

2017

# RESEARCH IMPACT



THE OHIO STATE UNIVERSITY  
COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL  
AND AEROSPACE ENGINEERING

# MESSAGE FROM THE CHAIR

This year has been a shining example of our continued commitment to research innovation. As we strive to advance from excellence to eminence, our Mechanical and Aerospace Engineering (MAE) students and faculty have developed technologies that directly impact societal needs. Join me in discovering some of the many significant advances that our MAE engineers are spearheading in medicine, mobility, materials and manufacturing.

As one of our newest faculty members, Bilin Aksun-Guvenc, stated simply, “We do not conduct our research for the sake of technology alone, but to help people.”

From closing the ‘first mile, last mile’ disparity gap using smart mobility to treating drug-resistant cancer cells using DNA origami nanostructures, our students and faculty are connecting passion with intellectual curiosity and high-impact research to change lives.

Take PhD student Rachel Baker, for example, who is featured on the cover of this issue of *Research Impact*, and who is an integral member of faculty Rob Siston’s research team. By pioneering a new approach for computer-assisted total knee arthroplasty, Baker and her fellow student researchers in the NeuroMuscular Biomechanics Laboratory can use computer simulations to estimate how patients’ muscles will function when walking, climbing stairs and getting out of a chair after surgery. In the future, her research will provide surgeons with the navigation and computational tools needed to adapt surgeries to an individual patient’s needs, whether that’s gardening, skiing or climbing stairs with ease. Her research goes beyond improving health outcomes; she wants patients to thrive.

Housed on one of the nation’s largest campuses, our department takes interdisciplinary research to the next level. Our world-renowned faculty advise a wide variety of state-of-the-art centers, including the nation’s largest independent vehicle test facility: the Transportation Research Center. Collaborations with The Ohio State University Wexner Medical Center; Comprehensive Cancer Center; Arthur G. James Cancer Hospital and Richard J. Solove Research Institute; the Air Force Research Laboratory; Honda R&D Americas; and the U.S. Department of Energy, among many others, allow us to push our research far beyond the university’s walls and have a positive impact on society.

I invite you to read this edition of *Research Impact* to learn how our MAE faculty and students are reimagining the future of science and engineering.

## **Vish Subramaniam**

*Professor and Chair*

*Department of Mechanical and Aerospace Engineering*

*The Ohio State University*



## DEGREES CONFERRED

*Academic Year 2016 - 2017*

<b>BS</b>	<b>227</b> MECHANICAL	<b>70</b> AEROSPACE	
<b>MS</b>	<b>78</b> MECHANICAL	<b>17</b> AEROSPACE	<b>11</b> NUCLEAR
<b>PHD</b>	<b>19</b> MECHANICAL	<b>8</b> AEROSPACE	<b>7</b> NUCLEAR

## STUDENT ENROLLMENT

*Autumn Semester 2017*

<b>BS</b>	<b>663</b> ME MAJOR	<b>588</b> ME PRE-MAJOR	<b>169</b> AE MAJOR	<b>262</b> AE PRE-MAJOR
<b>MS</b>	<b>136</b> MECHANICAL	<b>18</b> AEROSPACE	<b>4</b> NUCLEAR	
<b>PHD</b>	<b>155</b> MECHANICAL	<b>38</b> AEROSPACE	<b>19</b> NUCLEAR	

*In the Automated Driving Lab, Professors Bilin Aksun-Guvenc and Levent Guvenc work alongside Nitish Chandramouli, MAE graduate student, to take autonomous vehicles from the drawing board to the streets.*



## COLUMBUS: DRIVERLESS DESTINATION

*The nation's first Smart City will transform mobility with replication in mind*

Professors **Bilin Aksun-Guvenc** and **Levent Guvenc** are taking autonomous vehicles from the drawing board to the streets.

Their latest research is making driving more convenient for passengers, eliminating the challenges facing public transportation riders, and — most importantly — keeping those inside and outside of self-driving vehicles safe. To accomplish this, the city where the Guvencs' research is being conducted had to first be transformed.

In June 2016, Columbus was named the winner of the U.S. Department of Transportation's inaugural Smart City Challenge. The competition spurred cities across the nation to demonstrate their best vision for how advanced data, applications and transportation systems can be

used in their regions. The Guvencs' innovative research played a central role in making Ohio's capital city the ideal epicenter for intelligent transportation testing.

The newly established Automated Driving Lab (ADL), directed by MAE alumnus and faculty Levent ('92 PhD, Mechanical Engineering), leads the Smart City charge by using two state-of-the-art autonomous research vehicles and a hardware-in-the-loop simulator to study and develop connected and autonomous driving functions. Bilin's socially acceptable collision avoidance (SACA) algorithm ensures that these vehicles respect the personal space of pedestrians, bikers and other cars on the road while maneuvering a collision-free path.

The Guvencs' aim is simple: To develop a unified, replicable and scalable driving-assistance architecture

that can be used throughout the U.S. to help people and goods move quickly, safely, cheaply and efficiently. Their approach utilizes interfaces for typical sensors like GPS, camera, LIDAR, RADAR and V2V modem, generic steering, throttle and brake actuators, all within a multi-agent automated driving architecture connected by generic and scalable control and decision-making blocks.

The ADL sets itself apart by partnering with the nation's largest independent vehicle test facility: the Transportation Research Center (TRC). This one-of-a-kind center offers the lab a 7.5-mile high-speed oval test track, a 50-acre Vehicles Dynamics Area and more than 4,000 acres of road courses. "Without even going to the road, we are able to run the same experiment because we have validated models for both vehicles," said Levent.

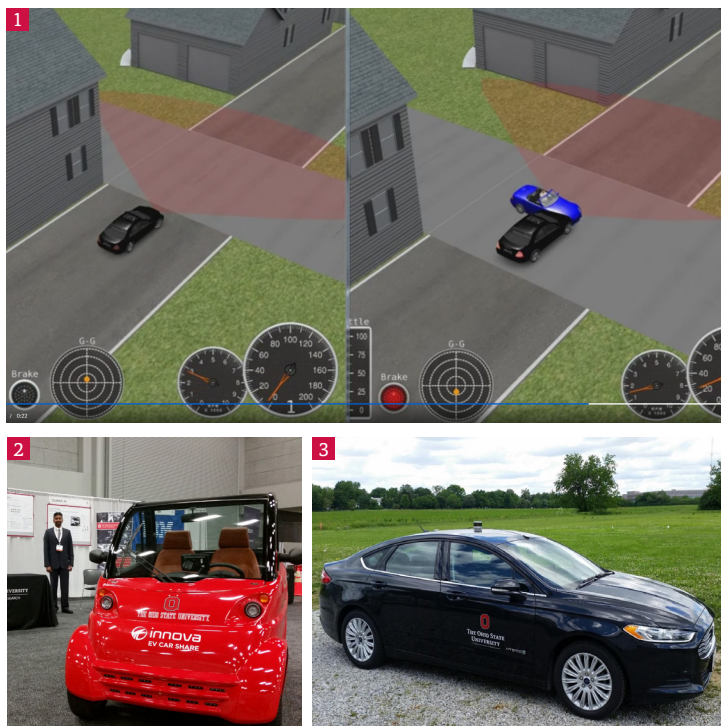
The Guvencs' research isn't just pushing driving technologies forward, it's having an impact on the city's most vulnerable populations.

