STRATEGIC PLAN STATEMENT

Foster a culture of innovation in education and research to enable the creation of ideas, knowledge and practices that will revolutionize aerospace engineering for the benefit of society.
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Time has gone by so quickly!

I am honored to have served as the chair of this amazing department — the first aeronautical program in the nation — for the past six years! As I enter my final year, I am very proud to reflect on the extraordinary accomplishments of Michigan Aerospace.

Since 2011, we’ve welcomed seven exceptional faculty members who are doing outstanding research in their respective fields. Karthik Duraisamy (PhD ’05, University of Maryland at College Park), who was recently promoted to associate professor, is partnering with researchers at Purdue University and the Massachusetts Institute of Technology to investigate combustion instabilities through a $4.2 million grant from the Air Force Research Laboratories and the Air Force Office of Scientific Research. Benjamin Jorns (PhD ’12, Princeton University), assistant professor and co-director of the Plasmadynamics and Electric Propulsion Laboratory, just received the AIAA Best Paper Award for his electric propulsion research. Dimitra Panagou (PhD ’12, National Technical University of Athens, Greece) is developing theoreric methods in order to address real-world constrained control problems via analytic, provably correct solutions. She was a recipient of a 2017 AFOSR Young Investigator Award and the 2016 NASA Early Faculty Career Award. Venkat Raman (PhD ’03, Iowa State University) was promoted to full professor with tenure this year. He works closely with Mirko Gamba (PhD ’09, University of Texas at Austin) to combine experiments with computer simulations to help companies test designs for rotating detonation engines. We are also delighted to welcome Jean-Baptiste Jeannin and Alex Gorodetsky to our faculty as assistant professors. Their research will help diversify our department through their respective expertise in computational science, autonomy and cyber-physical systems.

Our senior faculty are also exceptionally productive. In this past year alone, they have published 120 articles in prestigious journals and delivered 85 national and international talks, including 45 keynotes. Iain Boyd authored and published a text titled “Nonequilibrium Gas Dynamics and Molecular Simulation” with Cambridge University Press, and several of our faculty have received awards, including Peretz Friedmann who earned the highest honor that AHS International bestows on an individual for notable achievement in advancing the field of vertical flight aeronautics. Carlos Cesnik was recently appointed for a one-year term as the director of the AIAA Aerospace Design and Structures Group. James Driscoll’s “Experimental Assessment of Premixed Flames Subjected to Extreme Turbulence” won the Propellants and Combustion Best Paper. Lastly, I am grateful to SPIE, which hosted a conference in honor of my 70th birthday and my contributions to the field of smart structures in March of this year.

Professor John Shaw will be on sabbatical for the Fall term. Shaw will be starting his new book on the fundamental thermomechanical behavior of shape memory alloys during this time. Professor Iain Boyd will be on special assignment in Washington, DC, with the goal of enhancing the College of Engineering’s national engagement efforts.

Our faculty have also been successful in securing research support from prestigious foundations and government agencies. As announced at this year’s
Paris Air Show, our department received an $8.25 million grant to work with Airbus and Georgia Tech in a new cutting-edge research center: the Airbus-University of Michigan Center for Aero-Servo-Elasticity for Very Flexible Aircraft. This center will support faculty and students in the development of improved computer simulation tools and techniques for designing and evaluating future high-efficiency aircraft.

Our students have had an incredibly strong year, making waves in national competitions, industry and the research community. In June, the Michigan Aeronautical Science Association took home first place at the first Spaceport America Cup for their student-researched and -developed hybrid rocket. The M-Fly student design team achieved top 10 rankings in both the Regular and Advanced categories at the SAE Aero Design Competition. Other student teams have been developing improved autonomous aircraft, high-altitude balloons and small satellite systems. The hands-on experience our students have gained through such teams and our curriculum have positioned them to be in high demand by entities across the aerospace and automotive spectrums, including (but absolutely not limited to) NASA, The Boeing Company, GM, Lockheed Martin and SpaceX. Our students continue to demonstrate their burgeoning technical skills and creative approaches through the construction of blimps and hovercraft in our hands-on laboratory courses ENG 100 and AERO 205.

On the research side, our students are making meaningful contributions to the fields of propulsion, dynamics and controls, space systems, structures and materials. Over the past year, they have won a variety of AIAA Best Student Paper awards for topics ranging from the analysis of unsteady fluid structures to simulations of electric propulsion systems. They have also received highly competitive research fellowships from NASA, NSF, NDSEG and DoD and continue to push the boundaries of aerospace academia with their curiosity, innovative thinking and multidisciplinary approaches.

Finally, our alumni community never ceases to impress us with their great accomplishments. Some have become international entrepreneurs, like Jeff Froster (BSEA ’99) who leads an innovative low-energy building services firm, Froster Engineering, in Australia. Others, like Evan Hilgemann (MSAE ’15), have developed innovative space exploration technologies for NASA. The department is ever grateful to Nikolas (BSE Aero ’88, MSE ’89, MSE ’75, PhD ’76) and Denise Bletsos for their help in establishing a scholarship fund for Aerospace undergraduate students in need of support. Additionally, we congratulate alumnus and Michigan Senator Patrick Colbeck (BSEA ’87, MSAE ’88) for his recently announced candidacy for Michigan governor. We sincerely love hearing more about our alumni, where they are and how they are doing. Please continue to share your personal and professional stories!

I am proud of what we’ve accomplished over the past six years and excited about the future. Our department is strong and vibrant, and together we are committed to continuing our efforts to be innovators in education and research while revolutionizing aerospace engineering for the benefit of society. The possibilities are boundless.

Thank you for your ongoing interest and for your support.

Sincerely,

Daniel J. Inman
Clarence L. (Kelly) Johnson Collegiate Professor of Aerospace Engineering and Chair of Aerospace Engineering
FACTS + FIGURES

AEROSPACE RANK HISTORY

U.S. NEWS & WORLD REPORT RANKING

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AEROSPACE RANK COMPARISON

UNDERGRADUATE

1. Massachusetts Institute of Technology
2. Georgia Institute of Technology
3. University of Michigan-Ann Arbor
4. Purdue University-West Lafayette
5. California Institute of Technology

GRADUATE

1. Stanford University
2. Georgia Institute of Technology
3. Massachusetts Institute of Technology
4. California Institute of Technology
5. University of Michigan-Ann Arbor

U-M AEROSPACE RANKINGS

1. Grad School by GradPrograms.com (2015)

U-M CoE RANKINGS

CURRENT RESEARCH EXPENDITURES

$12,026,526
2017 Fiscal Year

FACEBOOK PAGE LIKES

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AEROSPACE ENGINEERING FACULTY

50 Faculty Members
(27 of whom are Tenure Track)

- 16 Full Professors
- 7 Associate Professors
- 4 Assistant Professors
- 1 Lecturer
- 3 Research Investigators
- 2 Assistant Researchers
- 6 Adjunct Faculty
- 12 Emeritus Professors
- 2 NAE Members
- 9 NSF and other YI Award Recipients
- 140 Memberships in Professional Societies
- 34 Memberships on Technical Committees, Boards, etc. at the National or International Level
- 200 National or International Awards

AE GRAD STUDENT RESEARCH

Graduated Students
(August 2016, December 2016 & May 2017)

- 13 PhD
- 59 MSE/SUGS

Grad Students
(Fall 2017)

- 116 PhD
- 75 MSE/SUGS
KHALED SHAHWAN JOINS MICHIGAN AERO ADVISORY BOARD

The Department of Aerospace Engineering is pleased to welcome Khaled Shahwan (MS CEE ‘88, MS AERO ’90, PhD AERO ’95) to its Industrial Advisory Board.

As a member of the board, Shahwan will help orient the department’s educational impact toward current academic, government and industry committees. Shahwan is expected to offer perspective into industry trends and needs, provide recommendations for course curricula and lab structures and promote cooperative relationships with industry partners.

About Shahwan

Khaled Shahwan has been at Fiat Chrysler Automobile (FCA) Technology Center since 1999, and is currently the technology lead for advanced carbon fiber materials, methods and strategies within the Advanced Development Engineering organization. Shahwan holds several leadership positions in industry as part of this role. He is the current chair of USDRIVE’s MTT and was the chair of the 2011 board of directors of USCAR’s Automotive Composites Consortium (ACC). He served as a member of that board from 2008 to 2012.

Shahwan has been the lead visionary and sole architect of several long-term R&D activities, ranging from validating novel methodologies for ultra-lightweight advanced composite materials to developing integrated engineering methodologies for advanced materials to be used in future automotive products. Since 2002, Shahwan has led development of fundamental methodologies to design and analyze modules for future autonomous vehicles at FCA (then DaimlerChrysler), including innovations in passive safety as well as active technologies is support of regulations.

Among his many memberships and accolades, Shahwan is a fellow of the American Institute of Aeronautics and Astronautics (AIAA) and a member of the American Society of Mechanical Engineers (ASME). He has authored more than 100 peer-reviewed journal publications, conference presentations and corporate and industry-government collaboration reports.
LEETECTURES ON DEMAND

The College of Engineering has archived a variety of videos, webcasts and presentations at a single website called MconneX. To view the following lectures on demand, delivered by faculty of the Department of Aerospace Engineering as well as external experts, visit engine.umich.edu/mconneX.

“AN ETHOLOGICAL APPROACH TO SUAVS FOR FIRST RESPONDERS”

James E. Hubbard, Jr.
Glenn L. Martin Institute Professor
University of Maryland

If one defines the SUAV robot as a mechanical or electronic agent that can extend human capacities, then the dog — which has been domesticated by humans as an aid in hunting, animal husbandry, warfare, protection, transport and search and rescue — represents the first “biological robot.” This research, the speaker explores a control architecture that allows human/robot interaction to mimic the relationship between a service canine and a team of first responders in a large-scale disaster scenario. Also explored are rigorous performance metrics that enable human first responders to work seamlessly in a blended response with an Aerial K9 robotic agent to locate targets of interest in minimum time, with minimum effort and maximum entropy.

“The Digital Industrial Revolution in Aerospace and Propulsion”

Eric J. Ruggiero
Engineering Manager, Sustaining Commercial Thermal Systems Design
GE Aviation

In the past five years, the intersection of high-speed microprocessors, inexpensive data storage and wireless communication technology has led to a paradigm shift in how physical assets are operated and monitored. While the use of prognostic health monitoring has been fairly commonplace in military aircraft products over the past two decades or more, this paradigm shift has now bridged and expanded into the commercial aviation marketplace. Leveraging GE’s deep-domain knowledge with data streams from engine assets is at the heart of the Digital Industrial Revolution. Digital Industrial is more than just data. It’s maximizing value for customer fleets in a number of ways including: asset monitoring, to help reduce unplanned maintenance and inspection burden; fleet optimization, to ensure flight paths and fuel burn are as efficient as possible; and improved reliability, to understand changes in operation severity that may adversely affect the performance of the product. This presentation illustrates the framework that makes Digital Industrial possible in the aircraft engine industry, connecting the dots between sensors, digital twin models and analytics to provide additional value to the customer. Examples are provided to illustrate how analytics can be used to help the customer and product. Also discussed are some of the challenges facing industry today, providing context for future research directions.

“US Airways Flight 1549: Seven Years Later: Safety, Autonomy and the Human Element”

Ella Atkins
Professor of Aerospace Engineering
University of Michigan

Occasionally, an aircraft accident captures our attention in a good way. The “Miracle on the Hudson” elevated a capable pilot to hero status and reminded us that life-threatening situations can indeed have a happy ending. It was no accident that the movie “Sully” was recently released near the 15th anniversary of the horrific 9/11 terrorist attack in New York City. The popular press has focused on the calm and clear thinking of the US Airways crew. This presentation will focus on the complementary hardware/software story: the existing Airbus technology that was instrumental in saving lives that day as well as the autonomy technology that could have prevented the need to land on a river altogether. Challenges in increasingly autonomous aerospace systems research, development and deployment are discussed, along with important social and legal questions we face as our air and ground vehicles begin to override our actions to protect us.

