COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
VIRGINIA TECH™

2019 ANNUAL REPORT MECHANICAL ENGINEERING

Revised and Corrected, Nov. 2019

CONTENTS

FROM THE DEPT HEAD

Welcome friends, alumni, and supporters of the Department of Mechanical Engineering at Virginia Tech. For several years now the department has been in the midst of a substantial growth curve that has seen an increase in the numbers of students, faculty, laboratories, research partnerships, and a broadening of what it means to be a mechanical engineer.

The fields of study within mechanical engineering have continued to evolve and today we are one of the most diverse fields in engineering, working on everything from nano-particles to extra-planetary robotics and equipment. From bio-inspired material, to bio-medical design, and from nuclear engineering to additive manufacturing that changes the way we design, develop, and build the hardware of tomorrow. Please take a glimpse of the outstanding and substantial research of our faculty and students which has grown significantly in recent years to national and international recognition.

I am proud of the work done by more than 100 full-time, affiliate, and adjunct faculty, and all our dedicated staff who propel the department forward, and the more than 1,100 undergraduates and more than 300 graduate students who stand by ready to lead us into the next generation. This annual report is a reflection of their efforts in making the department one of the most respected in the world.

Azim Eskandarian, Nicholas and Rebecca Des Champs Chair,
Department Head, Mechanical Engineering