"In Columbus, mobility directly impacts low-income areas, such as the Linden neighborhood," said Bilin. "The infant mortality rate in this community is affected by mothers' inability to find a way to the nearest hospital."

While public transportation can be quite convenient, it is not perfect. The mile or so that individuals need to walk from their homes to their first bus stop and from their last stop to their final destination is the problem. This "first mile, last mile" concept is currently one of the weakest links in smart mobility.

***"We don't conduct [our research] for the sake of technology, but to help people," said Bilin. "We want to make sure driving is safe and that no pedestrian or passenger in the car is hurt."***

With a Smart City grant from the National Science Foundation, the Guvencs and their team of graduate student researchers are developing low-speed on-demand automated shuttle technology to help solve this very challenge. This developing research blends very



[1] Using validated models for their research vehicles, the Guvencs are able to test their collision avoidance algorithms and controllers before taking the cars to the road.

[2] The Automated Driving Lab's small, all-electric autonomous research vehicle.

[3] The lab's full-sized hybrid autonomous research vehicle.

well with the city's emerging Smart Columbus bus rapid transport network, which would allow buses to bypass traffic lights. The Guvencs' autonomous electric shuttles are planned for operation in the city's 750,000-square-foot Easton Town Center shopping complex.

Their unique approach has the ability to work in similarly sized urban and traffic-dense environments. Through the National Institute of Standards and Technology's Global City Teams Challenge, the ADL and the city of Columbus have already connected with Boston, MA; Portland, OR; Greenville, SC; Washington D.C.; and Madison, WI as Smart Shuttle technical cluster collaborators.

*This top-down view through the reactor pool shows Ohio State's research reactor glowing from Cherenkov radiation, while being operated for an experiment.*



## ELEVATING NUCLEAR ENERGY RESEARCH

*DOE's \$1.5 million investment advances Ohio State's energy technologies*

For decades, The Ohio State University has advanced nuclear energy research and technology. This year, the Department of Energy (DOE) recognized the university's nuclear engineering program as both a valuable research partner for industry and a funding beneficiary.

Ohio State's Nuclear Reactor Laboratory (NRL) was named a Nuclear Science User Facilities (NSUF) program in August 2017, in honor of its distinct features and capabilities for global researchers. As an affiliated partner, the NRL will have access to world-class nuclear research facilities, technical expertise from renowned engineers, and assistance with experiment design, assembly, safety analysis and examination. Ohio State is the 16th NSUF partner site, joining the likes of MIT, Oak Ridge National Laboratory and the University of Michigan.

The DOE's investment in Ohio State's nuclear engineering program also includes \$1.5 million in research funding this year.

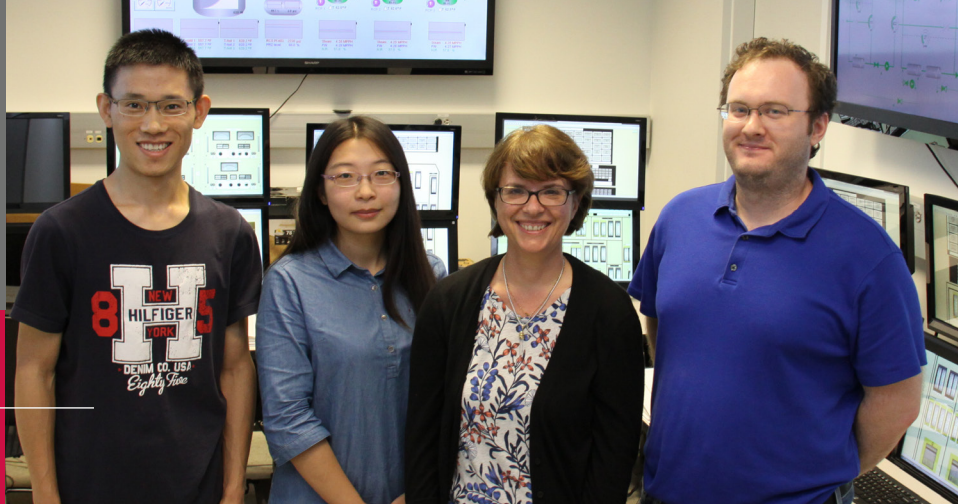
Professor **Tunc Aldemir** will use \$799,985 to develop a computationally feasible and user-friendly process to complement the traditional probabilistic risk assessment approach. His dynamic method will lead to a model of system behavior that provides a more complete representation in the presence of uncertainties. "We aim to augment the existing methodologies that are used to evaluate operational risk and develop solutions for their limitations," said Aldemir. His research team includes Ohio State's Alper Yilmaz, professor of geodetic engineering; Diego Mandelli and Andrea Alfonsi, Idaho National Laboratory; Yassin Hassan, Texas A&M University; and

*“These awards are a testimony to our leading edge research developments in probabilistic risk assessment, instrumentation and control.”*

- CAROL SMIDTS

Director, Nuclear Engineering program

*Professor Carol Smidts and her team of post-doctoral and PhD student researchers in the Risk and Reliability Laboratory. L-R: Yunfei Zhao, postdoctoral scholar; Huijuan Li, visiting scholar; Smidts; and Michael Pietrykowski, graduate fellow.*



Askin Guler Yigitoglu, Oak Ridge National Laboratory.

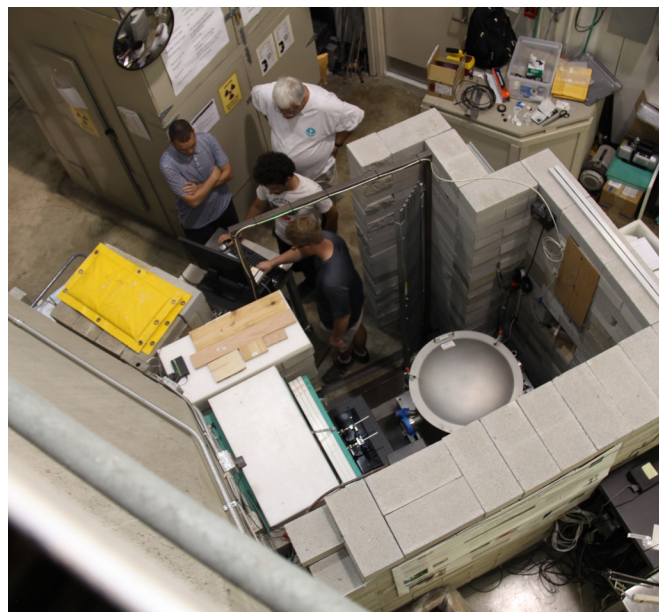
A \$249,945 award will allow Assistant Professor **Marat Khafizov** and his collaborators, Professor **Carol Smidts**, Professor **Lei Raymond Cao** and Professor Emeritus **Thomas E. Blue**, to conduct research on the impact of radiation damage. This includes the impact of that damage and the reactor environment on optical and mechanical properties of materials, such as fiber optic sensors. Khafizov, who directs the Thermal Properties of Materials for Extreme Environments Laboratory, will also use this award to purchase cutting-edge instruments, including photoluminescence and UV-Vis spectrometers, a radio-frequency spectrum analyzer and equipment for the characterization of fiber optic sensors.

