainger College of Engineering Chicago Initiatives.

Timothy Bretl (William H. Severns Faculty Scholar, professor/PhD, Stanford University, 2005) became an editor for the *IEEE Transactions on Robotics*. He was a visiting researcher at the Institute de Robòtica I Informàtica Industrial in Barcelona, Spain during his sabbatical leave in fall 2023.

Rodney L. Burton (professor emeritus/PhD, Princeton University, 1966) worked with Deborah Levin on satellite aerodynamics through a CU Aerospace R&D program. Advised a MechSE senior design team on the design of an electric propulsion thrust stand. Published a paper on electric rocket modeling in the *Journal of Propulsion and Power.*



Ioannis Chasiotis (Caterpillar Professor and University Scholar/PhD, California Institute of Technology, 2002) is the director of graduate studies and an associate head of AE. He was the chair of the 2024 Gordon Research Conference on Multifunctional Materials and Structures. He leads a research program on durable materials for space environments.

Huck Beng Chew (associate professor/PhD, National University of Singapore, 2007) received a National Science Foundation grant, taught an aerospace mechanics course at Danville Correction Center, published papers in *Acta Materialia, Extreme Mechanics Letters,* and *Applied Physics Letter*s, and served on the executive committee of The American Society of Mechanical Engineers materials division.

Matthew Clarke (assistant professor/PhD, Stanford, 2022) joined the faculty in 2023. He was listed on the *Forbes 30 Under 30* list for Science for his work in developing computational aircraft design tools with over 10,000 users worldwide.

Victoria L. Coverstone (professor emeritus, PhD, University of Illinois, 1992) serves as the faculty adviser for the NASA Revolutionary Aerospace Systems Concepts Academic Linkage student design team and participates in several AIAA assessment groups.

Bruce A. Conway (professor emeritus/PhD, Stanford University, 1981) presented a paper in December at the conference "New Trends and Challenges in Optimization Theory Applied to Space Engineering" in L'Aquila, Italy. He published a paper in April in the journal *Acta Astronautica* entitled "Optimal combined impulsive/low-thrust trajectories for asteroid deflection via kinetic impact."

Siegfried Eggl (assistant professor/PhD, University of Vienna, 2013) received the 2024 Grainger Engineering Outstanding Advisor Award. He won several grants from NSF and NASA to work on innovative celestial navigation technologies as well as asteroid science with the upcoming Vera C. Rubin observatory.

Gregory S. Elliott (professor/PhD, The Ohio State University, 1993) continues to lead the experimental team on the DOE Center for Exascale-enabled Scramjet Design and on the executive team for the Plasmatron X facility, which replicates the high-enthalpy conditions during reentry and hypersonic flight.

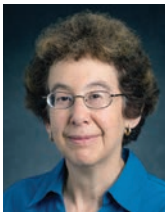
Jonathan B. Freund (Donald Biggar Willett Professor of Engineering and department head/PhD, Stanford University, 1998) continued to direct the Illinois DOE/NNSA-funded $17M Center for Exascale-enabled Scramjet Design and became co-editor of *Annual Reviews of Fluid Mechanics.* He is chair elect of the Division of Fluid Dynamics of the American Physical Society.

Philippe H. Geubelle (Abel Bliss Professor of Engineering and executive associate dean/PhD, California Institute of Technology, 1993) is a member of the multidisciplinary team centered at the Beckman Institute working on the development and manufacturing of recyclable thermoset composites as part of DOE EFRC and DARPA sponsored projects.

Andres J. Goza (assistant professor/PhD, California Institute of Technology, 2018) developed with his research team computational tools to integrate cutting-edge metamaterials into new paradigms for aerodynamic flow control, and understand whether heterogeneous properties like veins and stiff leading edges may benefit insect flight. His group has presented talks at AIAA and APS and has three manuscripts in review.

John Lambros (professor and Donald Biggar Willett Professor of Engineering/PhD, California Institute of Technology, 1994) delivered a keynote presentation at the 48th American Ceramics Society International Conference and Exposition on Advanced Ceramics and Composites on a combined Boeing/Air Force-funded effort on the study of bearing failure in ceramic joints under extreme loading conditions. Lambros serves on the Provost's Campus Budget Oversight Committee.