MECHANICAL ENGINEERING BY THE NUMBERS

Full Time Faculty

68

Affiliate/Adjunct Faculty

40

Chaired & Fellow Faculty

15

Laboratories & Centers

32+

ME Rank - Public Institutions

8

USNews Rankings 2019

Undergraduate Program Rank

15

USNews Rankings 2019

Graduate Program Rank

23

USNews Rankings 2020

Undergraduate Students

AY 2018-2019 - Sophomore-Senior only

1151

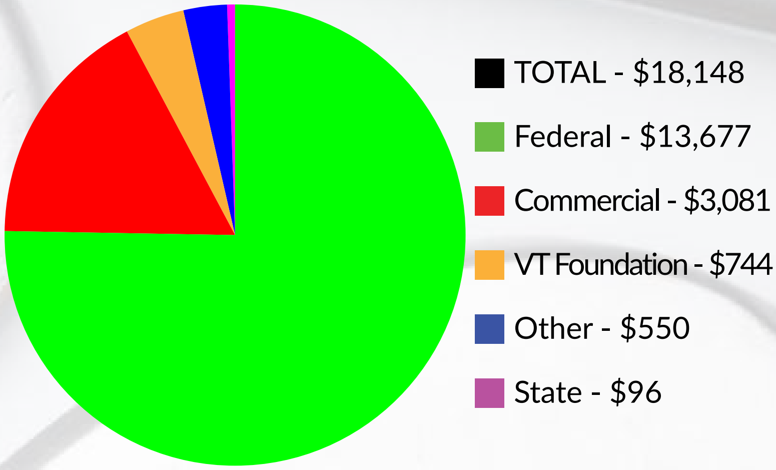
Graduate Students

AY 2018-2019

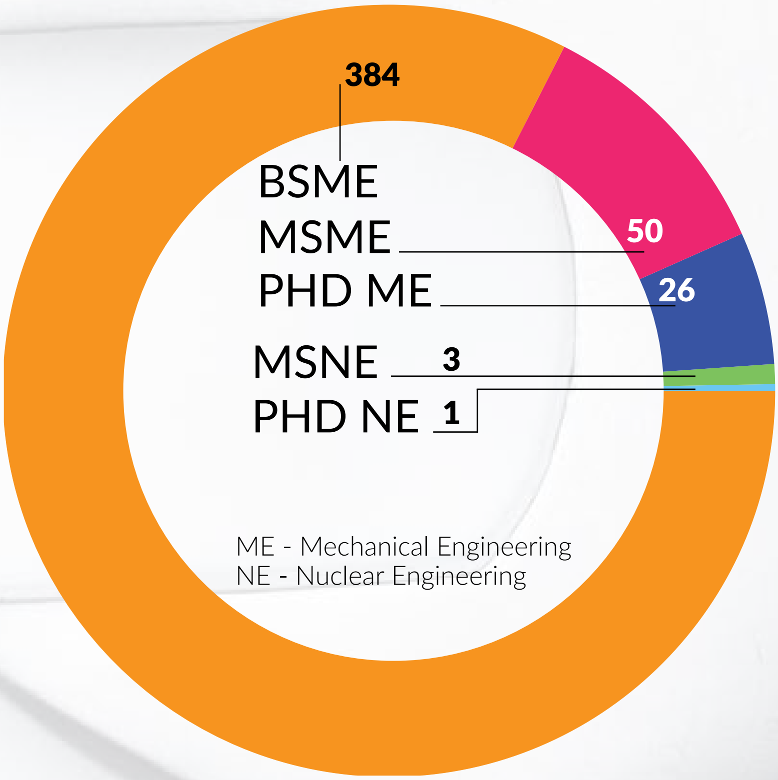
294

'18-'19 Total Research Annual Expenditures

In thousands



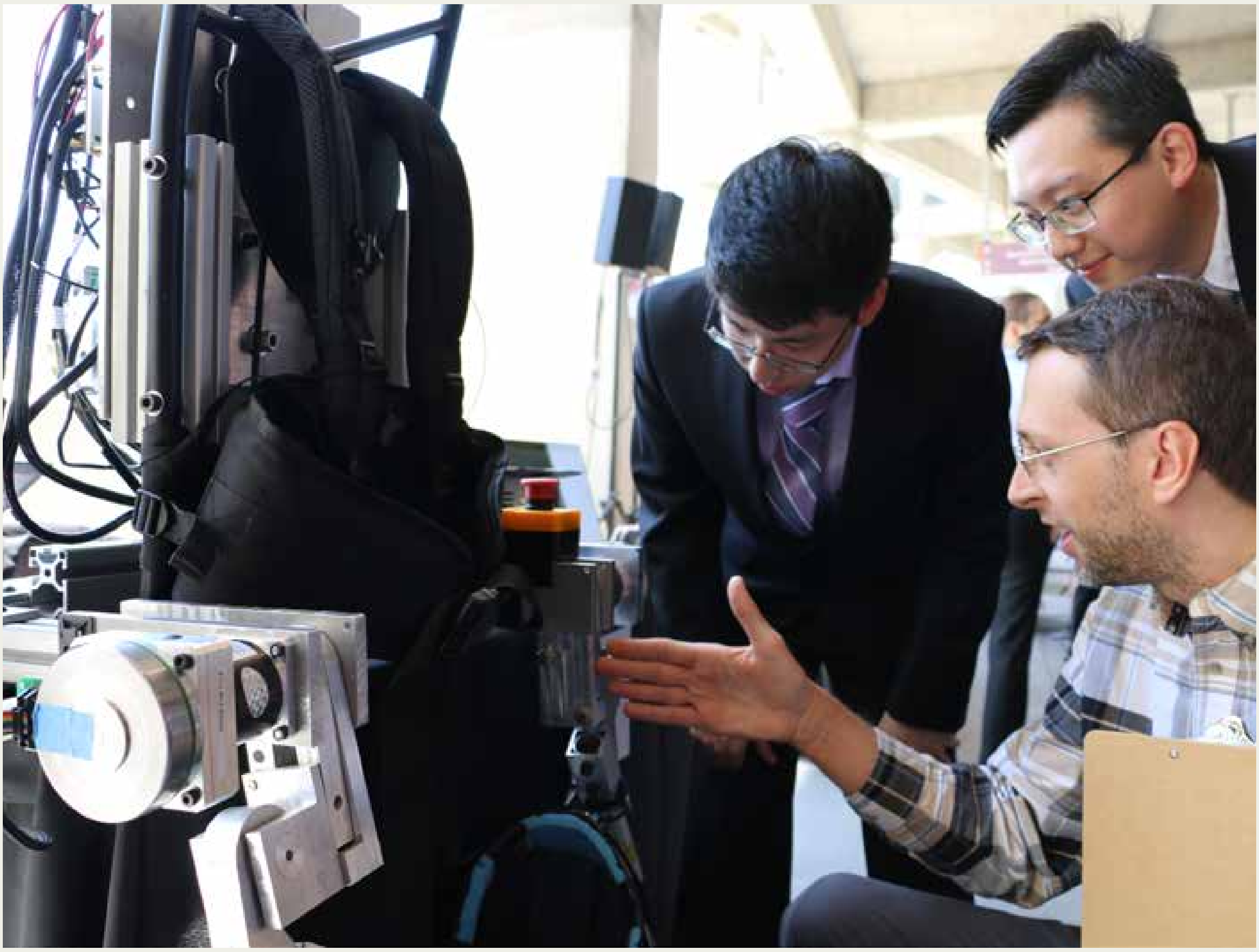
Degrees Conferred - 2018-2019



INNOVATE | ADVANCE
LEARN | INSPIRE

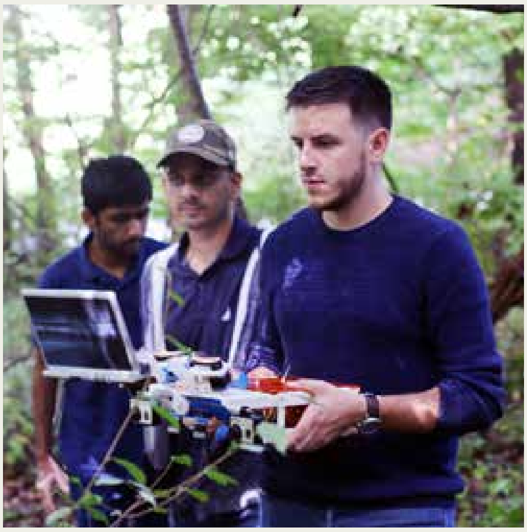
RESEARCH

THE TECHNOLOGY OF THE FUTURE REQUIRES THINKING BEYOND WHAT IS POSSIBLE. FROM NANO-SYSTEMS TO ROCKETS, RESEARCH INSPIRES NEW IDEAS, NEW DISCOVERIES, AND NEW TRUTHS



At the very core of the Department of Mechanical Engineering is our relentless desire to conduct research that pushes the boundaries, that takes what we've learned from the past and shapes it to fit the future. We do this by being collaborative, innovative, and unafraid of failure. Working with our partners within the university, and with contemporaries outside Blacksburg, mechanical engineering faculty embrace the value of collaboration and open new avenues of discovery.

Bio-inspired technology reinterprets sonar signals



In an effort to more effectively process sonar technology, the U.S. Navy has turned to an unlikely source for help – bats. Bats may provide the answer to a glaring problem of drone operation - navigating in dense natural environments. As part of a five-year project for the Office of Naval Research, mechanical engineering professors Rolf Mueller and Michael Roan, are collaborating with three other universities to develop a better model for the sonar skills of bats.