In addition to exploring radiation damage, Cao will lead a project improving the use and educational impact of the NRL. Cao, who directs the lab, will receive \$184,328 to recommission two of the facility's neutron beam ports.

One of the two beam ports, which is less frequently used than the other, will be able to provide more functions for in-situ characterization and irradiation of sensors and sensor materials at a high intensity of neutron radiation. This provides researchers with the experiential tools needed to make high-impact discoveries.

Cao's collaborators are Assistant Professor of Practice **Vaibhav Sinha** and **Andrew Kauffman**, associate director of the university's NRL.

In addition to the three research ventures, DOE provided the university with \$317,500 in funding for two fellowships and one scholarship through the Integrated University Program (IUP). When combined, the investment will transform Ohio State's nuclear energy research.



*At the Nuclear Reactor Lab, graduate student researchers measure the energy spectrum of the research reactor's neutron beam with scintillation detectors.*



Professor Mo Samimy (left) and his graduate advisee target current and future air transportation challenges at the university's Aerospace Research Center.

## ENSURING DRONE SAFETY FOR ALL

*ARC's aerospace experts increase UAV speed while making safety a priority*

Drones have gone from being exclusively military-grade to holding one of the most coveted positions on holiday wish lists. To say that they have gone mainstream is an understatement.

With a significant increase in availability, safety has become a major concern for both military and civilian unmanned aerial vehicle (UAV) use. "Imagine what happens when a jet engine sucks in a UAV that is flying near an airport," Professor **Jim Gregory** queried. "Or, when a drone loses power and falls out of the sky and lands on a bystander's head."

These are two of the many questions that guide the work of faculty researchers in the university's Aerospace Research Center (ARC).

As the main coordinator of aerospace and aviation

activities at Ohio State, ARC and its director, John B. Nordholt Professor **Mo Samimy**, tackle the ever-increasing list of global air transportation challenges.

"ARC was established in 2013 in response to the ever-increasing multidisciplinary nature of the aerospace field," said Samimy. "UAV is one example where researchers within and beyond the College of Engineering come together to respond to different applications."

One of ARC's most primary areas of focus is safety. In 2015, Gregory was named the lead principal investigator for the Federal Aviation Administration Center of Excellence on Integrated Unmanned Aircraft Systems in the National Airspace System. With more than \$50 million in funding over 10 years, this multi-disciplinary center brings together a team of experts from across the nation to study

drone safety.

Exploring UAV flight in a gusting wind environment is of particular importance as e-commerce companies move forward with plans for drone-based air delivery. By affixing an anemometer to a UAV, Gregory and his research team's latest project will measure the wind environment that delivery drones will endure in the future.

Motivated by the need for increased speed in the next generation of military aircraft, Gregory, who serves as ARC's associate director, and his team are also exploring ways to push UAVs to the limit.

This August, a team of ARC researchers, led by Gregory and Research Scientist **Matt McCrink** ('15 PhD), set a world speed record for a UAV of any size, pending verification. Their 70-pound jet aircraft flew autonomously with sustained average speeds of 147 miles per hour over an out-and-back course approximately 28 miles long, which also set a record for the longest UAV flight over an out-and-back course.

The UAV was uniquely equipped to handle this mission, with a custom-built flight controller, long-range fuel tanks, redundant radio control links, control via satellite communications link, and automatic dependent surveillance—broadcast (ADS-B) in and out transponder technology for avoiding collisions with other aircraft.

"We're hoping to spearhead a competitive technology push for higher speed, longer range and enhanced safety for UAVs," Gregory said following the flight.

In addition to prioritizing safety and speed, ARC aims to offer the breadth, depth and coordination needed to provide expert solutions to leading aerospace challenges. Associate Professor **Mrinal Kumar** is doing just that. With more than \$395,000 in funding from the National Science Foundation, he is developing a novel framework that can accurately and efficiently solve complex chance-constrained optimal control problems. Kumar's work will lead to significant contributions in autonomous flight path planning, NextGen air traffic operations and other multi-agent trajectory design problems.

Kumar, who directs the Laboratory for Autonomy in Data-Driven and Complex Systems (LADDCS), is collaborating with Professor Anil V. Rao, of the University



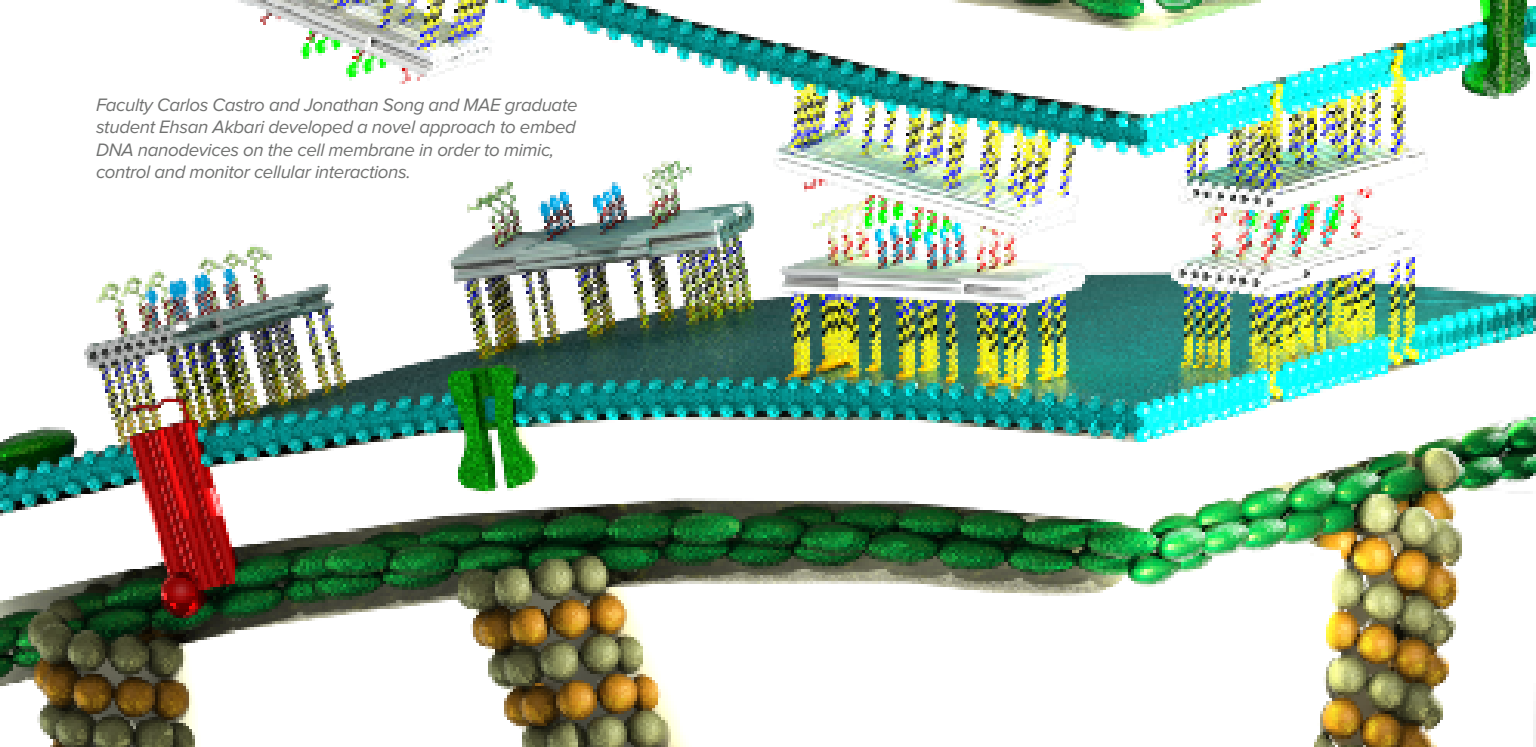
**[1]** Led by Professor Jim Gregory (far right) and Research Scientist Matt McCrink (second from right), the Aerospace Research Center at The Ohio State University set a world speed record for a UAV of any size.