“Data-Enabled Design for Combustion Dynamics in Propulsion Engines”

Vigor Yang
William R.T. Oakes Professor and Chair of the School of Aerospace Engineering
Georgia Institute of Technology

This interdisciplinary research lecture describes work in supercritical combustion, combustion instability, reduced-basis modeling (emulation), statistics, uncertainty quantification and machine learning. Recent breakthroughs in modeling and data analytics have substantially improved modeling capabilities at all levels. New techniques address issues specific to physics extraction and design evaluation of complex systems. This research will enable effective and efficient (practical time-scale) surveys of all known parameters, including design attributes and operating conditions, and their effects on system stability behavior.

“Reminiscences on My Career in Control”

Elmer G. Gilbert
Emeritus Professor, Aerospace Engineering
University of Michigan

In the last few years, I have been encouraged by colleagues to make some remarks on my career in the field of control systems. This seminar is my response. Emphasis is on the years 1957 to 1977, an exciting period in which both engineering practice and underlying research underwent great change. In particular, there was a dramatic increase in the use of mathematical theory and computational tools. While my remarks center on specific activities that involved me, they may also give historical perspectives on what happened in the general field of control. Subjects covered include the early development and application of analog computers; Applied Dynamics International; the canonical structure of linear systems and how my contributions differ from those of R.E. Kalman; algorithms for solving problems in optimal control and how they led to (very) fast procedures for computing the distance between objects in 3-space; optimal periodic control; and the stability of model predictive control.
Simulations to Help Designers Avoid Combustion Instabilities
On Jan. 10, 2013, the Saturn V F-1 gas generator completed a 20-second hot-fire test. Engineers are completing a series of tests at Test Stand 116 located in the East Test Area at NASA’s Marshall Space Flight Center in Huntsville, Alabama. The primary test objectives are to gather performance data from the refurbished gas generator and to demonstrate new test stand capabilities for conducting future tests with liquid oxygen and rocket grade kerosene fuel, known as Rocket Propellant 1. This digital data also will help engineers refine engine combustion computer models and analyze different fuel mixture ratio and soot production. All data will be valuable for the development of advanced propulsion systems.

Photo: NASA/MSFC
The problem has haunted the space program since its Apollo days: The flame inside a rocket engine literally spirals out of control, producing forces that can cause the engine to explode. It’s one of the reasons why some U.S. military and commercial satellite launches rely on Russian rocket engines to take them to space.

Now, a team of researchers at the University of Michigan, Purdue University and the Massachusetts Institute of Technology will try to get to the root cause with a $4.2 million grant from the Air Force Research Laboratories and the Air Force Office of Scientific Research.

New rocket designs need new rocket engines, but combustion instabilities make it difficult to develop these engines without blowing up some prototypes along the way. These wild flames go back to the prototype for the rocket that took astronauts to the moon. That engine exploded during a test.

The engineers discovered that the flame was driving a spiral current that resonated inside the engine, growing strong enough to blow the engine apart. But the physics of the current was so complicated that they couldn’t entirely work out what was happening.

To illustrate the problem’s pedigree, Karthik Duraisamy, associate professor of aerospace engineering at U-M and the director of its new Center of Excellence on Rocket Combustor Dynamics, showed a clip from the documentary “Moon Machines: The Saturn V Rocket.”

“Keep in mind that back in those days, we were designing rocket engines basically with slide rules,” says Sonny Morea, project leader on the engine for the Saturn V rocket.

The Saturn V engineers put extra metal plates inside the engine to damp out the oscillations, experimenting until they found the right configuration. This is how rocket engines are designed to this day, prolonging development time and causing cost overruns.

“Unfortunately, even with the tremendous advances in computing over the past 50 years, we are still not in a situation to perform efficient simulations to help designers understand and avoid combustion instabilities,” said Duraisamy.

He plans to get to the bottom of the problem by using mathematical techniques that can process a large cache of simulation data to extract information and create efficient physical models. At the heart of the project are algorithms and facilities developed at U-M, specifically meant for this purpose. The researchers will combine the data with physical models of the flow and flames inside the engine, testing and refining the models while they run.

Purdue has been building and testing rocket engines for decades. Propulsion researchers there, led by William Anderson, a professor of aeronautics and astronautics, will provide their expertise of the physics inside rocket engines and combustors. Researchers at MIT, led by Karen Willcox, co-director of the MIT Center for Computational Engineering, will consult on simplifying the computational models so that it is feasible to run them in a reasonable amount of time. Data sources include extensive experiments and simulations performed at Purdue and by the Air Force.

Blue Origin, a spaceflight services company, supports this work. “An accurate predictive model of combustion instability in liquid rocket engines will be an extremely useful tool in support of our American engine development programs,” said company president Robert Meyerson. “Blue Origin will be interested in a technical information exchange throughout the effort, and can provide practical advice on key problem areas and participate as a field tester of the predictive tools.”
Apollo 8, the first crewed Saturn V, launched from NASA’s Kennedy Space Center on Dec. 21, 1968. Here, the S-IC stage is being erected for final assembly of the Saturn V launch vehicle in Kennedy’s Vehicle Assembly Building. NASA’s Marshall Space Flight Center designed, developed and managed the production of the Saturn V rocket that powered the Apollo and Skylab missions. Today, Marshall is developing NASA’s Space Launch System, the most powerful rocket ever built, which will be capable of sending astronauts deeper into space than ever before.

Photo: NASA
Researchers “Rediscover” Engine that Promises More Efficient Power
ith an eye to improving the efficiency of natural gas power plants, the US Department of Energy is providing U-M researchers with $1.4 million to explore how to make rotating detonation engines practical for power generation. A jump of even a few percent in the overall thermal efficiency could mean a significant reduction in greenhouse gas emissions.

The efficiency gain comes from the different kind of fuel burn: a detonation, rather than the more ordinary deflagration (flame) currently used in the majority of energy conversion systems. In conventional natural gas combustors, a flame consumes the unburned air/fuel mixture, releasing their chemical energy into heat. A detonation wave releases energy much faster through the combination of a strong shock wave that compresses the air/fuel mixture and a chemical reaction that follows on its heels. In this mode, energy can be extracted more efficiently from each unit of fuel.

Mirko Gamba and Venkat Raman, respectively assistant and full professors of aerospace engineering, are combining experiments with computer simulations to help companies test designs for rotating detonation engines.

Not only are the engines expensive to build, a bad design can explode, explained Raman. “So we do simulations,” he said.

Rotating detonation engines go back to the 1950s. The idea was to confine a spinning detonation wave in a ring over a circle of fuel injectors. It would be more efficient than the combustors then used in rockets. Arthur Nicholls, a U-M professor emeritus of aerospace engineering, was one of the engine’s early pioneers.

“At least in the United States, he’s considered the first guy to try it out,” said Gamba, who leads the new project. “He could get it to start, but it would quickly die out.”

Nicholls ran experiments aimed at discovering whether the rotating detonation wave was a feasible means of propulsion for rockets. In the end, he couldn’t get the engine to run, but he believed it was possible. He summarized his experiments in a detailed report for the military in 1964. “At that time, people knew some properties of detonation, but they were not able to apply those properties to run these engines in practice,” said Gamba.

The US lost interest as other combustor designs progressed more smoothly. But Gamba says that on the other side of the Iron Curtain, 

“WITH WIDESPREAD ACCESS TO LARGE SUPERCOMPUTERS, YOU CAN HAVE A CLASS OF MODELS THAT ARE MORE DESCRIPTIVE, CONTAIN MORE PHYSICS AND ARE MORE COMPLICATED THAN WHAT YOU COULD DO 30 OR 50 YEARS AGO.”
the Soviet Union pressed on with rotating detonation engines, reporting what is thought to be the first sustained operation.

From top to bottom, simulations reflecting density, temperature and heat release as a detonation wave moves over a row of fuel injectors. And now, with natural gas power plants in vogue and conventional combustors near their maximum efficiencies, the US is interested again.

“Many of the top people in rotating detonation engines used to be graduate students or junior researchers back then, and they would visit Michigan,” said Raman. “So now, the role is reversed — they are the experts and we are trying to learn, but they are happy to teach us because they still associate this kind of technology with this university.”

In the mid-2000s, the Air Force Research Laboratories began publishing research on working rotating detonation engines.

“We can get something stable, but how far are we from the optimal? And what do we need to get to the optimal point? Those are practical questions that are still being answered,” said Gamba. He studies combustion, specifically combustion at high speeds, such as occurs in supersonic vehicles. Flames and shock waves are his home turf.

Gamba’s group will run experiments to help answer questions about how to optimize the propagation of the detonation wave. What affects its structure? What is the best way to mix the air and fuel — can the detonation wave help with this? Also, how much fuel is lost to regular burning as the air in the combustor heats up? And how does this affect the detonation wave?

Gamba and his students will build new experiments to replicate rotating detonation engines in addition to performing shock wave experiments in their existing equipment. Meanwhile, Raman and his group will build computer models that capture the physics of rotating detonation engines, enabling different engine designs to be tested. They will predict the outcomes of Gamba’s experiments to find out how accurate their models are and refine accordingly.

“With widespread access to large supercomputers, you can have a class of models that are more descriptive, contain more physics and are more complicated than what you could do 30 or 50 years ago,” said Raman. These models could one day inform the design of a working rotating detonation engine.
MARTINS TO SERVE AS PRINCIPAL INVESTIGATOR FOR MICHIGAN-AFRL PARTNERSHIP

Michigan Aerospace Professor Joaquim Martins has been selected to lead a highly competitive research partnership with the Air Force Research Laboratory (AFRL), establishing U-M as an AFRL Collaborative Center in Aerospace Vehicle Design (CAVD). This partnership will promote collaboration between AFRL, U-M and Rensselaer Polytechnic Institute, a contributing university, in the discovery of new numerical methods and tools for optimizing aircraft design and performance.

With their inherent complexity, aircraft systems can be notoriously difficult to simulate in high fidelity. In a recent collaboration with NASA, Martins developed a gradient-based numerical modeling framework capable of analyzing hundreds of coupled design variables automatically to generate an optimized aircraft configuration. The results of Martins’ simulations have been validated empirically through wind tunnel testing and by comparisons to other numerical models.

Martins and his Michigan co-investigators Carlos Cesnik, Krzysztof Fidkowski and Charles Mader will leverage previous modeling breakthroughs for the AFRL CAVD investigation. “All of our earlier work helped us learn, more than anything, what not to do,” Martins says. “It usually takes two to three rewrites to really get your algorithms just right. In this case, we are coming in with a computational framework with state-of-the-art numerical methods. We will now be able to learn from AFRL’s strength in geographically distributed networks, [allowing researchers to work from different locations] to create a [unified] framework.”

The collaboration will span five years, formally beginning in Fall 2017.

NEW FACULTY

Alex Gorodetsky joins the department as assistant professor. Gorodetsky was a John von Neumann Postdoctoral Research Fellow at Sandia National Laboratories in Albuquerque, New Mexico. Prior to Sandia, he completed his PhD and SM in the Department of Aeronautics and Astronautics at MIT, where he was advised by professors Sertac Karaman and Youssef Marzouk. He received his BSE in aerospace engineering from U-M. His research interests include developing applied mathematics and computational science to enhance autonomous decision-making under uncertainty, and he seeks to enable robotic systems to explore complex environments with little human interaction. He applies his research to wide-ranging areas including statistical inference and machine learning, numerical analysis, control and optimization.