Cedric Langbort (professor/PhD, Cornell University, 2005) received a two-year extension on his Army Research Office MURI grant on network information propagation. He presented results from this work at a variety of venues this year including McGill University in Montreal.



Deborah A. Levin (professor/PhD, California Institute of Technology, 1979) performs preeminent research in the science of hypersonic shock interactions, radiation models, and unsteady three-dimensional plasmas. She continues to serve on the Air Force Scientific Advisory Board.

Jason M. Merret (associate professor of practice/PhD, University of Illinois, 2004) was a member of the GCOE Executive Committee that achieved full membership of two specialized faculty on the committee. He completed his tenure as chair of AIAA's Aircraft Design Technical Committee and will be the ATIO Technical Chair for AIAA's Aviation Conference in 2025. He taught and advised the winning team of the 2023 AIAA Undergraduate Team Aircraft Design Competition.

Xin Ning (assistant professor/PhD, California Institute of Technology, 2015) received an AFOSR grant to build a unique facility for in-space structural manufacturing and testing and was an organizer and panelist of the inaugural AIAA SciTech Materials Early-Career Mentorship Panel.

Melkior Ornik (assistant professor/PhD, University of Toronto, 2017) is developing a workshop series linking U of I with University of Birmingham experts on autonomous vehicles, served as a project reviewer for International Space Station, and participated in a community learning reflective practice retreat in Ecuador.

Faculty highlights

Francesco Panerai (assistant professor/PhD, von Kármán Institute for Fluid Dynamics, Università degli Studi di Perugia, 2012) published a book chapter on thermal protection for space exploration and six journal articles including an "Annual Review of Fluid Mechanics" on ablation, and received five research grants.

Marco Panesi (Caterpillar Faculty Scholar, professor/PhD, von Kármán Institute for Fluid Dynamics and Università degli Studi di Pisa, 2009)

John E. Prussing (professor emeritus/ScD, Massachusetts Institute of Technology,1967)

Joshua L. Rovey (professor/PhD, University of Michigan, 2006)

Theresa A. Saxton-Fox (assistant professor/PhD, California Institute of Technology, 2018) was awarded the NSF CAREER award for work on unsteady turbulence. Her research group performed experiments on turbulent boundary layers undergoing accelerations and presented their findings at four conferences.

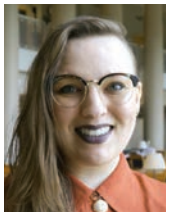
Michael S. Selig (research professor, professor emeritus/PhD, The Pennsylvania State University, 1992) published papers on the aerodynamics of multi-megawatt scale offshore wind turbines. His collaborators extend across multiple institutions, spearheaded by the University of Virginia.

Huy T. Tran (assistant professor/PhD, Georgia Institute of Technology, 2015) received a grant from NASA to research machine learning methods for collective autonomy and gave an invited talk at the Robotics: Sciences and Systems 2023 Inference and Decision Making for Autonomous Vehicles Workshop.

Laura Villafañe Roca (assistant professor/PhD, von Kármán Institute for Fluid Dynamics, Universitat Politècnica de València, 2014) received a third Early Stage Innovations award from NASA's STMD and funding for MRI flow experiments in collaboration with USMA. She gave five invited seminars across Europe and the US, published in *AIAA Journal*, and was named Young Observer to the USNC/TAM. She serves AIAA nationally and as Illinois Section Chair and continues as editor for *Measurement.*

Robyn Woollands (assistant professor/PhD Texas A&M University, 2016) received an AFOSR 2024 Young Investigator Award for astrodynamics and received funding from Aerospace Corporation, L3Harris Technologies, and the Air Force. She submitted five journal papers, attended and presented at SciTech, graduated two MS students, and three of her PhD students ascended to candidature.

Brian S. Woodard (director of undergraduate programs/PhD, University of Illinois, 2012) serves primarily as an assistant dean for undergraduate programs for The Grainger College of Engineering. He works to build the best class of Grainger Engineering students through community engagement, admissions, and recruiting, and first-year programs.



Elle Wroblewski (assistant professor/PhD, University of Illinois, 2022) is a specialized teaching faculty. Their research interests are sustainable and safe engineering, education outreach, and undergraduate student professional development. This year they taught AE 100, AE 202, AE 298 RES, and AE 312.