**[2]** Assistant Professor Randall Mathison and alumna Hannah Lawson Pier ('15 MS) inspect the turbine test facility at the Gas Turbine Laboratory.

of Florida, on this project. Their work aims to achieve computational scalability using the combination of a new class of high-accuracy semi-analytical approximations of chance-constraints, low-dimensional collocation methods for discretizing continuous optimal control problems. The duo is also developing a novel nonlinear programming problem solver.

With a team of 26 faculty members, six postdoctoral researchers and research scientists, and six administrative personnel, ARC's research contributions will continue to make the university and the state of Ohio national leaders in aerospace and aviation innovation.

Faculty Carlos Castro and Jonathan Song and MAE graduate student Ehsan Akbari developed a novel approach to embed DNA nanodevices on the cell membrane in order to mimic, control and monitor cellular interactions.



## HITTING CANCER WHERE IT HURTS

*MAE engineers use DNA origami and microtechnology to kill cancer cells*

Used in the past to destroy drug-resistant tumors, DNA origami – the nanoscale folding of DNA to create two- and three-dimensional shapes – is being used for the first time to deliver life-saving medicine to leukemia cells.

Associate Professor **Carlos Castro** is working with a team of researchers at The Ohio State University Wexner Medical Center to combat acute myeloid leukemia (AML) cells that have developed a resistance to the drug daunorubicin. Once the drug's molecules are detected, the AML cells immediately pump them back out the opening of the cell wall.

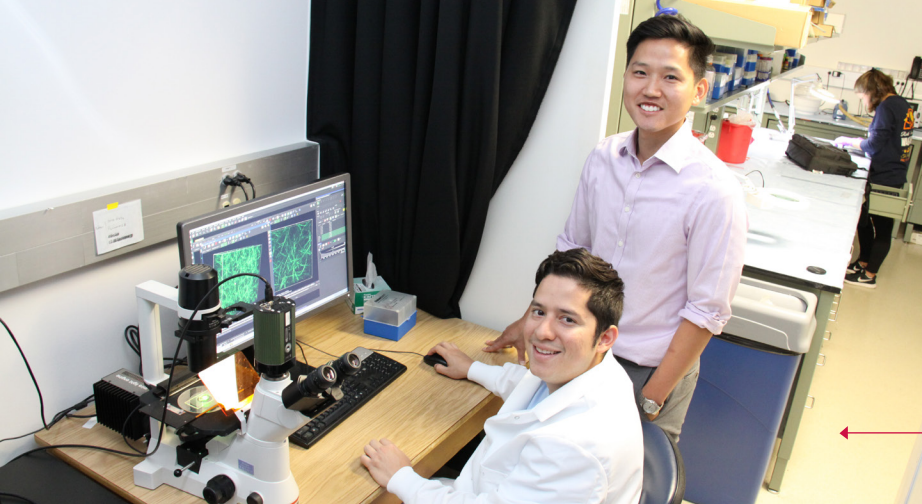
By packaging the drugs in a capsule made of folded DNA, Castro and his team evade the AML cells' defenses. Then, they can hit cancer where it hurts.

"DNA origami nanostructures have a lot of potential

for drug delivery, [including] enabling new ways to study drug delivery," said Castro. "For instance, we can vary the shape or mechanical stiffness of a structure very precisely and see how that affects entry into cells."

His study, which was published in the journal *Small*, is co-authored by Professor John Byrd, the D. Warren Brown Chair of Leukemia Research. Other co-authors include Emily McWilliams, Matthew Webber, Randy Patton, Comert Kural and David Lucas.

His work with nanostructures doesn't end there. Castro is working alongside Assistant Professor **Jonathan Song** to prevent plasma leaks across individual blood vessels. By affixing nanostructures to cells, the duo's nanotransducers can be designed to identify and measure the mechanical forces that orchestrate the assembly



*“We blend engineering design and cancer biology to ‘reverse engineer’ tumors in their microenvironment.”*

- JONATHAN SONG  
Assistant Professor,  
Mechanical and Aerospace Engineering

*Alex Avendano, MAE graduate student, and Assistant Professor Jonathan Song (right) study a 3D model of a tumor in a microenvironment.*

and patterning of tissue structures. This approach could also be used to embed sensors onto cell surfaces in order to measure physical or chemical cues of the local environment, which could be early indicators of cancer or other diseases. Funded by an American Heart Association Innovative Research Grant, Castro and Song’s work with MAE graduate student **Ehsan Akbari** and alumna **Molly Mollica** (’16 MS) was published in *Advanced Materials*.

Song is furthering the department’s cancer fighting research by exploring blood vessels’ role in the growth of cancerous tumors. With support from a Pelotonia Idea Grant, Song will use microtechnology and tissue engineering to develop a disease model of advanced cancers. This, in turn, will enable him to use 3-D imaging to study the tumor conditions that create hostile cancer microenvironments. The funding from Pelotonia, an annual cycling movement that has raised more than \$130 million for cancer research, will empower Song and his team to develop therapeutic strategies for stopping tumor growth.

“Cancer is not only immensely difficult to treat, it is very challenging to study,” said Song, “We blend engineering design and cancer biology to ‘reverse engineer’ tumors in their microenvironment.”

Song’s collaborators include Mike Ostrowski, co-director of the Molecular Biology and Cancer Genetics program at The Ohio State University Comprehensive Cancer Center, and graduate student **Alex Avendano**.