Jean-Baptiste Jeannin joined Aerospace as an assistant professor. Prior to coming to U-M, Jeannin was a researcher at Samsung Research America in Mountain View, California, where he worked on software correctness and security. His research focuses on the verification of cyber-physical systems with an emphasis on aircraft applications, as well as on tools for JavaScript. He spent two years as a postdoctoral fellow at Carnegie Mellon University, where he worked with the FAA on aircraft collision avoidance. He earned a PhD in computer science from Cornell University, and a Diplôme d’Ingénieur from École Polytechnique, France. In his spare time, he likes to fly small airplanes.
Professor Carlos Cesnik has been appointed to a one-year term as the director of the AIAA Aerospace Design and Structures Group (ADSG), and will also serve as a member of the association’s newly created Council of Directors. In the former role, Cesnik will oversee numerous technical committees that focus on design (Design Engineering, Multidisciplinary Design Optimization, Non-Deterministic Approaches, Survivability and Systems Engineering) and structural topics (Adaptive Structures, Materials, Spacecraft Structures, Structural Dynamics and Structures). These committees are significant contributors to many technical initiatives within AIAA and to annual AIAA forums and conferences.

During his term, with ADSG, Cesnik noted that he will focus on “supporting the Technical Activities Division (TAD) and AIAA at large, in charting a course to effectively move to a new governance model while maintaining TAD’s function as a premier technical backbone of AIAA.” He also hopes to capitalize on “challenges in our Institute, our industry and our society in general” to “substantially increase the scope and quality of what [AIAA] can offer members.”

Cesnik is an AIAA lifetime member and fellow. From 2009 to 2014, he served as deputy director for Structures, and from 2015 to 2017 as deputy director for Design and Structures within the Aerospace Design and Structures Group. In addition, he has held many other leadership roles within the organization.

Klemin Award goes to Friedmann

Peretz Friedmann, U-M’s François-Xavier Bagnoud Professor, was this year’s recipient of the Dr. Alexander Klemin Award, the highest honor that AHS International bestows on an individual for notable achievement in advancing the field of vertical flight aeronautics.

In a career that spans 45 years, Friedmann has made outstanding and lasting original contributions to rotary-wing aeroelasticity, on-blade control of vibration and noise, optimum design of low vibration helicopter rotors, rotorcraft aeromechanics and unsteady aerodynamics. These contributions have advanced the understanding of rotorcraft aeromechanical behavior and have had a major impact on modern helicopter design.

Washabaugh earns third Silver Shaft

The U-M chapter of Sigma Gamma Tau, the aerospace engineering honor society, awarded its 2017 Silver Shaft Award to Peter Washabaugh, Arthur F. Thurnau Professor of Aerospace Engineering. The students selected Washabaugh as the faculty member who best demonstrated the qualities of “exceptional student instruction, clarity, sincerity and enthusiasm for aerospace.” This is the third time in five years that the professor has received this award.

Washabaugh is best known for his instruction of the ENG 100 and AERO 205 courses, which allow students to build, test and race blimps and hovercraft. These student projects are exhibited bi-annually during “Aerospace Day,” which the professor has helped grow into an Aerospace Department semester highlight.

His research interests include experimental solid mechanics, fracture mechanics, instrumentation, non-destructive testing and optimization.

Cambridge publishes Boyd’s new book

In March 2017, Cambridge University Press released a new textbook, titled “Nonequilibrium Gas Dynamics and Molecular Simulation.” This scholarly work, authored by U-M’s Iain Boyd with Thomas E. Schwartzentruber, provides an updated treatment of molecular gas dynamics topics for aerospace engineers, or anyone researching high-temperature gas flows for hypersonic vehicles and propulsion systems. It demonstrates how the areas of quantum mechanics, kinetic theory and statistical mechanics can combine in order to facilitate the study of nonequilibrium processes of internal energy relaxation and chemistry. Boyd is the James E. Knott Professor of Engineering.

PROMOTIONS

Karthik Duraisamy

To associate professor. Develops computational models, algorithms and uncertainty quantification approaches for application in the aeromechanics of fixed and rotary wing aircraft, wind turbines and hypersonic cruise vehicles.

Duraisamy was also appointed director of U-M’s new Center of Excellence on Rocket Combustor Dynamics, which will simulate flows and flames inside rocket engines in the hopes of laying the groundwork for smarter, more reliable designs. (See related story on page 12.)

Venkat Raman

To full professor. Specializes in the development of computational models for turbulent reacting flows associated with aircraft and scramjet engines, stationary power generation and the synthesis of novel materials.

Henry Sodano

To full professor. Focuses on advanced aerospace materials with an emphasis on composite materials, multifunctional materials, additive manufacturing, ceramics and nanotechnology.
ASME Recognizes Sodano’s Energy Harvesting Paper

Professor Henry Sodano’s work was recently honored by the American Society of Mechanical Engineers. ASME named him author of the year’s best paper on energy harvesting, titled “ZnO Nanowire Interfaces for High Strength Multifunctional Composites with Embedded Energy Harvesting.”

At its most basic level, energy harvesting involves the development of materials that can convert non-useful or undesired forms of energy, such as structural vibrations, into beneficial forms of energy, like electricity. Ideally, these energy-harvesting materials are multi-functional, enhancing structural strength along with providing energy production capabilities. As detailed in his award-winning publication, Sodano’s team has successfully developed a simple, scalable and cost-effective process for making these energy-harvesting systems more physically robust. “The initial method my team was using in the creation of energy harvesting composites was coating a fiber with a solid shell of ceramic,” Sodano notes. “After some initial analysis, we found that there was a stress concentration at the interface [of the fiber and the ceramic shell]. I knew that by changing the morphology [of this interface] from a discrete interface to a functional gradient, we could reduce the stress concentration [and strengthen the material]. We invented the concept of using an array of zinc oxide (ZnO) nanowires to create this gradient.”

This array of ZnO nanowires not only served as a functional unit in the energy-harvesting composite, it also greatly improved the structural performance of the material, increasing the elastic modulus and tensile strength of the composites by 34.3 percent and 18.4 percent, respectively.

This innovation represents a natural progression of Sodano’s decade-plus work with multi-functional materials. “I have a structural dynamics background,” he explains. “I first became involved with multi-functional materials a number of years ago, when it was just starting to become popular. Embedding multiple capabilities in a single material requires you to redesign the material [from a molecular level]. I quickly realized that if I was to work in this field, I had to learn to process materials, which I had never done before. As I learned, I started peeling back layers of complexity and making impacts in different fields.”

Sodano’s Aerospace Materials Lab reflects the diverse nature of the field, with one postdoctoral and seven PhD students hailing from the aerospace, materials science and macromolecular departments. Sodano explains the advantage of this eclectic team makeup: “Your ability to approach a problem improves when you have different perspectives. Very few materials labs are focusing on aerospace applications, so we are able to make a unique impact.”

The aerospace applications of this research could be far-reaching. With the potential to generate energy on any structure that is subject to force loading, this material could be incorporated into airplane wings to generate energy as the aircraft flies or into spacecraft to supplement mission power requirements. Due to this breadth of possible applications, Sodano will look toward industry demand to guide future development. “The key is to have companies start to explore [our material’s uses] and to have them work with it in their settings,” he says. “The Air Force Research Lab in Dayton [OH] is already looking into how they can mass produce it and make the process scalable.”

SPIE Tribute Conference Held in Inman’s Honor

On March 28–29, SPIE, the professional society for optics and photonics technology, hosted a tribute conference honoring Aerospace Chair Daniel Inman for a lifetime of contributions to the field of smart structures. The tribute sessions, which were embedded into the broader 24th Annual International Symposium on Smart Structures and Material Systems held in Portland, Oregon, included presentations on self-sensing actuation, morphing structures, structural health monitoring and energy harvesting. In addition to the lecture series, a special luncheon was held. U-M Mechanical Engineering Chair Kon-Well Wang delivered the luncheon keynote, leading a gentle ‘roast’ of Inman, supplemented by student anecdotes and videos.

When asked about his selection for this tribute, Inman responded in good humor. “In my case,” he said, “it was the good looks. Having won several other lifetime achievement awards in the areas of smart structures, vibrations and structural health monitoring [might also have played a role]. These tributes are usually done at key birthdays or after death. Fortunately, this one was in honor of my 70th birthday.”

Inman continued: “I think my role [at the conference was] to have a tough skin, to laugh and to be grateful! I greatly enjoyed catching up with almost 30 of my current and former students and many colleagues and friends, as well as others I mentored along the way. I also had several technical papers at the conference, and many of my current students and postdocs presented papers.”

Inman is a pioneering and transformative force within the SPIE Smart Structures community. In 2003, he received the SPIE Smart Structures and Materials Lifetime Achievement Award.

Aerospace Chair Daniel Inman (left) with Texas A & M Professor Dimitris Lagoudas at the 2017 SPIE Tribute Conference. Photo: Pablo Tarazaga/Virginia Tech
MASA TEAM SOARS AT SPACEPORT AMERICA CUP

In June, representatives of the Michigan Aeronautical Science Association (MASA) competed in a five-day event to launch a rocket of their own design and manufacture carrying no less than 8.8 pounds of payload to a target height of up to 30,000 feet above ground level. The competition, held at Spaceport America in New Mexico, drew more than 90 college teams from six continents. Last year, MASA took home second place in the advanced — 30,000 feet — hybrid engine category. This year, the team took first place in the category and was declared winner of the overall contest. This performance earned the inaugural Spaceport America Cup for them and the university.

The competition, sponsored by the Experimental Sounding Rocket Association, pits students from the world’s top engineering programs against each other. Students seek to launch their rockets to a predetermined altitude. Points are earned for coming closest to the target altitude, as well as for the students’ presentations and their safety plans and procedures.

But the competition isn’t the only draw. For many, it’s a prime opportunity to network with leading aerospace firms who attend to recruit the next generation of engineers and industry leaders. Virgin Galactic, Blue Origin, Space X, Jacobs and 18 other companies took advantage of having the cream of the crop in one place.

“I’m so thrilled to see all the students excited about engineering and rockets and space,” said Jane Kinney, assistant director of the Commercial Spaceflight Federation in Washington, DC. “To be able to go to Spaceport America and actually launch the projects they’ve been working on is wonderful. It gives students hands-on experience before they get out in the world.”

Leaders of MASA’s 2017 team included Robyn Hinchman (president), Ben Corson, Nishant Gohel, Madhav Goli, Austin Harms, Rishi Jashnani, Michael Johnson, Abhiram Krishnan, Alexander Monticciolo, Alex Philpott, Tyler Sandberg, Jacob Sigler, Nick Sterenberg and Sophia Yu.

AE MASTER’S STUDENT RECEIVES COMPETITIVE VERTICAL FLIGHT FOUNDATION SCHOLARSHIP

Aerospace Engineering graduate student Ryan Patterson has been selected for a coveted Vertical Flight Foundation scholarship from the American Helicopter Society (AHS). As a top applicant, Ryan will receive the Santino “Tino” Pancotti Scholarship, honoring the former technical lead for Agusta and AgustaWestland (now Leonardo Helicopters).

Ryan was honored at the AHS Grand Awards Banquet during the 73rd annual Forum & Technology Display in Fort Worth, Texas on May 10, 2017.

ABOUT RYAN

Nearing completion of the sequential undergraduate/graduate studies program in aerospace engineering at U-M, Ryan recently decided to continue as a doctoral student. He works with François-Xavier Bagnoud Professor Peretz Friedmann on utilizing active flow control on helicopter rotor blades for noise and vibration reduction. His research will involve developing a reduced-order computational model based on computational fluid dynamics data for efficient calculation of aerodynamic loads on a blade. In this way, control studies can be performed to assess the effectiveness and feasibility of the active flow control technology for implementation onto helicopter rotor systems.