Mueller has been developing a bat robot using data from his two decades of study of horseshoe and Old World round leaf nosed bats in Asia and Europe.

"The idea is the input to the robot - a collection of echoes taken from the forests - are run through a computer simulation of what we think the bat's brain is doing," Mueller said. "Then we try to make sense of the signals. It's like focusing a camera lens – you keep adjusting your input until you get the clearest image."

A big part in deciphering the signaling process comes from a small cluster of one-half centimeter microphones designed by Roan, that will create an additional correlation for brain researchers.

"The project is really about creating a biosonar," Roan said.

Rolf Mueller
Professor

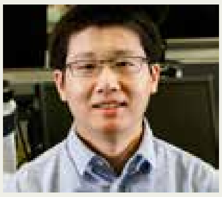
Research Focus: Bio-inspired technology; Biodiversity in biological form and function; Biosonar sensing.

Michael Roan
Professor

Research Focus: Acoustic materials development and testing; Audio engineering; 3D acoustic immersion

More bats - In a seprate paper, this one in the Proceedings of the National Academy of Science, Rolf Mueller (above) changes how researchers look at bat sonar by showing the movement of a bat's ears creates a Doppler shift, which the bat can sense, helping them achieve their uncanny ability to navigate through thick vegetation.

Sea urchins provide clue to light materials



Ling Li
Assistant Professor

Research Focus: Biological structural materials; Bio-inspired materials

In the search for strong, lightweight materials, researchers are looking to sea urchins, which have spines made of chalk, a generally brittle substance.

The complex three-dimensional structure of sea urchin spines that is 70 to 80 percent porous creates a stable and strong structure. Studying the sea urchin is part of a $540,000 National Science Foundation grant being investigated by Ling Li.