An American Heart Association Scientist Development Grant will further advance his research’s impact. As the department’s first recipient of this prestigious award, Song will investigate the slow-moving flows within tissues and tumors that guide the formation of new blood and lymphatic vessels. Using this approach, he can help determine how molecular mechanics influence the patterning of blood and lymphatic vessel networks, which can have important applications for accelerating wound healing.

“We leverage the capacity of our microfabricated systems to precisely control the mechanical forces associated with fluid flow to enable new insights into the underlying biology,” said Song, who serves as the principal investigator of the Microsystems for Mechanobiology and Medicine Laboratory.

This work is also influencing the next generation of cancer fighting engineers. Take Akbari, for example, who is advised by Song and has recently developed a sophisticated system that mimics the branching structure of blood vessels. Akbari’s insight into this unexplored area will allow him to truly predict where angiogenesis occurs based on the local fluid mechanical determinants.

By identifying the key players that drive tumor and cancer progression, MAE’s team of researchers will kill cancer’s fighting chance.

*“Understanding turbulence is a long-standing challenge in the scientific and technical community, and this project seeks to tackle the problem at another level of complexity.”*

- JACK J. MCNAMARA  
Associate Professor,  
Mechanical and Aerospace Engineering



## LEADING THE FLIGHT REVOLUTION

### *McNamara and team tackle ultra-high-speed flight*

**W**ith atmospheric hypersonic flight planned for the next decade or two, it won't be long before aircraft traveling up to 4,000 miles per hour are changing the face (and speed) of aviation.

Associate Professor **Jack J. McNamara's** research aims to develop the technologies needed to bring hypersonic flight from concept to reality, with a particular focus on the nation's military forces. His work seeks to impact complex, design-driving and design-opening interactions at both the component and vehicle levels. As the director of the Air Force Research Lab (AFRL)-University Collaborative Center in Structural Sciences, McNamara and his multi-disciplinary team pursue solutions for the technical challenges obstructing the development of reusable hypersonic aircraft. The center's partners include the AFRL, Arizona State University, the University of Illinois – Urbana Champaign and Johns Hopkins University.

“Because of the unique challenges of hypersonic environments, the technical approach toward this goal is to understand, model and carry out analysis on complex multi-scale, multi-physics responses and interactions throughout the fluid, structure and material,” said McNamara, who also directs Ohio State's Multi-Physics Interactions Research Group.

Consistent with these goals, his most recent project, sponsored by the Air Force Office of Scientific Research, will enable the development of reliable tools for the tractable response and life prediction of structural systems through deep understanding of the interaction between high-speed turbulence and compliant surfaces. This project is using a progressive decomposition of the fluid/structure interaction to improve researchers' understanding of the highly nonlinear interactions and energy transfer for both turbulent boundary layer and shock/boundary-layer interaction environments. His collaborators include MAE's Glenn Chair and Professor **Datta V. Gaitonde** and Professor Joanna Austin, California Institute of Technology.

“Understanding turbulence is a long-standing challenge in the scientific and technical community, and this project seeks to tackle the problem at another level of complexity,” said McNamara. “Hypersonics have very thin operational margins – the only way around them is a deep understanding of the dominant physics and the development of multi-disciplinary engineering solutions.”

His focus is clear: Make hypersonic flight possible, while managing the extreme environment encountered when flying five times faster than the speed of sound.

# SVC GRANTED FUNDING RENEWAL

*With Phase III funding, the Smart Vehicle Concepts Center (SVC) will leverage new R&D discoveries*

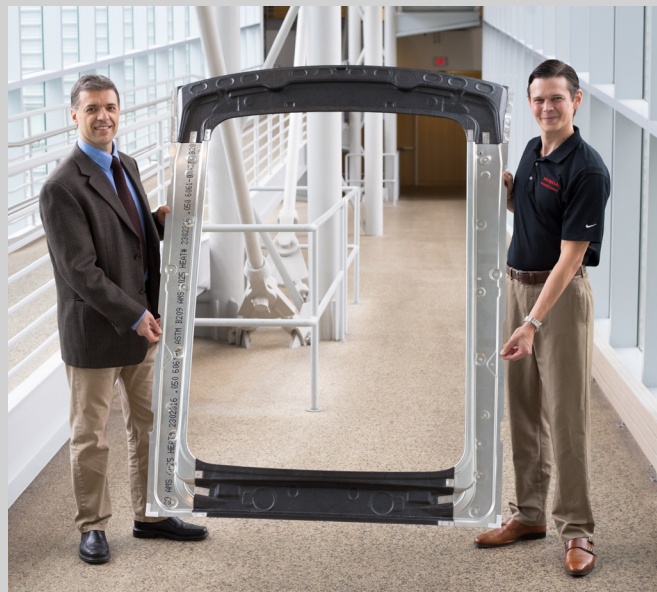
The Smart Vehicle Concepts Center (SVC), a National Science Foundation Industry-University Cooperative Research Center (IUCRC), was granted a five-year renewal effective August 1, 2017. With this award, the SVC has become a single-site Phase III National Science Foundation (NSF) IUCRC consortium.

With an NSF investment acting as a catalyst, the SVC was established in 2007 to develop research programs of common interest to its member organizations; contribute to the nation's research infrastructure base; promote synergistic research and education as a means to enhance the intellectual capacity of the workforce; and facilitate technology transfer.

Operating in pre-competitive mode, SVC researchers conduct scholarly research on smart materials applied to ground and aerospace vehicles. The strong industry relevance of the programs supported within the SVC leads to well-trained engineers and researchers at the undergraduate, master's and doctoral levels with both experimental and theoretical expertise, which the member organizations covet.

During Phase II, the SVC has attracted an average of nearly 14 full memberships each year coming from 10 distinct full member organizations. During that five-year period, the center supported an average of 13 PhD, five MS and five BS students each year, yielding a total of nearly 75 journal articles, 40 conference papers, and more than 40 dissertations and theses.

Led by Professor and Honda R&D Americas Chair **Marcelo Dapino**, the SVC will continue to position Ohio State as a leader in smart vehicle technology research. "A strong focus of the Phase III renewal is to expand the center's research portfolio to address emerging needs in the industry," said Dapino. "The NSF proposal outlined a vigorous effort toward sustainability of the center beyond the next five years along with plans for growing our faculty



*Professor Marcelo Dapino (left), his SVC team and MAE alumnus Ryan Hahnen, of Honda R&D Americas ('07 BS, '09 MS, '12 PhD), developed a technology for seamlessly joining carbon fiber reinforced composites and metal structures.*

base and developing collaborations with other institutions."

The SVC leadership team includes Professor **Rajendra Singh**, Assistant Professors **Vishnu Sundaresan**, **Soheil Soghrati** and **Ryan L. Harne**, and Research Assistant Professor **Scott Noll**. The SVC Industrial Advisory Board, chaired by Thomas Greetham of Moog, Inc., is comprised of representatives from the center's member organizations and meets twice each year.