In addition to rotorcraft, Ryan is interested in wind energy — a field that he gained exposure to during an internship at Sandia National Laboratories — and in the work being done to advance and expand technology in the world energy market.
COLLEGE OF ENGINEERING RECOGNIZES AEROSPACE STUDENT LEADERS

The Aerospace Engineering Department is composed of a formidable student body of inspired, driven and passionate students. Each year, the College of Engineering recognizes a handful of these students who demonstrate exceptional academic performance, leadership skills and community contributions. Following are the 2017 honorees.

Reebehl El-Hage:
Cooley Writing Contest
Reebehl is a senior with double majors in aerospace engineering and political science. He also has an international minor in engineering.

While attending the University of Michigan, Reebehl has been involved in the political environment on campus, speaking out in favor of free speech and open dialogue, and has been quoted in numerous media outlets, including the Washington Post, New York Times and the Detroit News.

He plans on attending law school after graduation, in the hopes of pursuing a career in patent law.

Beldon Lin:
Distinguished Leadership Award-Undergraduate Students
Beldon is a junior double-majoring in aerospace engineering/engineering physics. His main interests lie in computational sciences, plasma physics, electric propulsion and aircraft design.

This past year, he worked as a research assistant at the Plasmadynamics and Electric Propulsion Laboratory, designing and testing a thrust vectoring system for the CubeSat ambipolar thruster. In addition to his research, Beldon is the advanced class chief engineer for M-Fly as well as a member of the Outreach Committee of U-M’s student AIAA chapter where he coordinates Aerospace Day activities.

Kaelan Oldani:
Arthur B. Singleton Prize
Kaelan is a freshman from Ann Arbor, Michigan. Last summer, she worked for the Escape Room company Decode Detroit designing and building interactive puzzles.

She is a member of the Michigan Triathlon Team, the American Institute of Aeronautics and Astronautics, the Women in Aeronautics and Astronautics student group and the Society of Women Engineers. She will be returning to the Women in Science and Engineering Residential Program next year as a mentor.

Chaaru Raghavan:
Distinguished Achievement Award
Chaaru is a senior from Round Rock, Texas. She is the president of Sigma Gamma Tau and a research assistant in the autonomous aerospace systems lab. She is also involved in AIAA’s Outreach Committee, the College of Engineering’s Undergraduate Student Advisory Board and the Center for Engineering Diversity and Outreach’s mentoring program.

Chaaru is primarily interested in conceptual aircraft design and interned in the product development organization at Boeing Commercial Airplanes last summer.

After graduation, she plans to complete another internship at Boeing before returning to complete her one-year master’s degree in Aerospace Engineering through the SUGS program.

Katie Reichl:
Distinguished Leadership Award-Graduate Students
Katie is a fourth-year PhD student in the Department of Aerospace Engineering. Her research focuses on reducing aircraft vibration by embedding lightweight suppression systems into aircraft structures.

Katie is the co-director of the graduate component of the Society of Women Engineers, where she helps to host networking events, a workshop series, professional development sessions, general social events and outreach activities for elementary school students to promote excitement in engineering. She also acts as secretary for U-M’s chapter of the American Society for Engineering Education, and facilitates workshops for undergraduate students to provide training for software they’re expected to use for engineering classes.

Tyler Sandberg:
A.D. Moore Award
Tyler is a junior from Walnut Creek, California. His interests lie in rocket propulsion. In his spare time, he heads the propulsion team for the Michigan Aeronautical Science Association; in this role, he has spearheaded development of a hybrid rocket engine to power the team’s sounding rocket up to 30,000 feet in national competitions.

After graduation, Tyler hopes to complete a master’s degree before entering industry to work on rocket engines that will power the next generation of human spaceflight.
NEW AE CENTENNIAL SCHOLARSHIP REWARDS 12 OUTSTANDING UNDERGRADS

Michigan Aerospace is excited to share news of the beginning of a scholarship fund — supported by a generous gift from Pratt & Whitney — that will offer tuition assistance for the department’s students. The recipients of the first Aerospace Engineering Centennial Scholarships are highlighted below. Criteria considered in the selection process included academic excellence, leadership qualities, contribution to the culture of the department and financial need. The $2,000 scholarship awards are to be applied to tuition for the Fall and Winter terms.

Nicholas Applegate: Nicholas is a sophomore majoring in Aerospace Engineering. He is currently interested in computational fluid dynamics and its application to aircraft design and analysis. He is a member of the SAE aerospace design team, M-FLY; in this role, he conducts trade studies on body wing and tail configurations, taking factors like taper ratios, wing configurations, wingtip devices and lift/drag coefficients into consideration. He also contributes to the Structures M-Fly subteam, where he uses tools such as CAD and finite element analysis.

Janyu Bhatt: Janyu is a senior with an interest in spacecraft, rockets and propulsion. He aspires to work on developing technology that will facilitate space exploration and place humans on Mars. He is an active member of the Michigan Aeronautical Science Association rocketry team; in this role, he helped to develop the hybrid rocket motor that received second place at the 2016 Intercollegiate Rocket Engineering Competition.

Connor Klok: This past year, senior Connor Klok interned for RATHCO Safety & Supply Inc. as a traffic control specialist. In this role, Connor was responsible for organizing lane closures, construction detours and freeway traffic switches, providing him with an understanding of traffic engineering plans. Since 2015, Connor has been a member of the AIAA U-M Student Chapter Professional Development Committee, organizing workshops for AIAA members to improve their professional communication and networking skills.

Christian Kneubel: Sophomore Christian has a special interest in space systems design. He enjoys contributing to NASA, U-M’s competitive rocket building group, as a member of the propulsion team. Over the summer, Christian conducted research at NASA Glenn Research Center. He investigated atomic oxygen erosion of polymers in low-earth orbit. To do so, he and his team generated computational models of low-earth orbit atomic oxygen from empirical tests, matching their results to data from the International Space Station.

Beldon Lin: Beldon is profiled on page 25.

Steven Marion: Steven is a junior. He enjoys language study and is proficient in both Japanese and French. During his free time, he serves as a peer mentor for the Services for Students with Disabilities Department at Michigan. In this role, Steven attends training workshops and mentors students one on one. He is a member of the National Society of Professional Engineers and the U-M Engineering Dean’s List.

Elliott Miller: Junior Elliott Miller came to Michigan with the dream of becoming an astronaut, but has recently become interested in working in the intelligence sector or on military/defense projects. He is in his third year of study in Russian language and literature, and plans on visiting or studying abroad there in the future. This past summer, Elliott spent a month in Nepal, helping to distribute water filters in the Gorkha district to families near the epicenter of an April 2015 earthquake and trekking through the Himalayas to the base camp of Mt. Everest. During his freshman year, Elliot had the opportunity to row and compete nationally on the Men’s Rowing Team. He has worked for Two Men and a Truck, the university service SafeRide and as an office intern with Cambridge Michigan Language Assessments.

ian O’Rourke: Ian is an aerospace junior pursuing a minor in computer science. He participates in the M-Fly student design team as the avionics lead. This past summer, Ian interned at Space Exploration Technologies (SpaceX) in Hawthorne, California, working on the Falcon 9 rocket. In his free time, he enjoys building and flying remote-controlled aircraft.

Connor Roach: Conner is a junior with a passion for the defense industry. Specifically, he has the desire to work with aerodynamics on high-performance military aircraft. After completing his bachelor’s degree, he plans to continue his education as a master’s student. Conner is currently acting as the initiates chair for Sigma Gamma Tau, and plans to pursue further leadership roles within the organization. In addition to his aerospace involvement, Connor is serving his second year as the philanthropy officer for Alpha Sigma Phi Fraternity; in this role, he has organized charity events that have received recognition from the Office of Greek Life as well as U-M President Mark Schlissel.

Stephen Tyson: Senior Stephen Tyson’s desire to study aerospace stemmed from a lifelong dream of traveling through the vastness of space and watching “Star Trek: The Next Generation” as a kid with his father. He believes that we all have an obligation to be aware of the struggles that affect humanity, other life forms and the planet, and that it is possible to pursue a career while improving the world around us. During his free time, Stephen enjoys tutoring at the Engineering Learning Center, ballroom dancing and skateboarding. He recently received a full-time offer from The Boeing Company.
Chris Weston: Chris is a junior from Houston, Texas studying aerospace engineering with minors in math and music. He is interested in aerodynamics, propulsion, and hypersonics, and currently works as an undergraduate researcher under AE Associate Professor Venkat Raman. Chris is an active member within multiple student organizations, including the student chapters of Tau Beta Pi and the American Institute of Aeronautics and Astronautics and the AIAA Design, Build, Fly team. Outside of class, Chris enjoys running and playing the clarinet in the campus band.

Joshua Wilheim: Joshua is a sophomore looking toward earning a future master’s degree. He has been interested in aircraft and spacecraft since early childhood, when he first started reading books about aviation and visited Cape Canaveral. His interests within the field include controls, guidance and navigation systems for aircraft and spacecraft. He is a member of the multidisciplinary project Secure Cloud Manufacturing, programming “smart” cameras and logic controllers for a small manufacturing testbed. A member of the Michigan Aviators, Joshua loves to fly, having earned his private pilot certificate in high school. In addition to flying, Joshua is the vice president of finance for U-M’s AIAA student chapter, creating budget proposals, tracking club expenditures and organizing fundraising opportunities.

For incoming freshmen, ENGR 100 provides an early glimpse into the world of collegiate engineering design. Though all offerings of this course contain common core elements, such as a central design challenge and technical communication requirements, each section focuses on a distinct discipline ranging from music signal processing to underwater robotics. In Winter 2017, a new ENGR 100 section was implemented that spotlights previously underrepresented topics: atmospheric and space sciences.

The idea for the section stemmed from a discussion between the council of Students for the Exploration and Development of Space (SEDS) and Professor Peter Washabaugh, who saw an opportunity to increase freshman engagement in space research through hands-on coursework. As space science and aerospace engineering are strongly intertwined, Washabaugh considered this enhanced engagement a boon for the entire Michigan aero community.

Arun Nagpal, an electrical engineering junior and co-president of SEDS, ran with the idea. “The impetus for creating this class was to encourage students to get involved in space science and atmospheric sensing,” he explains. “ENGR 100 is supposed to give students an idea of the full spectrum of Michigan engineering options, and I realized [after talking with Washabaugh] that there was no section to convey the work of the Climate and Space Sciences (CLaSP) department. I wanted to introduce freshmen to the idea that the atmosphere is a living, breathing thing of scientific interest.”

Together with CLaSP Professor Aaron Ridley and EE master’s student Abhinav Muralidharan, Arun developed a series of labs aimed at incrementally exposing students to the electrical and software skills they would need to design and program an atmospheric instrument. He notes:

“We took inspiration from the master’s-level space instrumentation course CLaSP 584, which enables students to develop a circuit board with atmospheric sensing capabilities. We took that board and broke it down into discrete parts that could be replicated in weekly labs.

"In this way,” Arun continued, “[students] learned the principles of sensing, [Arduino] coding and microprocessor theory, and ended up with payloads that could measure temperature, humidity, acceleration and pressure.”

Students also had the opportunity to modify their payloads to add additional sensors and functionality. They gained hands-on experience soldering components and experimented with the best approaches to processing their data.

After completing their boards, students had the opportunity to see their instruments in action aboard high-altitude balloons. “We partnered with the Michigan Balloon Recovery and Satellite Test Bed design team for this phase,” Arun explains. The payloads were packaged four at a time, so that teams could reference each other’s data sets and subtract out noise.

The last couple of weeks of the course emphasized flight review and effective data presentation: “The students were able to practice explaining their work by writing technical memos with their labs.”