New faculty

Wayne Chang earned his PhD in mechanical and aerospace engineering from the University of California Irvine in 2011 with a specialty in air quality and combustion modeling. He is a teaching assistant professor in the department. Prior to joining the faculty, Chang had two, three-year postdoctoral research positions at Illinois—one in atmospheric sciences and the other in the Dept. of Mechanical Sciences and Engineering, where he was a lecturer for seven years. In AE, he has already taught five different courses, including structures, and controls/dynamical systems.

Fabien Evrard is a new assistant professor in the department with his specialty in computational fluid dynamics and multiphase flow modeling. He earned his PhD in mechanical engineering from Imperial College London in 2018, followed by a postdoctoral research position at the University of Magdeburg and a Marie Skłodowska-Curie postdoctoral fellowship at Cornell University. Evrard has authored or co-authored 32 publications. In AE, he teaches computational aerodynamics.

Jordan T. Smart is an assistant professor in the department. He received his PhD in aeronautics and astronautics from Stanford University in 2023 after holding positions as an engineer and in leadership development programs at Lockheed Martin. He is the co-founder of Aerospace Research Community, LLC and Stargazer Design Technologies, Inc. He teaches aerospace systems design and is currently working on a project sponsored by the National Science Foundation entitled "Designing the Future: Generative Configuration Design."

Hiroyasu Tsukamoto earned a PhD in space engineering with an emphasis in autonomous control and robotics from Caltech in 2023, where he received the Best Dissertation Award. Before joining the faculty at Illinois, Tsukamoto was a postdoctoral researcher in robotics at NASA's Jet Propulsion Laboratory. This past year, he was involved in research and technology development projects for system-level distributed spacecraft autonomy at JPL and Caltech.

Faculty research areas

Aeroacoustics
Daniel Bodony
Jonathan Freund

Aeroelasticity
Lawrence Bergman
Daniel Bodony
Philippe Geubelle
Andres Goza

Aerospace Materials
Jeff Baur
Ioannis Chasiotis
Huck Beng Chew
Philippe Geubelle
John Lambros
Francesco Panerai

Aerospace Structures
Jeff Baur
Lawrence Bergman
Xin Ning

Aerospace Systems Design and Simulation
Phillip Ansell
Matthew Clarke
Victoria Coverstone
Jason Merret
Michael Selig
Jordan Smart
Huy Tran

Applied Aerodynamics
Phillip Ansell
Daniel Bodony
Matthew Clarke
Gregory Elliott
Andres Goza
Theresa Saxton-Fox
Michael Selig
Jordan Smart
Laura Villafañe Roca
Brian Woodard

Astrodynamics
Bruce Conway
Siegfried Eggl
John Prussing
Robyn Woollands

Combustion and Propulsion
Daniel Bodony
Rodney Burton
Wayne Chang
Gregory Elliott
Jonathan Freund
Philippe Geubelle
Deborah Levin
Marco Panesi
Joshua Rovey

Computational Fluid Dynamics
Daniel Bodony
Fabien Evrard
Jonathan Freund
Andres Goza
Deborah Levin
Francesco Panerai
Jordan Smart

Controls, Dynamical Systems, and Estimation
Timothy Bretl
Victoria Coverstone
Cedric Langbort
Melkior Ornik
Hiroyasu Tsukamoto

Experimental Fluid Mechanics
Phillip Ansell
Gregory Elliot
Melkior Ornik
Francesco Panerai

Flow Control
Phillip Ansell
Daniel Bodony
Gregory Elliott
Jonathan Freund
Andres Goza
Theresa Saxton-Fox
Laura Villafañe Roca

Hypersonics
Jonathan Freund
Deborah Levin
Francesco Panerai
Marco Panesi

Small Satellites
Rodney Burton
Victoria Coverstone
Siegfried Eggl
Deborah Levin
Joshua Rovey

Space Systems
Timothy Bretl
Rodney Burton
Victoria Coverstone
Deborah Levin
Melkior Ornik
Joshua Rovey
Jordan Smart
Hiroyasu Tsukamoto
Robyn Woollands

Unihabited Aerial Vehicles
Phillip Ansell
Timothy Bretl
Gregory Elliott
Melkior Ornik
Michael Selig
Jordan Smart

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