The IUCRC Program was established by the NSF in 1973 to develop long-term partnerships among industry, academia and the government. The IUCRC Program currently supports more than 80 centers across the country, each one with a distinct focus.

*At the launch event for CDME's Experiential Entrepreneurship Education (E3) program, MAE student Emmanuel Adu spoke about his own R&D project sponsored by the one-of-a-kind program. He aims to develop optimized injection molding process parameters for varying thermoplastic materials.*



# CONNECTING RESEARCH AND INDUSTRY

*The Center for Design and Manufacturing Excellence (CDME) links academia and corporate America*

Located in the heart of the Midwest, The Ohio State University's central location makes industry collaboration not only convenient, but mutually beneficial thanks to one of the newest centers on campus.

The Center for Design and Manufacturing Excellence (CDME) utilizes the expertise of Ohio State's world-class faculty, staff, students and centers to support design and manufacturing discoveries for industry partners. With an initial investment of \$6.8 million in federal funding and support from the College of Engineering, CDME serves as the manufacturing port of entry into Ohio State. The center's partners receive the highest level of product validation, design, commercialization and manufacturing support due to their exclusive access to the university's engineering, business and applied science assets.

MAE alumnus **Dan Kimmet** ('71 BS, '72 MS) led the charge to widen CDME's industry network. Kimmet, who served as the vice president of operations at Eaton Corp. before becoming CEO of Dillin Corp., brought his phenomenal managerial skills to CDME as its executive director from 2014 to 2015. The center, and its list of collaborators, grew under his leadership.

CDME's faculty experts offer cutting-edge solutions to combat the manufacturing industry's toughest challenges. Professors **Farhang Pourboghrat**, **Jami Shah** and **Krishnaswamy Srinivasan** advise CDME's management team as Research Advisory Committee



members. Their meaningful feedback directly impacts the center's commercialization efforts.

In addition to supporting partners in corporate America, CDME is inspiring the next generation of engineers.

The center's new Experiential Entrepreneurship Education (E3) Program is the first in the nation to combine state-of-the-art

educational programs in product design, manufacturing, commercialization, and business modeling with advanced on-site prototyping capabilities and real-time, industry-sponsored research and development projects.

The program empowered MAE undergraduate student **Emmanuel Adu** (left) to develop optimized parameters to use during the injection molding process for varying thermoplastic materials.

With \$3.5 million in funding, the E3 program works with industry partners to prepare Ohio State engineering students to become future business leaders and high achievers, either in the industry or their own start-ups.

"This is the future of technology-based, entrepreneurship education," said CDME Executive Director **John Bair**.

"[Here] faculty, students and industry professionals will study and practice the commercialization of innovative products and services."



Credit: University Communications, The Ohio State University



Professor **JOHN M. HORACK**

### *Horack installed as Neil A. Armstrong Chair*

**P**rofessor **John M. Horack** was installed as the inaugural Neil A. Armstrong Chair in Aerospace Policy on May 8, 2017, at the first-ever Armstrong Space Symposium.

Horack has been a leader in aerospace innovation since 1987. At the National Aeronautics and Space Administration (NASA), he moved his way up the ranks from an assembly, test and calibration scientist to the manager of the Science and Mission Systems Office at the Marshall Space Flight Center.

Horack's groundbreaking research explores gamma ray bursts – hypernovas that emit as much energy in 10 seconds as our sun will release in its entire lifetime. After NASA, Horack went on to serve as vice president of research at the University of Alabama and then vice president of Teledyne Brown Engineering's Space Systems group.

Today, in addition to his role as Armstrong Chair and professor of aerospace engineering, Horack serves as a board-level executive for the International Astronautical Federation (IAF) and co-chair of IAF's Select Committee on Satellite Commercial Applications.

In these roles, Horack works to ensure that space and its benefits are open to everyone, regardless of gender, generation or geography.

He remarked:

***"Space is not a luxury anymore; it is a necessity, woven into our everyday lives."***

Propelled by a generous investment from Huntington Bank, Horack's new role is housed in both the College of Engineering and the John Glenn College of Public Affairs at The Ohio State University.

## *Selamet's lifetime of achievement*

To recognize Professor **Ahmet Selamet's** significant contributions to the mechanical engineering field, the Society of Automotive Engineers (SAE) International named him the 2017 recipient of the Ralph K. Hillquist NVH Lifetime Achievement Award. This honor, which is given to only one individual every other year, recognizes those who have made outstanding contributions to ground vehicle noise, vibration and harshness research for 15 years or more.

Throughout his esteemed career, Selamet has conducted extensive analytical, computational and experimental research that has advanced the foundations of wave dynamics and acoustics in engine breathing systems. A substantial portion of his research on acoustics has examined the suppression of noise generated by flow and flow-acoustic coupling encompassing a wide frequency range, including whoosh, whistle, chirp, hoot and ring. For nearly three decades, Selamet's Flow, Engine, Acoustics, and Turbocharger Research Laboratories have provided unique educational opportunities for the next generation of automotive engineers. In addition to his research contributions, the award recognizes Selamet's service to the field. For more than 20 years, he has organized the intake and exhaust sessions at the SAE Noise and Vibration Conference. He was named a SAE Fellow in 2003 and received the organization's Ralph R. Teetor Award in 1999. Among other national and international honors, Selamet was named a Fellow of the Acoustical Society of America and a Senior Fellow for the Center for Automotive Research.



## *Cho receives prestigious DARPA Young Faculty Award*

**H**anna Cho's passion for understanding nonlinear dynamics in micro and nanoscale mechanical systems – some so small that they are almost invisible to the naked eye – will contribute to the U.S. Department of Defense's national security research. A \$499,769 Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA) will support Cho's work to utilize intentional nonlinearity to manipulate the mechanical resonance in order to achieve performance otherwise unattainable in linear settings. This competitive DARPA award aims to identify and engage rising stars in junior faculty positions in an effort to transform the research capabilities of the nation's military force. The knowledge obtained through Cho's study will provide strategies to optimize the nonlinear properties in the design of microelectromechanical systems (MEMS), producing transformative applications using resonant devices for sensing, energy harvesting and signal processing. This will have a real-world impact on soldiers' potential use of MEMS on the battlefield. Her latest project ties in directly with Cho's work as director of the university's Micro/Nano Multi-physical Dynamics Laboratory.



## FACULTY RECOGNITION

*Assistant Vice President for Aerospace and Aviation* **MEYER BENZAKEIN**

### *Benzakein leads NASA electric aircraft engine R&D project*

Professor **Meyer Benzakein**, assistant vice president for aerospace and aviation at The Ohio State University, was notified on April 3, 2017 that the multi-institution team he formed to focus on electric propulsion had been selected for NASA's University Leadership Initiative (ULI). Ohio State is one of only five teams selected to support NASA's aim to provide transformative solutions to system-level aeronautics problems. Benzakein's team will develop advanced lithium sulfur high-energy batteries, advanced electronics and thermal management solutions to be incorporated in hybrid turbo electric propulsion systems for large commercial aircraft. Researchers and graduate students from Ohio State's Center for High Performance Electronics and the Center for Automotive Research will play key roles. External partners include teams at the University of Maryland, North Carolina A&T State University, Georgia Institute of Technology, University of Wisconsin, Case Western Reserve University, General Electric, and the NASA Glenn Research Center. "This is a unique opportunity for Ohio State and its partners to define aircraft propulsion for the future and solidify the nation's leadership in a highly competitive field," said Benzakein.