Overall, Arun feels that this course intimately ties into the mission of SEDS. “SEDS is all about advocating for space and spacelift,” he says. “An important part of that is making sure people have the opportunity to discover a passion for the industry. We wanted to give freshmen greater exposure to space science, with the knowledge that it may influence their eventual choice of major and career.”
AEROSPACE GRADUATE STUDENT RECOGNIZED FOR TOP ACADEMIC ACHIEVEMENT

Aerospace Engineering doctoral student Puneet Singh was recently named the recipient of the College of Engineering’s Richard F. and Eleanor A. Towner Prize for Distinguished Academic Achievement. This award is presented to the outstanding graduate student (master’s or PhD level) in each degree program. Criteria considered by the department awards committee include the student’s active participation in research, leadership and academic performance.

About Puneet

Puneet is a PhD candidate working under the guidance of François-Xavier Bagnoud Professor Peretz Friedmann. His research focuses on the aeromechanics of rotary-wing vehicles, specifically coaxial rotor helicopters. He uses Lagrangian methods to model the wake of rotor blades along with computational fluid dynamics-based, reduced-order models for calculation of loads for vibration studies.

Puneet completed his bachelor’s and master’s degrees in aerospace engineering at the Indian Institute of Technology, Kanpur in 2013. He spent three months at Shinshu University and GEN Corporation in Nagano, Japan, modeling the world’s smallest personal helicopter, as a recipient of the Honda Young Engineer and Scientist Award. Puneet is a recipient of the Michigan Branch of the Telluride Association scholarship. In 2014, he received the Vertical Flight Foundation’s Joe Mallen Scholarship from the American Helicopter Society. He was also a finalist for the GNC Student Paper Competition at the 2014 AIAA SciTech.

Puneet aspires to be part of a future in which vertical lift is a fast, clean, quiet and accessible mode of transportation for everyone.

AE RESEARCHER JARED HOBECk HARNESSES ENERGY FROM PIEZOELECTRIC GRASS

In a world full of motion and solar radiation, energy can be harvested from many natural systems. Why not a field of grass?

Jared Hobeck, a postdoctoral research fellow in Professor Daniel Inman’s Adaptive Intelligent & Multifunctional Structures Lab, is harnessing the movement of synthetic grass blades in wind to generate energy to power small electronics and in situ sensors.

His grass blades, which are little more than thin vertical sheets of metal, use the direct piezoelectric effect to convert the swaying motion of grass into electric pulses. Jared explains the origin of this research, which was featured on episode 105 of the TV show “Nature Knows Best”: “SAIC [Science Applications International Corporation] released a very open-ended design request; they wanted something to harvest energy in low-velocity, highly turbulent fluid flow. I submitted four ideas, three of which followed more
traditional turbine/propeller-type
designs and one which I considered
out-of-left-field (the grass design).
They surprisingly asked me to pursue
that [unconventional] one.”

Jared’s initial concept for the piezoelec-
cric grass stemmed from observations
of natural systems.

“For inspiration,” he says, “I started
watching videos of things moving in
wind and water: seaweed, sea grass,
leaves, different types of turbines and
vortex-induced vibration generators. I
realized that [energy harvesting] devic-
es like turbines are a one-shot deal —
if some mechanical parts get tangled
in debris or break, the machine won’t
produce power. However, with grass,
there is a built-in redundancy — if a
single piece fails, the rest can remain
in motion. It’s a simple, outside-the-
box solution.”

To characterize the power production
capabilities of his grass design, Jared
placed a small array of the grass in
a wind tunnel. Initially, the system
was a bit finicky, requiring specific
wind speeds and turbulence patterns
to produce energy. However, after
experimental testing in Michigan’s
2’ x 2’ wind tunnel, Jared’s team had
a breakthrough: they realized that
above a critical wind speed, the “field”
of grass would achieve a state of
resonance in which large, synchronized,
wave-like motion was caused by the
array’s own self-sustaining turbulence.
Notes Jared: “This property was
completely unexpected and exactly
the selling point we needed to make
our piezoelectric grass design viable.
Before, all the energy production was
localized to a specific part of the array;
this new discovery meant that the
entire array could achieve and maintain
significant levels of energy production.
Interestingly, this same phenomenon
of grass resonance] has been documented
in agricultural journals. Farmers noticed
that their crops were being destroyed
when they achieved a certain resonant
motion in the wind that exceeded their
stress limit.”

Moving forward, Jared is considering
further experimentation with the
geometry and configuration of the grass
blades to optimize their power produc-
tion. Initial exploratory experiments
suggest that a simple orientation of the
piezoelectric grass in rows and columns
could be the most efficient.

Jared envisions widespread appli-
cations for this technology. Due to
its inherent redundancy and minimal
required maintenance, these grass-like
arrays could be placed in remote loca-
tions, both on land and underwater, to
power scientific instruments or sensors.
They could also be scaled to fit inside
ventilation systems and other regions
of airflow to power cell phones and
other small electronics.

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Three Aerospace Engineering PhD
Candidates Receive Amelia Earhart
Fellowships

Aerospace PhD candidates Devina Sanjaya (front row left), Pinar Acar
(middle) and Sarah Cusson (right) were selected as recipients of the
prestigious Zonta International Amelia Earhart Fellowship.

Zonta International established the Amelia Earhart Fellowship in 1938
in honor of legendary pilot and Zontian, Amelia Earhart. The fellow-
ship is intended to support female contributions to aerospace-related
sciences and engineering. Today, the Amelia Earhart Fellowship of
$10,000 is awarded annually to 35 talented women pursuing PhD/
doctoral degrees in aerospace-related sciences or engineering
around the globe. Since the program’s inception, Zonta International
has awarded 1,508 Amelia Earhart Fellowships with a value totaling
more than $9.3 million, to 1,079 women in 70 countries.

About Sarah
Sarah is a NASA Space Technology
Research Fellow and graduate stu-
dent researcher in the Plasmadynam-
ics and Electric Propulsion Laboratory
led by Professor Alec Balimore, dean
of engineering. She is investigating
high-powered Hall Effect Thrusters
for space applications. Previously,
Sarah worked as a structures and
propulsion engineering intern at The
Boeing Company and as a graduate
student research scientist at the Air
Force Research Laboratory.

About Pinar
Pinar is a graduate research
assistant under Associate Professor
Veera Sundararaghavan in the Multi-
Scale Structural Simulations Labo-
atory. Her research focuses include
spatio-temporal reconstruction of
2D and 3D microstructure evolutions
using the Markov Random Field
approach; reduced order modeling
for optimization of microstructures
under process-design-property con-
straints; and probabilistic modeling
of microstructural property descrip-
tors and property closures. She
previously received her bachelor’s
and master’s degree in aerospace
engineering at Istanbul Technical
University.

About Devina
Devina is a François-Xavier Bagnoird
Fellow under Associate Professor
Chris Fidkowski. Her research
interests include the development of
algorithms to improve the robustness
and accuracy of computational fluid
dynamics methods, error estimation,
uncertainty quantification, adaptive
methods and parallel computation.
She is currently working on develop-
ing a novel algorithm for generating
high-order, curved meshes. In 2015,
Devina received the Best AIAA Stu-
dent Paper Award in CFD as well as a
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Aerospace engineering is not just relegated to the realm of planes and spacecraft. It permeates everything where aerodynamics are relevant, including the design of high-performance sports equipment. Kyle Hanquist and Kevin Neitzel, then both AE PhD students, proved that when they competed on the 2016 season of the Golf Channel series “Driver vs. Driver.”

As one of the show’s 11 finalist teams, Kyle and Kevin (“Team Michigan”) worked with Wilson Lab engineers to design, test and refine a high-performance driver that would win the support of a panel of judges. The prize included $500,000 and the chance to see their driver commercially sold under the Wilson Staff name.

As Kevin explains, the duo’s involvement on the show stems from their entrepreneurial attitude: “Before hearing about the competition, [Kyle and I] were already interested in market applications for our [aerospace] research. We participated in the National Science Foundation’s Innovation Corps program that taught us to pitch and sell our ideas to a non-technical audience. We actually learned about the ‘Driver vs. Driver’ competition through a line item in a College of Engineering email while we were traveling in Europe to I-Corp conferences. The more we thought about it, the more the competition seemed like a perfect opportunity to mix engineering with our mutual hobby, golf.”

In developing their proposal, Kyle and Kevin focused on one of Wilson Staff’s central tenets — innovation. Kyle notes: “When you talk about innovation in golf, you think of the shift from wood to metal drivers. You think of adding dimples to golf balls. Today, the strict regulations of the USGA [United States Golf Association] close the box a little on huge transitions like that. Still, Wilson was looking for a driver that gives a large jump in performance.”

To achieve this performance jump, Team Michigan grounded their design approach in aerodynamics principles. As researchers in Professor Iain Boyd’s Nonequilibrium Gas and Plasma Dynamics Lab, Kyle and Kevin were accustomed to using computational fluid dynamics techniques to model high-speed systems. They applied these same techniques to the design of their driver. “When we were designing our driver,” Kyle explains, “we used CFD to see how we could change the shape of the driver to reduce its drag. We used the wind tunnel [at Michigan] to test our design. We printed a 3D model of our driver, and were able to smooth and sandpaper certain parts to see how the airflow reacted. We looked for features that kept the airflow attached, indicating drag inducing separation.”

As two of the few engineers among the finalists, Kyle and Kevin considered their computational background an advantage: “Engineers like looking at the numbers, which is a lot of what this competition is about. We knew we could create a great performing driver with low drag, a good moment of inertia and an ideal weight. Aerodynamics is a big focus in golf today.” —Kyle Hanquist

Though their design cycle resembled that applied to traditional aerospace systems, the team was forced to keep some additional factors in mind. “When you are designing and working with sports equipment, aesthetics mean a lot more,” says Kevin. “For aerospace, it is almost purely about function. However, with golf clubs, it’s as much about buyer perception. People have to like the look and shape of your driver. If [your aesthetic] is wildly different, it may throw people off and affect the player/club relationship.”

Though the pair didn’t win the ultimate prize, the competition afforded them a unique opportunity to apply their research to a commercial environment. To Kevin, “our goal was to do our best, enjoy the experience and make the university look good.”

Kyle and Kevin formally presented their design analysis in a publication titled “Aerodynamic Optimization of a Golf Driver Using Computational Fluid Dynamics” at the AIAA SciTech Forum this past January. They have also collaborated in establishing an Ann Arbor aerodynamics design firm called Smart Blue Innovations.
FIVE MICHIGAN UNDERGRADUATES ATTEND “WOMEN IN BLUE: A PROFESSIONAL SYMPOSIUM” AT BLUE ORIGIN

The Women in Blue: A Professional Symposium, sponsored by space-flight services company Blue Origin, began with a sobering statistic: Only 15 percent of employees in the aerospace workforce are female. The symposium emerged from the desire of Blue Origin’s leadership to improve this figure through directed efforts to engage and network with students at the university level.

Of the two dozen university students in attendance at the November 2016 gathering, five were associated with U-M’s undergraduate engineering programs (left to right): Rebecca Martin, Ariel Sandberg, Kelly Henckel, Becky Hill and Valerie Chen.

These students hailed from numerous research groups across the aerospace department. Rebecca, Ariel and Valerie are contributors to the Michigan Exploration Laboratory under Professors James Cutler and Peter Washabaugh. Kelly is a researcher who works in the Autonomous Aerospace Systems Lab of Professor Ella Atkins. Becky works for the Adaptive Intelligent and Multifunctional Structures Lab with Professor Daniel Inman. As Kelly, co-founder of U-M’s Women in Aeronautics and Astronautics (WAA) group with Rebecca, Ariel and Becky, explains, “Coming from a department that does not have a significant representation of women, it was very valuable to connect with other women in the industry. Conferences like [Women in Blue] give us the opportunity to ask these women the questions that impact our daily campus lives: ‘How do you cope with being the only woman on the team? How do you handle feeling like you are being treated differently?’”