By using design rules gathered from studying biological systems and inputting those rules into the design of bio-inspired lightweight ceramic materials, Li said he hopes the information can be applied to creating lightweight panels and other components.

Diseases spread by 'sneezing' plants

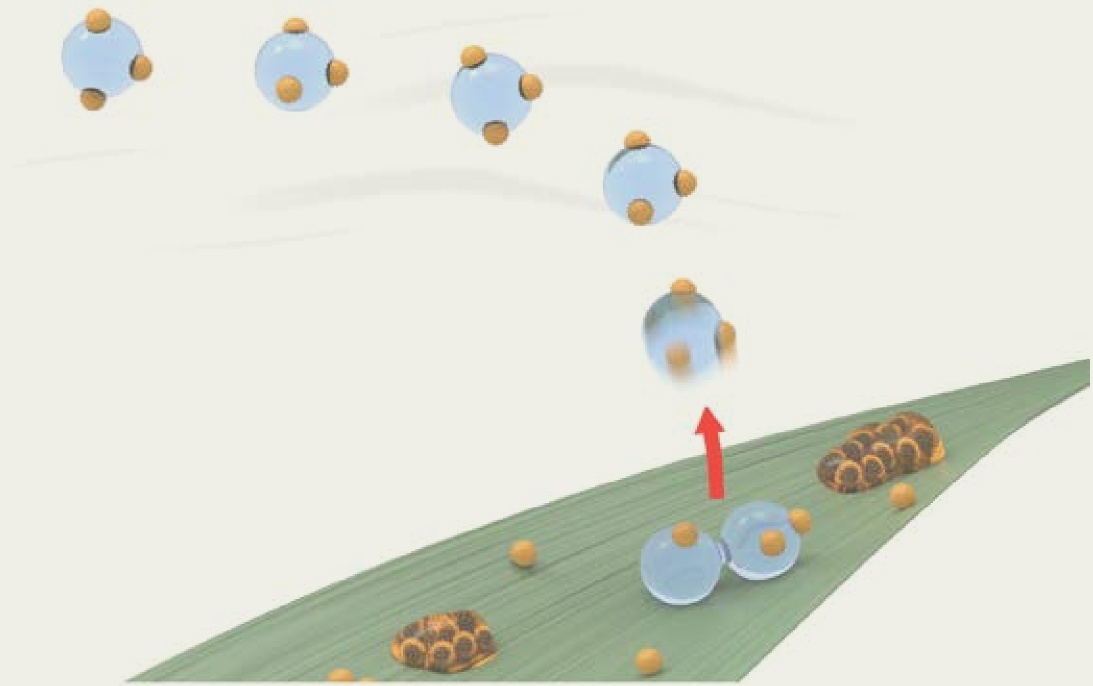
Jonathan Boreyko
Assistant Professor

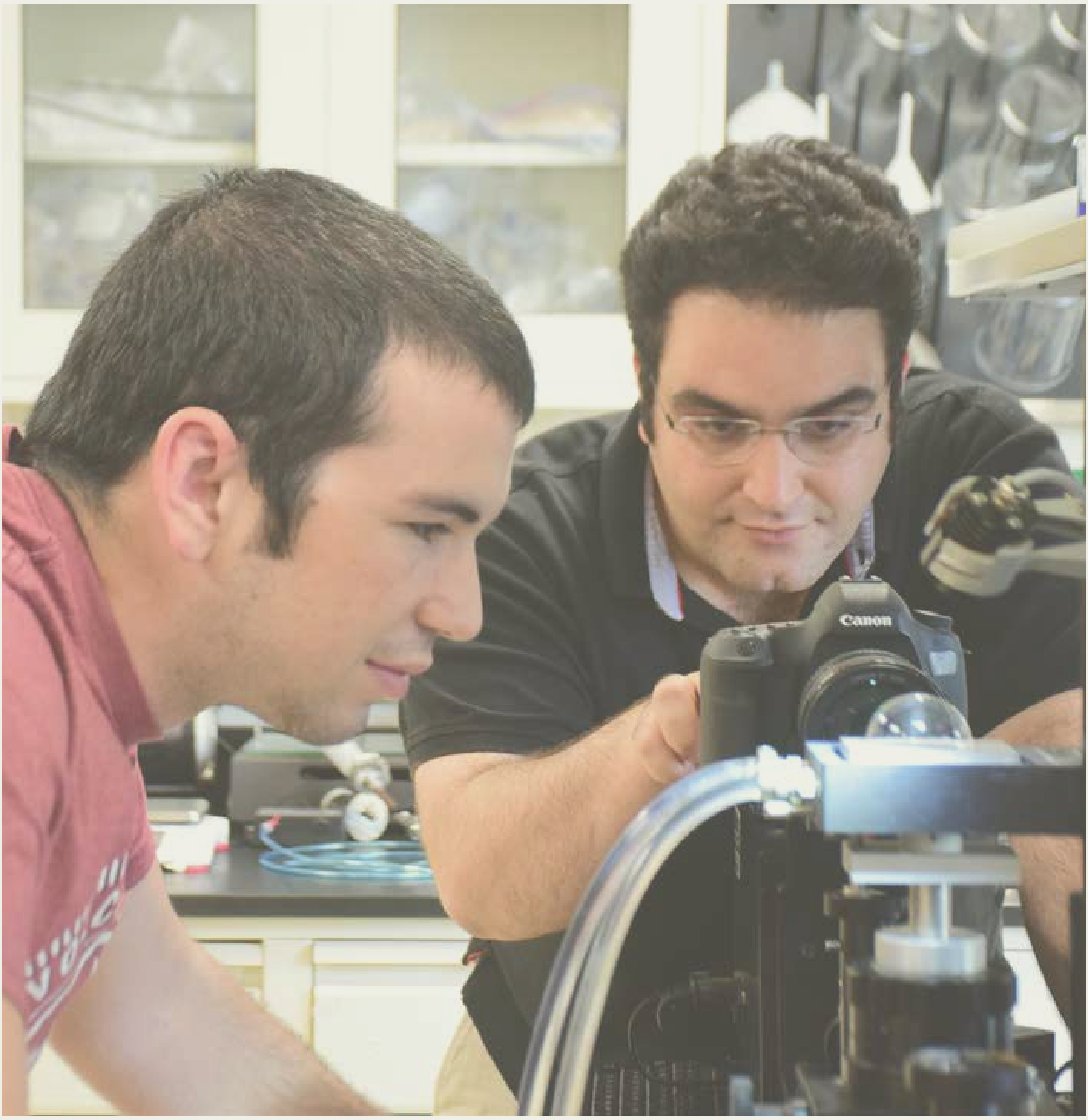
Research Focus: Interfacial fluid mechanics; Biomimetic engineering; Water and energy harvesting; Droplet dynamics; Synthetic trees

In an article published on the cover of the Journal of the Royal Society Interface, Virginia Tech researchers have found that wheat plants 'sneezing' off condensation can vastly impact the spread of spore-borne diseases such as wheat leaf rust which can cause yield losses of up to 20 percent or more in the United States, and higher losses in less developed agricultural nations.

The study is part of a three-year grant from the US Department of Agriculture's National Institute of Food and Agriculture to study the dispersal of wheat pathogens by rain splash and jumping-droplet condensation. Jonathan Boreyko, assistant professor of mechanical engineering is a co-PI on the nearly $500,000 project.

"Conceptually, what the plants are doing is sneezing," Boreyko said. "The jumping droplets, at the rate of 100 or more an hour, are a violent expulsion of dew from the surface. It's good for the plant because it is removing spores from itself, but it's bad because, like a human sneeze, the liquid droplets are finding their way onto neighboring plants. Like a cold, it's easy to see how a single infected plant could propagate a disease across an entire crop."





Study bubbles - Christian Kingett (left) and Farzad Ahmadi, study how bubbles freeze. They found that boundary layer heating pulls ice particles up and distributes them around a bubble's interior causing faster freezing. The work will change how researchers look at the process of freezing.

Joseph Meadows
Assistant Professor

Research Focus: Combustion; Heat transfer; Advanced laser diagnostics; Thermoacoustics; Pressure gain combustion

Game-changing filters being tested

The U.S. Dept of Energy has a goal of carbon filtration using solid sorbents by 2030. Virginia Tech's Advanced Power and Propulsion Laboratory is home to a proof-of-concept experiment that could help launch a billion-dollar business that will have enormous implications on how pollutants are collected and recycled, and thus impact the long-term goal.