*Professor* **CAROL SMIDTS** *and Professor* **RAMA YEDAVALLI**

### *Smidts and Yedavalli elevated to IEEE Fellows*

As a trailblazer in the nuclear engineering field, Professor **Carol Smidts** was recognized for her career, research and service accomplishments by being named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). She is joined by less than 0.1 percent of the association's voting members in this member grade elevation. Smidts, who serves as the director of the university's nuclear engineering program, was recognized by IEEE for her contributions to the reliability analysis of high-assurance systems. As the lead researcher for the Reliability and Risk Laboratory, Smidts' work explores probabilistic risk assessment, dynamic methodologies, continuous event trees and Markov analysis.

IEEE's Life Fellow status is reserved for individuals who have truly distinguished themselves through their sustained and lasting contributions to the association. Professor **Rama Yedavalli**'s exemplary service to IEEE coupled with his leadership, volunteerism and dedication to advancing technology earned him this prestigious honor. Yedavalli, who directs the Distributed Engine Control and Simulation Laboratory, researches systems level robust stability analysis and control design for uncertain dynamical systems, distributed control, adaptive control, hybrid systems control and control of time delay systems. "Life Fellow status speaks to Professor Yedavalli's professional achievements in technology as well as the significant impact he has made on the growth and development of IEEE," said Karen Bartleson, IEEE president.



Associate Professor **HAIJUN SU**, Professor **MARCELO DAPINO** and Professor **JUNMIN WANG**

## *Su, Dapino and Wang earn NSF National Robotics Initiative Award*

**W**ith support from a National Robotics Initiative (NRI) Award, presented by the National Science Foundation (NSF), Associate Professor **Haijun Su** and his team will accelerate the use of robots in the United States. Su is the principal investigator for the “Shape Morphing Arm Robotic (SMART) Manipulators for Simultaneous Safe Human-Robot Interaction and High Performance in Manufacturing,” project. His award was the only NRI honor given to The Ohio State University and one of only three awards presented to an Ohio team. Su, who directs the Design Innovation and Simulations Laboratory, is joined by co-principal investigators **Marcelo Dapino** and **Junmin Wang**, professors of mechanical engineering.

The three-year award will improve the design of robotic systems that benefit numerous fields, including the health care, automotive and military sectors.

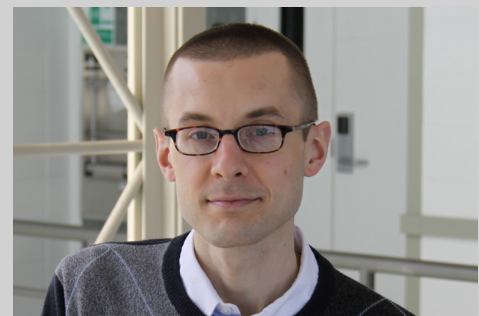
The team’s research also addresses safety challenges by offering expertise in shape morphing and design optimization of compliant mechanisms; electronically-controlled stiffness modulation with smart materials; and performance maximization by optimal motion control. The arms of the team’s SMART manipulators, for example, are made of smart material composite beams highly compliant at high speeds for maximum safety and stiff at low speeds for maximum control performance.



Assistant Professor **RYAN L. HARNE**

## *Harne wins Haythornthwaite Young Investigator Award*

**T**he American Society of Mechanical Engineers (ASME) awarded **Ryan L. Harne** the 2016 Haythornthwaite Young Investigator Award. The prestigious award, based on selection by the ASME Applied Mechanics Division, recognizes excellence in theoretical and applied mechanics research for early career faculty. The award will support research conducted in Harne’s lab — the Laboratory of Sound and Vibration Research — that will formulate a detailed understanding of the complex dynamic responses of built-up structural systems subjected to loads that promote post-buckling, regularly encountered by aircraft which are slender structural platforms. These platforms may exhibit skin (or shell) buckling due to combinations of thermal, mechanical and acoustic loads which increase stresses on the platforms, reduce performance of the system and accelerate fatigue processes. “The outcomes of the research will be fundamental advancements in understanding how built-up structural systems subjected to such adverse loads may be best operated and designed for safety, efficiency and long-life,” Harne said. This award, presented to only four researchers in 2016, will allow Harne’s lab to experimentally investigate the sensitivities that govern complex dynamic behaviors, using the results as critical validation for theoretical characterization efforts conducted in parallel.



# NEW FACULTY APPOINTMENTS | 2017-18

**Bilin Aksun-Guvenc** | *Research Professor*



With more than two decades of automotive control systems research, Bilin Aksun-Guvenc serves as an expert on autonomous vehicles; socially acceptable collision avoidance; and automated driving in smart cities.

**Clarissa Belloni** | *Assistant Professor*



Clarissa Belloni's research focuses on the analysis of hydrokinetic and low-head hydro power, building on experience in wind farm aerodynamics as well as advanced thermodynamics cycles.

**Ran Dai** | *Assistant Professor*



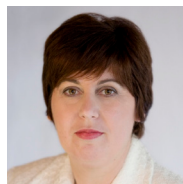
Ran Dai joins the department as director of the Autonomation and Optimization Laboratory. Her research will focus on the motion planning and decision making of autonomous systems, and computational optimization.

**Vicky Doan-Nguyen** | *Assistant Professor*



With a dual appointment in MAE and the Department of Materials Science and Engineering, Vicky Doan-Nguyen's research uses nanomaterials to produce global solutions for electrical energy storage and conversion challenges.

**Pelagia-Iren Gouma** | *Professor and Orton Chair of Ceramics Engineering*



As a faculty member in both MAE and the Department of Materials Science and Engineering, Pelagia-Iren Gouma's research focuses on developing novel nanomaterials for biotechnology, manufacturing, electrical and chemical applications.

**Scott Noll** | *Research Assistant Professor*



Scott Noll aims to solve virtual product development challenges through advanced modeling and experimental approaches. His research interests include nonlinear structural dynamics, vibrations, inverse identification and experimental modal analysis.

**Alok Sutradhar** | *Assistant Professor*



Alok Sutradhar will bring his expertise in bio-inspired design; biomedical modeling; additive manufacturing; computer-aided design; biomimetics; and topology optimized design of engineering and biological structures to MAE this fall.

**Richard Vasques** | *Assistant Professor*



Richard Vasques is particularly interested in neutron transport in stochastic mixtures and computational methods. His work focuses on advanced modeling and simulations; fission reactor physics; and non-classical transport methods.