Throughout the day, speakers gave presentations that spotlighted female leadership and expertise in the industry. They spoke of the strategies that enabled their professional voices to be consistently and deliberately heard, and of their determination in the face of difficult odds.

The UM WAA delegation was eager to absorb lessons that might increase female engagement in Michigan’s aerospace program. Kelly continues: “One part that especially resonated with me was the discussion by representatives of Olin College, where women make up the majority of their mechanical engineering students. They talked [at length] about mentorship initiatives within their department. A lot of these initiatives are focused on promoting a sense of inclusion among freshman women [through practices such as putting at least two women on project teams] and having students set individual goals at the beginning of group tasks that push them to experiment outside their conventional gender-based roles.”

For Rebecca, inspiration could be found in the stories of women like keynote speaker Anousheh Ansari, founder of the Ansari XPRIZE and the first self-funded woman to travel to the International Space Station. “Dr. Ansari has incredibly ambitious life goals,” explains Rebecca, “and she just goes for them. She doesn’t ask permission, doesn’t look left or right or question her dreams. I entered aerospace with the hope of becoming an astronaut, and the fact that Dr. Ansari got herself to space has given me even more drive and motivation to do so.”

Given the level of gender imbalance in the aerospace field, it is unlikely that any conference will produce immediate change. However, U-M’s WAA officers hope that each event helps to establish the foundation of dialogue and increasing visibility that is necessary to stimulate recruitment and retention in the future.

FRANCISCO KULYCKIJ RECEIVES AEROSPACE’S DISTINGUISHED LEADERSHIP AWARD

Graduating senior Francisco Kulyckij was selected as the recipient of the Distinguished Leadership Award “for exemplary leadership in the department and for positively influencing peers in class and within extracurricular organizations.” The leadership award is annually presented by Sigma Gamma Tau, the aerospace honor society, in conjunction with U-M Aerospace faculty.

About Francisco

Francisco was born in Buenos Aires, Argentina and later lived in Venezuela and Florida. He has been a resident of Michigan for the past 10 years. Upon graduation, he will be starting a full-time job with Boeing Commercial Aircraft in Seattle as an aerodynamics configuration engineer in the Flight Sciences group.

During his time at U-M, Francisco was involved in M-Fly, SGT and AIAA. He dedicated most of his time to M-Fly, the university’s largest design/build/ fly project teams. Over the years, he acted as construction manager, aerodynamics lead and team captain. He also volunteered for SGT, which he served as social chair, internal vice president and president. In his free time, he enjoys cooking, reading, traveling and hanging out with friends; he’s also a soccer fanatic. Every Sunday, he watches his favorite Argentine team play on TV.
They’re calling it the first time capsule in space. Under the mantle of the university’s bicentennial, a team of students is building a small satellite called a CubeSat, containing interviews from 1,000 members of the U-M community as well as an experiment to test DNA as a medium for storing data in space. Their goal is to enable the satellite to orbit the Earth for 100 years—until the university’s tricentennial celebration.

The Michigan Bicentennial Archive (M-BARC) team believes that time capsules do not have to be buried in the ground. As their website explains, “Like history itself, a time capsule should be alive, a thing of power and will. It should wrestle against the laws of nature and, in turn, its recipients must do the same.”

One of the biggest challenges that the team faces with its project relates to radiation. Radiation wreaks havoc on digital data. Data printed onto CDs is safe, but the storage medium is too big. So the team is working with the university’s Lurie Nanofabrication Facility to nanoprint 8 to 30 GB of data on a 1-inch silicon chip. At least 10 chips will be placed at different orientations in the satellite to provide backups in case of collisions.

Radiation could also impact the team’s DNA experiment, which tests the genetic code’s ability to store information in space. One microgram of DNA can hold 900 terabytes of data—equivalent to 11,000 iPhones. The team had tried to encode the Michigan fight song into the DNA, but had no luck. According to Christopher Twilling, team lead of sequencing, “the fight song is redundant within itself, [so] it read like cancer to the DNA.” Instead, the team will use U-M’s mission statement.

Future Michigan scientists will be able to see how well the synthetic DNA holds up. “They’ll know exactly what the sequence should be, and be able to see how much it is messed up after 100 years,” said faculty lead Aaron Ridley, a professor in the Department of Climate and Space Sciences and Engineering.

Building the satellite might have been the easiest part, if it didn’t need to
stay in Earth’s orbit for a century. From the moment it launches, the satellite’s orbit will start to decay. It wouldn’t last 20 years, let alone 100, without a propulsion system. “Small satellites typically don’t have propulsion,” Ridley said. “There’s just not room for a lot of fuel.”

The team is currently comparing electrical and chemical thruster systems to solve that problem.

The original idea for M-BARC was to design the payload and send the time capsule to the moon, an idea proposed by Thomas Zurbuchen, a former U-M planetary science professor who is now head of NASA’s Science Directorate. “That’s probably why it was so appealing to engineering students. It was achievable!” said Kevin Tebbe (MSE ’16), former student lead and one of five founding team members who worked on feasibility studies.

As the team grew to 30 students across 20 majors (all part of the Multidisciplinary Design Program), so did its ambitions. Students took on the challenge of designing the satellite and orbit pattern themselves, in addition to the ISR-approved DNA experiment and the capture and encoding of 1,000 interviews. Finishing all of these elements in concert over the next two years will require persistent progress from students in engineering, science and liberal arts disciplines as well as the expertise of faculty, staff and scientists across the globe.

The team expects to begin construction of the payload portion of the CubeSat during the Winter 2017 semester. The payload includes the DNA experiment and data chips containing the interviews.

M-BARC will actually launch two satellites. The first, expected in late 2017, will be a test vehicle, about a third of the size of the eventual CubeSat. To facilitate the test, the team will use a free launch—worth approximately $150,000—that they earned from the United Launch Alliance. As part of the launch grant, the U-M team will build the electrical and most of the structural components of the satellite and work with students from Ypsilanti High School’s STEM/Middle College to develop its structural fabrication.

Ultimately, in the next century, U-M hopes to retrieve the time capsule by using a laser to locate the satellite’s built-in reflectors.
ALUMNI NEWS
MICHIGAN ALUM EVAN HILGEMANN DEVELOPS INNOVATIVE SPACE EXPLORATION TECHNOLOGY FOR NASA

As an engineer at the NASA Jet Propulsion Laboratory (JPL), Evan Hilgemann (MSAE '15) is drawing on hands-on experience he gained as a Michigan Aerospace Engineering graduate student to develop innovative space exploration technologies, including small satellites and exoplanet observational tools.

Hilgemann first gained exposure to small satellites as a graduate research assistant for the Michigan Exploration Laboratory (MXL), a leading CubeSat development group under AE Professor James Cutler. At JPL, Hilgemann worked as the mechanical lead for a large-aperture CubeSat antenna designed to measure high-frequency radio signals from low-Earth orbit. As Hilgemann notes, “In MXL, I was focused on guidance, navigation and control and attitude determination control systems; for the JPL CubeSat mission, I was doing mechanical design. Though the specific problems were different, my MXL research familiarized me with the process and mindset of working on smaller spacecraft, which was very valuable.”

Since delivering the CubeSat hardware, Hilgemann has joined the “Starshade” development team. JPL’s Starshade is designed to enable direct observation of planets outside our solar system by blocking out the light of a distant star around which a dim “exoplanet” is orbiting. This can be visualized as using your hand to block out the light from a bulb to see a small bug buzzing around — except that the bulb is 1 billion times brighter than the bug. “In the same way that, at the beginning of the 1900s, we began having a decentralized view of our galaxy,” he explains, “we are having a growth of perspective now. We are understanding that there are planets outside our solar system, and with technology like Starshade, we can study them.”

To achieve its goal of blocking out distant starlight for an on-looking telescope, the Starshade must be precisely fabricated. This comes with a unique set of technical challenges. “The petal shape of the Starshade is designed to prevent light from diffracting around the edges and into the telescope,” says Hilgemann. “If your Starshade was circular, your telescope would see rings of light that would totally wipe out the visibility of the planet. To get rid of that effect, you need to manufacture the Starshade to very specific tolerances.”

How specific? The perimeter of the petal has a profile tolerance of 100 microns, or about the width of a human hair. The radius of the edge of the petal has to be even more precise, with a tolerance of only 1 micron. To accommodate these strict requirements, Hilgemann and his
team members have had to be careful about the materials and processes that they implement. “Right now, we are looking into amorphous metals,” he explains. They don’t have a crystal structure, which gives them the benefits of both metals and ceramics in one package. Because they don’t have grain boundaries, the etching process can be done very uniformly and doesn’t result in jagged edges [that could scatter light].”

Moving forward, Hilgemann is eager to gain exposure to new aspects of mission development. “Coming off my CubeSat work, I am interested in gaining some broader experience with flight design,” he says. “Starshade is a very hands-on, active prototyping environment. I hope to be able to bring the design to maturity [for potential use on missions like the WFIRST telescope], which should be an interesting challenge.”
AERO GRAD JEFF FROSTER TURNS INTERNATIONAL ENTREPRENEUR

While studying aerospace engineering at the University of Michigan, Jeff Froster (BSAE ’99) could not have anticipated his unique career evolution. Today, he is an international entrepreneur, leading an innovative, low-energy building services firm in Perth, Australia.

From the start, Froster had a passion for solving problems holistically. (Early internship experiences, in which he was required to approach problems as small parts without the ability to engage in broader system development, left him cold.) After graduation, Froster applied his aerospace critical thinking and communication skills to a new field: building services. Over the next four years, he gained greater exposure to sustainable building design, ultimately receiving his Professional Engineering certification.

At that time, Froster grew wary of the increasing economic stagnation he observed in local industry. He received some unexpected advice: take a working holiday abroad.

Thus, in 2004, Froster found himself leaving his stable Michigan life for New Zealand. Initially, he was struck by the differences in hiring cultures between the United States and New Zealand. From his experience, interviews in the United States were exceedingly rigid and focused on fact-recall, whereas New Zealand firms seemed to prioritize temperament, compatibility and company fit. Beginning with an initial consultancy position in Wellington, Froster rapidly gained extensive experience as a mechanical engineer for several high-profile building firms and on numerous defense projects.

In 2012, he struck out on his own, founding Froster Engineering to tackle the industry problems that he had seen throughout his career. He looked to his aerospace background to provide inspiration. “The aerospace industry is by nature team-oriented, and requires that project performance be looked at from a holistic standpoint,” he explains. “It would be absurd to design a Boeing passenger aircraft without considering engineering performance and passenger comfort. Alternatively, in the building industry, it feels a bit archaic — everyone is specializing more and more, which means everyone is seeing an increasingly smaller and smaller picture. For example, architects are kept out of the conversation on engineering form, meaning they don’t have the ability to make a sustainable design given their limited understanding of building physics and thermal performance.

“I wanted to make the building industry more like aerospace and bring the developer, engineer and architect all into the discussion together early on.”

So far, Froster’s vision has been well-received. “I recently worked with a developer,” he notes. “I spoke candidly to him about all the technical elements of the design — the building standards, the heat loads, the [structural] design — and he started to open up about his concerns. This kind of dialogue is critical.”

Reflecting on his international journey, Froster advises current students to “put yourself out there. Be confident in your skills and where you come from — a degree from Michigan goes a long way. [Traveling abroad can] throw you in the deep end and outside your comfort zone, giving you the ability to take on new challenges. Try to think about the bigger picture and resist following the norm.”