Partnering with MOVA Technologies based in Pulaski, Virginia, Joseph Meadows, an assistant professor of mechanical engineering in the College of Engineering, will analyze the company's panel-bed filters at his test cell in the lab. With Meadows, Stephen Martin, an associate professor of chemical engineering, will serve as the subject-matter-expert in the field of solid sorbents.

"Working with MOVA, we will measure the efficacy of the company's panel-bed filters at absorbing various pollutants, saturation time for various conditions and contaminants, and optimize the system's operational parameters," said Meadows. "In the future, we will investigate these parameters in realistic temperature and pressure environments."

Traditional scrubbers remove pollutants en masse leaving tons of collected waste that requires expensive specialty treatment or storage. MOVA's panel-bed filters are designed to selectively remove individual contaminants, which can then be easily sold on as products in their own right – lowering the amount of pollutants that are put into storage by recycling waste into products.

Examples of applications that use recycled waste include: fly ash used in cement, sulfur dioxide used in preservatives and wastewater treatment, nitric oxide used by the fertilizer and medical industries, and carbon dioxide sold as carbon emission credits.

Mechanical Engineers develop process to 3D print piezoelectric materials

Piezoelectric materials that inhabit everything from cell phones to greeting cards may be getting an upgrade thanks to work discussed in the journal Nature Materials.

Xiaoyu 'Rayne' Zheng, assistant professor of mechanical engineering and his team have developed methods to 3D print piezoelectric materials that can be custom-designed to convert movement, impact and stress from any directions to electrical energy.

Piezoelectric materials come in only a few defined shapes and are made of brittle crystal and ceramic – requiring a clean room to manufacture. Zheng's team developed a technique to 3D print these materials so they are not restricted by shape or size. The material can also be activated – providing the next generation of intelligent infrastructures and smart materials for tactile sensing, impact and vibration monitoring, energy harvesting, and other applications.

The model they developed allows them to manipulate and design arbitrary piezoelectric constants, resulting in the material generating electric charge movement in response to incoming forces and vibrations from any direction. Unlike conventional piezoelectrics where electric charge movements are prescribed by the intrinsic crystals, the new method allows users to prescribe and program voltage responses to be magnified, reversed or suppressed in any direction.

Xiaoyu 'Rayne' Zheng
Assistant Professor

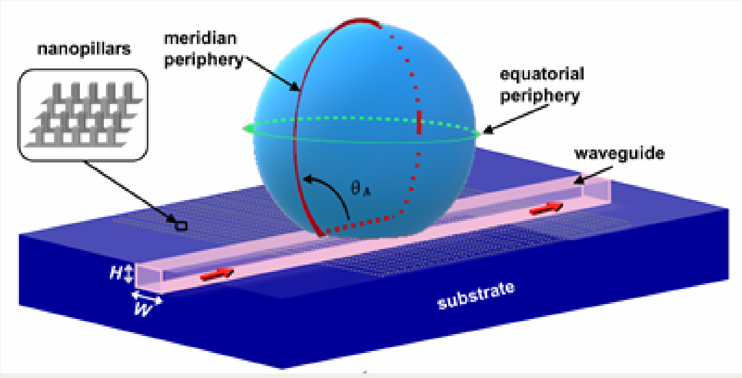
Research Focus: Hierarchical multifunctional materials and systems; Mechanics of materials; Micro and nanotechnology; Biomedical microdevices

3D printing graphene - Working with Lawrence Livermore National Laboratory, Virginia Tech researchers including Xiaoyu 'Rayne' Zheng, developed a way to 3D print complex objects from graphene, a high performing material used in the battery and aerospace industries. Graphene is one of the strongest materials tested, with high thermal and electrical conductivity making it suitable for applications in batteries, aerospace, heat management, sensors, and catalysis. The ability to manufacture with graphene will allow for the optimization of strength, conductivity, mass transport, and weight density that was unachievable with graphene aerogels.

Liquid droplets paving the way for highly sensitive sensors

Jiangtao Cheng
Associate Professor

Research Focus:
Optofluidic solar concentrators based on electrowetting on dielectric-driven liquid prisms



Sensitive, miniaturized sensing systems are important for medical and environmental diagnostic and monitoring applications. Chip scale integrated photonic sensing systems that combine optical, electrical, and fluidic functions are especially attractive for sensing applications due to the high sensitivity of optical sensors, the small form-factor of chip scale systems, and the low processing cost.