**To learn more about the groundbreaking research being conducted by our new 2017-18 faculty, visit [go.osu.edu/newmae17](http://go.osu.edu/newmae17).**

## *Jans awarded two prestigious DOD fellowships*

This summer, **Elijah Jans** was named the recipient of two highly competitive graduate fellowships from the Department of Defense (DOD): The National Defense Science and Engineering Graduate (NDSEG) Fellowship and the Science, Mathematics and Research for Transformation (SMART) Scholarship. While students are able to apply to receive both awards, the conditions of appointment require participants to only choose one.

Ultimately, Jans accepted the NDSEG Fellowship. The three-year award, which provides full-tuition funding, will empower Jans to study the many ways in which spectroscopy and laser diagnostics allow researchers to investigate phenomena that was previously not possible.

“Focusing on quantum mechanics, lasers, physical gas dynamics, and statistical thermodynamics offers the fundamental knowledge I need to be engaged in spectroscopic research,” he said.



Jans’ work, which can be used by the DOD to detect hazardous gases and bioweapons during military settings, will have a direct impact on national security. The main goal of his doctoral research is to develop laser diagnostics using Coherent Anti-Stokes Raman Spectroscopy (CARS) and cavity ring-down spectroscopy (CRDS).

Jans’ faculty advisor is Professor **Igor Adamovich**, who directs the university’s Non-Equilibrium Thermodynamics Laboratory.

## STUDENT RECOGNITION



KAYLEIGH GORDON | MS

## *Sparking space collaboration*

The 2017 Global Space Exploration (GLEX) Conference, hosted in Beijing, China, brought together top scholars and decision-makers from the aerospace policy and research community, including MAE master’s student **Kayleigh Gordon**. The conference tied in perfectly with her own research interests investigating the technical capabilities of Chinese space launch vehicles. Due to NASA being prohibited from collaborating bilaterally with China, Gordon has her sights set on scholarly partnerships with the country. As a student researcher in the Battelle Center for Science and Technology Policy, she is currently developing the first-ever Conference for Sino-American Cooperation in Outer Space, which will take place in 2018 at Ohio State.

Gordon’s work will also impact the United States’ space exploration goals. She was selected as a 2017 student intern in the White House Office of Science and Technology Policy. In this role, she will provide scientific, engineering and technological advice to the President and others within the Executive Office of the President. She is advised by Professor **John M. Horack**, Neil A. Armstrong Chair in Aerospace Policy.



## STUDENT RECOGNITION

### → NEUROMUSCULAR BIOMECHANICS LABORATORY

#### *NMBL student research team customizes surgery*

**L**ed by Associate Professor **Robert Siston**, the team of student researchers in MAE's NeuroMuscular Biomechanics Laboratory (NMBL) see a future where surgical outcomes far exceed patients' expectations. By leveraging mechanical engineering principles, the team aims to optimize the functional outcomes of surgical interventions such as total knee replacement surgery. While their main focus is the treatment of knee osteoarthritis, their overarching goal is to provide a scientific basis to treat a variety of human movement disorders.

Currently, the lab team is pioneering a new approach for computer-assisted total knee replacement, where surgeons use specialized equipment to make measurements inside of the operating room and use computer simulations to estimate how muscles are used to walk, climb stairs and get out of a chair after surgery.

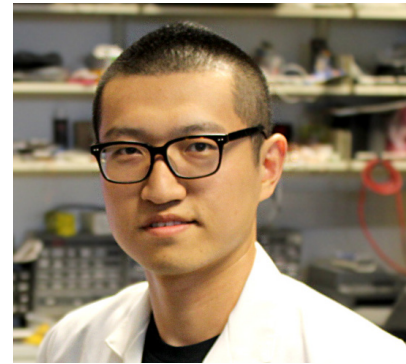
The NMBL's comprehensive approach "represents the first effort to parameterize key aspects of this surgical technique and objectively relate intra-operative measurements to post-operative outcomes," said Siston.

### QUANQI DAI | MS

#### *Dai publishes on his novel electrical energy approach*

**F**or **Quanqi Dai**, engineering has always been a verb. The MAE graduate student chose to study mechanical engineering because he enjoys "the process of making scientific discoveries for practical applications and sharing them with others."

His research has done just that. Dai's work focuses on nonlinear structural dynamics and vibration energy harvesting. His work with Assistant Professor **Ryan L. Harne** to develop a novel approach to supply electrical energy for microelectronic devices using nonlinear vibration energy harvesters was published in the *Journal of Intelligent Material Systems and Structures*. Currently, Dai is an integral student researcher in Harne's Laboratory of Sound and Vibration Research.

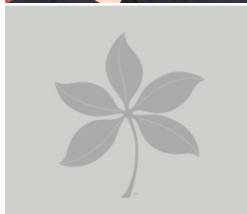


## *Chuirazzi and McCary named INL Graduate Fellows*

**W**illiam Chuirazzi and Kelly McCary, graduate students in the department's nuclear engineering program, were named 2017 Idaho National Laboratory (INL) Graduate Fellows.

This newly established fellowship aims to foster connections between the INL and its university partners, including The Ohio State University. Upon the completion of their coursework, INL Fellows Chuirazzi and McCary will be employed at the INL as they conduct research for their PhD theses.

At the INL, Chuirazzi's research will center on neutron radiography using the laboratory's Neutron Radiography Reactor as part of its Materials and Fuels Complex. Chuirazzi is advised by Associate Professor **Lei Raymond Cao**, director of the university's Nuclear Reactor Lab. "I am excited for the opportunity to improve my knowledge on



neutron imaging at INL, as their facilities and mentorship provide an excellent environment for me to further my doctoral studies," Chuirazzi shared.

McCary will continue her research on in-pile fiber optic instrumentation at the INL in the High Temperature Test Lab. Professor Emeritus **Thomas E. Blue** serves as McCary's faculty advisor. "I hope that our research will help in the development of more accurate and informative sensing technology that will

ultimately be implemented in the next generation of nuclear reactors," said McCary. In addition to this fellowship, McCary was named a Nuclear Energy University Program Graduate Fellow in 2015 and completed an INL internship in April 2017.

## *Simeunovic receives NSF Fellowship*

**A**ndrej Simeunovic, a mechanical engineering graduate student, was named a 2017 recipient of the National Science Foundation (NSF) Graduate Research Fellowship Program (GRFP). Simeunovic will use this competitive award to develop an endoscopic surgical robotics-based additive manufacturing tissue engineering device; picture a Da Vinci surgical robot that 3D prints synthetic tissue constructs inside the body. He was selected from more than 13,000 national applicants.

The GRFP provides three years of financial support within a five-year fellowship period. Simeunovic is advised by **David Hoelzle**, assistant professor of mechanical and aerospace engineering. MAE graduates **Jillian Grace Yuricich** ('16 Aerospace Engineering) and **Neil Stanley Ramirez** ('17 Mechanical Engineering) were also awarded funding support from the NSF GRFP.





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### Autumn 2017

*Research Impact* is a free publication  
from The Ohio State University.

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