In 2014, Froster founded the U-M Alumni Club of Australia. Since then, the club has hosted an annual meetup to watch the Michigan-Ohio State football game — at 3:00 a.m. his time. As he explains, “The club gives us an opportunity to network and feel a sense of home.”
This year marks the 50th anniversary of the first fatalities in America's space program: the Apollo 1 mission crew of Virgil “Gus” Grissom, Roger Chaffee and U-M’s Edward White (MS '59).

On January 27, 1967, the Apollo Command and Service Module experienced a catastrophic failure while undergoing a launch rehearsal test at Cape Kennedy Air Force Station Launch Complex 34. The module was intended to launch three weeks later on February 21, 1967, as a foundational flight in NASA's ultimate quest to the moon. During this rehearsal test, a fire broke out in the Apollo cabin; in the five minutes it took for the cabin to be unsealed, the crew had perished. The failure resulted in key mechanical and procedural alterations that laid the groundwork for improved safety and success in successive Apollo missions. The cabin atmosphere was changed from 100 percent oxygen to a less combustible mixture of oxygen and nitrogen. Flammable materials were removed from the cabin, and the capsule's hatch design was modified to allow for quick evacuation in case of emergency. Institutionally, a separate safety organization was established within NASA to ensure objective and rigorous mission safety assessments.

**ABOUT WHITE**

The son of a career military pilot, White was immersed in aviation from a young age. By the age of 12, he had controlled a T-6 trainer under the guidance of his father, and his passion only increased over the years. In 1952, he received a bachelor of science degree from West Point, and rose to the position of lieutenant colonel in the US Air Force. He spent almost four years in Germany as a member of a fighter squad, flying F-86 Sabre jets and F-100 fighter jets.

In 1957, White decided to work toward joining America’s elite astronaut corps. Believing an advanced degree would make him a more competitive candidate, he enrolled at the University of Michigan for graduate school. In 1959, White received a master's degree in aeronautical engineering. He also enrolled in Air Force Test Pilot School, serving as a test pilot in the Aeronautical Systems Division at Wright-Patterson Air Force Base in Ohio.

In 1962, White's dream was realized: He was selected as an astronaut for Project Gemini, the follow-up program to Mercury. He specialized in the development of flight control systems, a role he greatly enjoyed for the opportunity it afforded him to incorporate "the pilot's own touch" into the spacecraft design.

On June 3, 1965, White — the pilot of the Gemini 4 mission — made history as the first American to walk in space. He conducted an extravehicular activity during the spacecraft’s third revolution of the Earth.

In 1966, he was named as one of the pilots of the Apollo 1 mission.

Left to right: Virgil Grissom, Edward White, Roger Chaffee. Image: NASA
THE BLETSOSES ESTABLISH UNDERGRAD SCHOLARSHIP FUND

Nikolas (BSE Aero ’68, MSE ’69, MSE ’75, PhD ’76) and Denise Bletsos recently made a gift to establish a scholarship fund for the Department of Aerospace Engineering. The Nikolas A. and Denise A. Bletsos Endowed Scholarship Fund will provide need-based support to Aero undergraduates. This gift qualifies for the Bicentennial Opportunity Matching Initiative.

With an interest in airplanes and space flight, Nikolas Bletsos emigrated to the US in pursuit of these passions. In industry, he first worked on the space shuttle for Rockwell International and later as an employee of The Aerospace Corporation, where he specialized in the areas of launch vehicles and upper stages, including new designs of shuttle-type vehicles. As director of the guidance analysis department, he advised the US government on the military side of the space program. A proud alumnus and ardent supporter of the Department of Aerospace Engineering, Bletsos served on Aero’s Industrial Advisory Board for many years, and was the 2005 recipient of the College’s Merit Award for the department.

His wife, Denise, contributed to both NASA and Department of Defense space programs while employed by Rockwell International (later Boeing). She was in charge of strategic planning in support of the space shuttle, satellite systems and space communications projects, spanning a broad spectrum of space-related civilian and military activities. She holds a BA Honors degree from a university in the UK, as well as an MS from the University of California, Irvine.

FORMER AEROSPACE FACULTY MEMBER DANIEL SCHEERES ELECTED TO NATIONAL ACADEMY OF ENGINEERING

Michigan alumnus (BSAE ’87, MSAE ’88 and AE PhD ’92) and former U-M aerospace faculty member Daniel Scheeres has been elected to the 2017 class of the National Academy of Engineering (NAE). Scheeres was honored by the NAE for his “pioneering work on the motion of bodies in strongly perturbed environments, such as near asteroids and comets.” He is also the radio science lead and co-investigator for NASA’s OSIRIS-REx asteroid sample return mission.


Among his many additional accolades, Scheeres is a fellow of the American Institute of Aeronautics and Astronautics as well as the American Astronautical Society. Asteroid 8887 is named “Scheeres” in recognition of his contributions to the scientific understanding of the dynamical environment about these rocky bodies.
Final Faeth lecture features Vigor Yang

Over the course of its history, the Michigan Aerospace department has been shaped by a continuum of passionate and visionary faculty and students. Since 2008, the department has recognized one especially transformative figure through an annual memorial lecture series: Professor Gerard “Jerry” Faeth.

In the spirit of Faeth’s seminal research in combustion science, heat transfer and aerospace engineering, Vigor Yang, chair of the School of Aerospace Engineering at Georgia Institute of Technology, was invited to deliver a Faeth Memorial Lecture address — the last in a series of 10.

His lecture coupled deep technical content with reflective tributes on the professional and personal impacts of Faeth. Yang offered insights into “Data-Enabled Design for Combustion Dynamics in Propulsion Engines,” discussing approaches to developing efficient and robust capabilities to understand, analyze and predict combustion dynamics in contemporary and future propulsion systems (See more information on page 7.) An incredibly accomplished combustions scholar in his own right, Yang recounted his early encounters with Jerry Faeth: “I took a course from Jerry in the summer of 1979 [at Penn State University] — that was not an easy summer for me. For those who did not know him well, Jerry could seem intimidating. But, if you were humble enough, you could learn from his high-powered lectures. For those who met Professor Faeth, he was tall. It was so easy to ‘look up to him,’ so easy for us to develop a wonderful respect and admiration for him, and I say that from the heart and not just the mind.”

In addition to the lecture, a tribute video was compiled with anecdotes from Faeth’s former colleagues and students — many of whom are now established industry leaders and researchers. Dean of Engineering and Aerospace Professor Alec Gallimore provided one such testimony. “The person who was the most influential to me was the late Professor Jerry Faeth,” he said. “Jerry was a titan in his field, without a doubt, very respected, feared by many, and he took me under his wing. He was actually the person who helped shepherd my promotions. I viewed him very much as a mentor, and I emulated some of the things I did based on how he operated and the leadership he demonstrated within the department and the university.”

Jerry Faeth’s daughters — Christine Faeth, Ellie Damo and Lori Faeth — were in attendance, and were gifted with a plaque in honor of their extended support of and collaboration with the Michigan Aerospace department. After the lecture, a poster session was held in the FKB atrium showcasing research directly grounded in Faeth’s breakthroughs and intellectual legacy.

M250 ENGINE JOINS HARDWARE DISPLAYED IN FXB ATRIUM

At the AIAA Region III Student Conference on April 1, a new addition to the François-Xavier Bagnoud Atrium was unveiled: a Rolls-Royce M250 aircraft engine.

First flown in 1961, M250 engines have been installed in more than 170 aircraft types, ranging from military and civil helicopters to unmanned US Navy surveillance helicopters.

The engine is on loan from the archives of the Rolls-Royce Allison Heritage Trust Museum in Indianapolis, Indiana. Rolls-Royce’s increasing collaboration with Michigan Aero has been spearheaded by U-M alumnus Kathryn Elliot (BSME ’83), chief of system performance and operability at Rolls-Royce, and Daniel T. Jensen, head of engineering for services. The engine was presented by Rolls-Royce engineer and U-M alumnus Ben Harter (BSAE ’05). At the unveiling, Aerospace Chair Dan Inman noted, “In our department, we try to solidify the applications of our theory courses through labs and other hands-on work. It is always wonderful to have a great piece of hardware to inspire our students and faculty alike.”

YOU ARE INVITED

HOME COMING LUNCH & CENTENNIAL MOON TREE DEDICATION CEREM ONY

Friday, October 27, 2017 at Noon
François-Xavier Bagnoud Building & Courtyard

Michigan Engineering Homecoming Weekend is the perfect opportunity to visit campus to reconnect with friends and former faculty, interact with student teams, celebrate alumni of distinction, enjoy a delicious tailgate and rediscove the College of Engineering.

This year’s lunch will include a special Centennial Moon Tree Dedication Ceremony. T-shirts will be available for purchase to memorialize the event. See you there!

RSVP by October 20 at: bit.ly/2vlcEoD

A Rolls-Royce M250 engine is added to FXB’s collection. Photo: Ariel Sandberg
CELEBRATING SUCCESS: NAE INDUCTEE JAMES HUBBARD VISITS U-M

On February 9, 2017, James E. Hubbard, Jr., the Glenn L. Martin Institute Professor at the University of Maryland, visited U-M Aerospace Engineering to deliver a graduate seminar titled, “An Ethological Approach to SUAVs for First Responders,” exploring a control architecture for human-robot interaction that mimics the relationship between service canines and rescue teams. (See more on his lecture on page 7.)

Hubbard is a fellow of AIAA and the American Society of Mechanical Engineers, is credited with more than 150 technical publications and 24 US and worldwide patents and, in 2016, was inducted into the National Academy of Engineering.

James Hubbard was born on December 21, 1951 in Danville, Virginia. The son of a civil rights worker, he had a tumultuous childhood of acute exposure to America’s racial tensions. At 11 years old, he moved with his family to Baltimore, Maryland, where a critical chapter of his life began. There his mother, seeking to focus his energies in an organization like the Boy or Sea Scouts, mistakenly enrolled him in Sea Cadets, a youth organization associated with the US Navy. Reflecting on his experience, he noted, “I learned discipline, how to be fearless, a love for country and confidence. I was taught to never give up, not even when you’re down and out.”

Following high school, he earned a marine engineer license and served as one of the first black engineers at sea. He also spent a year in Vietnam with the Merchant Marine.

Returning to the United States, Hubbard began his undergraduate studies at Morgan State College and later transferred to the Massachusetts Institute of Technology (MIT). Hubbard characterized the intensity of his first weeks at MIT as “drinking water from a fire hose.” He found himself ill-prepared for the transition, and struggled academically. After an encounter with the police, Hubbard met with his department chair, half-expecting to be expelled. Instead, the two worked to establish a support group at MIT to help black students achieve their academic goals.

As his education progressed, Hubbard was identified as a strong candidate for a faculty position in the institute’s college of engineering. At the conclusion of his third degree, Hubbard became an assistant professor in mechanical engineering.

During a break from academia, Hubbard held research positions in the private sector and launched two companies of his own. In 2004, Hubbard accepted an offer from the University of Maryland to return to teaching and to direct its Center for Adaptive Aerospace Vehicle Technology/NIA. In the years since, Hubbard has had many impactful interactions with students that fueled his ongoing passion for mentorship. “Without the mentors I encountered in my life,” he explains, “I would not be here today.”

REMEMBERING TRAILBLAZER WILLIE HOBBS MOORE, FIRST AFRICAN AMERICAN WOMAN TO RECEIVE A PHD

As the first African American woman to earn a PhD in physics from any American university, Willie Hobbs Moore was a trailblazer in both the national and local Michigan technical community. She received three degrees from the University of Michigan (BSEE ’58, MSEE ’61, PhD Physics ’72), specializing in the secondary chlorides of polyvinyl-chloride polymers for her doctoral studies.

Moore was born on May 23, 1934 in Atlantic City, New Jersey. A first-generation college student, she entered the University of Michigan in 1954, the same year of the landmark Brown v. Board of Education desegregation ruling. She progressed through Michigan’s undergraduate and graduate electrical engineering programs, ultimately working under noted infrared spectroscopist Samuel Krimm for her physics doctoral studies.

From 1972 to 1977, Moore authored over 30 papers with Krimm and collaborators; she was published in a myriad of scientific journals, including the Journal of Molecular Spectroscopy, the Journal of Chemical Physics, and the Journal of Applied Physics. Throughout her career, Moore held engineering positions at Bendix Aerospace Systems Division, Barnes Engineering Company, Sensor Dynamics Inc. and the Ford Motor Company, where she rose to an executive position.

Since her passing in 1994, the Willie Hobbs Moore Award has been curated by the Women in Science and Engineering (WISE) organization in her honor. In 2016, Aerospace Engineering Assistant Professor Dimitra Panagou was a recipient of this award for her technical contributions and outstanding student mentorship.
Looking beyond: Author Margot Lee Shetterly discusses modern resonance of NASA's “Hidden Figures”

Countless individuals have helped shape the character of the University of Michigan across its 200-year history. Unfortunately, some of these influential figures have remained hidden, obscured by time and the social constructs of their eras. One focus of CoE’s celebration of Michigan’s bicentennial is to shed light on this embedded diversity and the quiet heroes behind engineering’s greatest triumphs.

On January 24, Margot Lee Shetterly, author of the book “Hidden Figures,” delivered a keynote address at U-M discussing the lives and impact of the female African American mathematicians who helped America win the space race. Shetterly estimated there may have been up to 1,000 women working for NASA as “computers” (mathematicians) in the 1960s, making the essential calculations that enabled America’s journey into orbit and, eventually, to the moon. Though acknowledging each of these women individually “would have taken an encyclopedia,” Shetterly identified a common thread amid their stories. She noted that “one of the motifs in the movie is ‘looking beyond,’ referring to the innovative mathematics that was needed to calculate [the Apollo mission] trajectories. But that phrase has multiple layers of meaning. [It refers] to what the real-life women had to do just to work at NASA [and] what they had to do to receive excellent educations. … [Their] goal was not to stand out because of differences, but to stand out because of their talent. They had to stand together with their colleagues to do something that had never been done before.”

In addition to the three trailblazing women detailed in the movie adaptation of “Hidden Figures” — Katherine Johnson, Mary Jackson and Dorothy Vaughan — Shetterly spoke of several prominent University of Michigan alumnae, including Dorothy Hoover (PhD ’55). “Dorothy was a human computer at Langley Laboratory,” she explained, “who worked closely with Robert T. Jones. Prior to joining NASA, she had been a teaching fellow at U-M, and in 1950, was promoted to an aeronautical research scientist. I would also be remiss not to mention Michigan grads James Williams and Terrance Byrdsong, who were [among] the first black men hired as engineers at NASA.”

In her talk, Shetterly emphasized the necessity of discussing these individuals not as “exceptional,” but as “extraordinary” ordinary people. “Our job is to recognize the power in the people we encounter every day,” she said. “The Einstein archetype is a stubborn thing; it no doubt contributes to the problem we have with filling the pipeline. Once we see these women and really value their contributions, we have an obligation to tell their stories. They determine both our futures and the meaning of our past. They never lose their ability to change how we see others and how we see ourselves.”

Moving forward, Shetterly believes it is essential that the lines between social identities continue to be blurred: “It’s tempting to slot ‘Hidden Figures’ into black history or women’s history. We tend to talk as if they are totally removed from American or military or space history. Aviation history cannot be told without discussing African Americans and women in engineering. … Only now are our eyes sharp enough to truly see and understand their contributions.”
The University of Michigan has eagerly embraced expanding diversity in the aerospace industry. This feature, which appeared in the departmental newsletter in honor of National Women's Month, takes a look at the past and trailblazers of the aerospace department.

THE PAST: FIRST FEMALE AEROSPACE ENGINEER

Elizabeth “Elsie” MacGill was a woman of seemingly innumerable “firsts.” In 1927, she became the first woman to receive an electrical engineering degree in Canada, from the University of Toronto. MacGill became the first woman in North America — perhaps even the world — to receive a master’s in aerospace engineering (University of Michigan).

In 1929, MacGill was afflicted with polio, a condition that she was told would leave her unable to walk. During her recovery, she wrote numerous aviation articles and pursued a doctoral degree at MIT. Steadily gaining a reputation as a formidable engineer, MacGill was appointed in 1938 to the position of chief aeronautical engineer of the Canadian Car and Foundry Company. There she designed the Maple Leaf II trainer, becoming the first female aircraft designer in the world. During World War II, MacGill led production of the Hawker Hurricane fighter airplanes, which earned her the nickname “Queen of the Hurricanes.” Her success in this role garnered such international attention that a comic book was published in the United States in her honor. During this time, MacGill also developed solutions for the winter operation of airplanes, including deicing protocols and retrofit skis for snow landings.

In 1953, Elsie MacGill received the Distinguished Achievement Award from the Society of Women Engineers. In 1971, she was awarded the Order of Canada for her “services as an aeronautical engineering consultant and as a member of the Royal Commission on the Status of Women.” In 1983, she was inducted into Canada’s Aviation Hall of Fame and was an inaugural inductee into the Canadian Science and Engineering Hall of Fame. The daughter of a suffragist, MacGill was also a vocal advocate of women’s and children’s rights.

THE PRESENT: FIRST FEMALE AEROSPACE ENGINEERING STUDENT GROUP ON CAMPUS

For almost 90 years after Elsie MacGill graduated from the University of Michigan, the women in the Department of Aerospace Engineering remained a small but emboldened community. Then, in 2016, the Women in Aeronautics and Astronautics (WAA) student organization was founded to provide a cohesive voice for this community. Kelly Henckel, CoE undergraduate and WAA founder, provides perspective on the group’s origins: “Aerospace is traditionally one of the least diverse majors as far as gender and minorities go. Coming into the department, I saw that we lacked some of the same initiatives that other departments have to support underrepresented groups. I wanted to change that, and help cultivate a more supportive environment for our students as well.”

As an organization, WAA seeks to provide mentorship and professional opportunities for women in the department. “One of our biggest depart-
“We’ve seen mentees grow from eight last year to more than 20 today. By grouping students into ‘families’, we’ve created a much more engaging community for women in this major.”
—Kelly Henckel

“We’ve also developed a corporate reception event,” she continued, “which gives business representatives and our students the chance to interact as individuals outside the confines of a career fair. This program has been an overwhelming success.”

In describing WAA, Henckel was careful to clarify that the group is not restricted to female membership. “Anyone should feel comfortable joining,” she explained. “We’re trying to make aerospace more accessible to women, a goal that requires us all — men, women and binary alike — to get involved.” Nor is WAA limited to students in the aerospace department. Said Henckel: “We’ve recently partnered with other groups, like the U-M chapter of oSTEM, the LGBTQA association for STEM students.

“We’ve come quite a way since the time when all the women in our department could be counted on one hand.”

Industry Advisory Board Member Karen Albrecht can attest to that era; when she graduated with a bachelor’s degree in aerospace engineering from U-M in 1972, she was the only woman pursuing the degree. “I never really realized there was discrimination against women in aerospace,” she noted, “until I got to class and saw that I was the only one. It was a little unnerving. Then, in my early career at NASA, there were times when the women’s bathroom was half a mile away. I had a sign that said ‘Karen’ that I’d put on the men’s bathroom when I was using it.”

She reflects on the boundaries she broke as she rose through the ranks: “I had mentors along the way. After I left NASA and went to Martin Marietta, I remember walking into my boss’ office to discuss my job performance. He said that some people had been concerned when he hired a woman, but they weren’t concerned anymore. Honestly, that was a surprise to me, because my expectations of myself were always much higher.”

Albrecht went on to develop an illustrious career as an aerospace engineer working on the space shuttle, missile launch systems and commercial and high-performance military aircraft.

THE FUTURE

Both Albrecht and Henckel are optimistic about the future path of women in the field. As Albrecht explains, “I’ve seen an uptick in female engagement the past two or three years. We now have more diversity of knowledge and experience on the aerospace faculty [with Ella Atkins, Anouck Girard, Dimitra Panagou, Nakhiah Goulbourne and Margaret Wooldridge] and on the department’s advisory board [with Debra Faktor-Lepore, Trudy Kortes and Jennifer Duke.] I’ve seen huge growth and evolution in the ‘products’ created by our department: the students! Not only has their technical knowledge increased, but also their outreach involvement, well-roundedness and diversity.”

“Beyond WAA, I see other groups in the department pushing for change. I see the university making [diversity and equity] a big priority, especially in STEM fields like aerospace. Of course, we aren’t going to go from a female student population of 10 percent to 50 percent overnight. But the fact that we are here and that the department is supporting this progress is a huge step in the right direction.”
—Kelly Henckel
ABHINAV DASARI
(MSE '13, PHD '17)

Abhinav Dasari died November 27, 2016. Originally from India, Dasari completed a bachelor’s degree in aeronautical engineering in 2012 from Sathyabama University. He arrived at U-M in 2012, where he completed a master’s in aerospace engineering in 2013 and continued into the PhD program.

Dasari was a highly motivated and dedicated student, excelling in both the classroom and in research. He received the Rackham Centennial Fellowship at Michigan. While at U-M, he focused on the study of combustion processes for rocket propulsion. He was very active in engaging junior students through teaching, tutoring and outreach activities.

THOMAS C. ADAMSON, JR.

Thomas Adamson, who chaired the Department of Aerospace Engineering from 1983 to 1991, passed away on October 9, 2016. After earning a BS from Purdue and advanced degrees from the California Institute of Technology, he joined the University of Michigan as an associate research engineer. Possessing rare technical aptitude and a lifelong passion for aviation, he rose to become a full professor in seven years. Adamson’s broad professional interests included fundamental aspects of high-speed aerodynamics, aircraft propulsion and combustion, and he is well known for his work on detonation waves, transonic flows and supersonic jets. He published widely and gave numerous presentations at other universities and professional meetings. His many doctoral students have achieved distinguished careers in universities and research laboratories.

Beyond his research, Adamson was a highly effective and engaging educator, and was noted for advising and mentoring more than 70 graduate students to their PhDs and beyond. On the university level, Adamson was recognized with the Distinguished Faculty Achievement Award in 1980. His achievements in research and education were further honored by his election as a fellow to the American Institute for Aeronautics and Astronautics.

As chair, Adamson was instrumental in attracting talented faculty members to the department. He also played a pivotal role in planning and fundraising for the François-Xavier Bagnoud Building. Throughout his career, Adamson provided exceptional educational leadership, and was always willing to share his time and talents with faculty, colleagues and students.

AWARD IS CREATED IN MEMORY OF STAFF MEMBER

In June 2017, the Department of Aerospace Engineering announced the creation of an annual staff dedication award in honor of U-M electrical technician Mart Stenzel.

Martin “Mart” Stenzel was born on July 25, 1960 in Plymouth Township, Michigan. From a young age, he possessed a love for aviation and tinkering, as his friend Dan Sabo recounts: “Mart, another friend and I were the average small-town nerds — we loved flying remote-control planes, tinkering with projects to build, making things. ... I recently learned from Mart’s sister Paulette that he planned to build a solar-powered bicycle. That was Mart — nothing changed in that regard.”

Paulette expanded on her brother’s diverse set of passions: “Mart loved all things related to aerospace, but he fought against mountaintop mining and fracking and for such issues as preserving rainforests.”

Stenzel passed away on April 15, 2015.
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<th>Name</th>
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2016-17 + AEROSPACE ENGINEERING ANNUAL REPORT
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