While optical sensing with a detection limit down to single nanoparticles has been achieved by various methods, microcavity sensing attracts much attention because their high quality factors (Q factor) and small mode volumes enable significant enhancement of light-matter interactions. Microcavity sensing has seen tremendous progress and the sensing performance has been demonstrated by detecting single biological molecules. However, detection in liquids with whispering gallery mode (WGM, i.e., closed circular beams supported by total internal reflections at the external cavity interface) cavities was achieved only in rare cases. No real and stable high Q-factor sensing experiment with non-solid optical resonators has been reported to date.

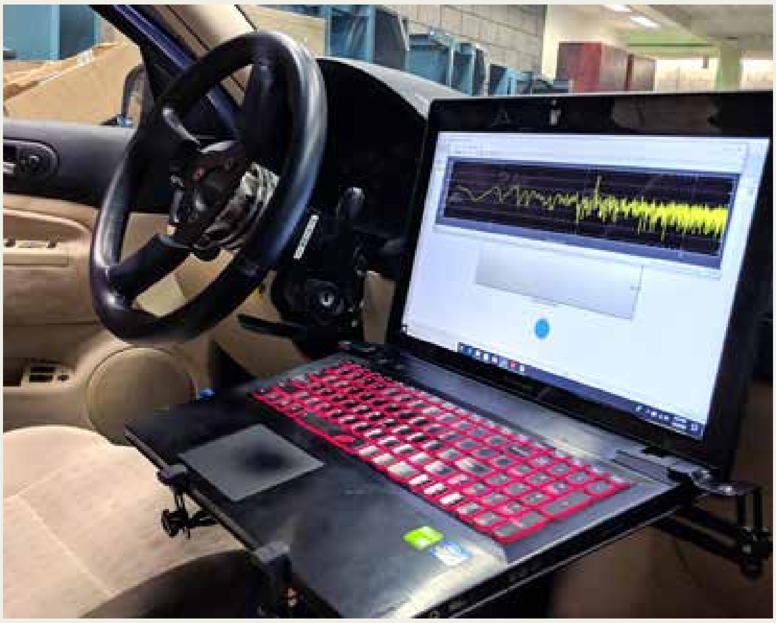
Creating intelligent tires for safer automobiles

Saied Taheri
Professor

Research Focus:
Tire and vehicle dynamic modeling and simulation;
Intelligent tire development and application;
Vehicle chassis systems control

The concept of intelligent tires was introduced more than a decade ago. Various tire companies invested in developing this technology internally and a few have come to market with a preliminary product.

The idea is to measure, in real-time, the tire vibration characteristics and make indication of various important parameters such as road surface type and condition, friction potential, wear, hydroplaning, health monitoring, and load. Knowledge about any of the above parameters could potentially help with improving safety of the transportation system, specially with autonomous vehicles. At CenTiRe, research on this topic started 8 years ago and continues towards realization of the concept into a viable product.



With funding from NSF and several tire companies, we have been able to put the intelligence in the tire. One such example is a real-time machine learning algorithm which can predict the road surface type and its state (wet, dry, snow, or ice). Current efforts are focused on estimating friction between the tire and the road and feeding that information into the advanced chassis control systems on-board the vehicle (ABS, VSC, ADAS, etc.)

Bahareh Behkam
Associate Professor

Research Focus: Micro/nanoscale systems engineering with special interest in biotic (living)/abiotic (synthetic) interfaces.

Engineering nano-textured surfaces to lessen microbial biofilm formation

Healthcare-associated infections are a major cause of death in the United States. Up to 70 percent of these types of infections are attributable to microbial biofilm growth on implantable medical devices, particularly catheters.

An article in the American Chemical Society's Applied Materials & Interfaces journal introduces a thermodynamic-based modeling framework that may one day result in lowering the instances of biomedical-device associated infections.

The modeling breakthrough came from an interdisciplinary team of faculty from Virginia Tech's Macromolecules Innovation Institute led by Associate Professor Bahareh Behkam, working with Amrinder Nain and Michael Ellis, also associate professors in mechanical engineering, and Alan Esker, professor and chair of the chemistry department in the College of Science.

Because items like catheters are inserted into the body, the buildup of biofilm is often detected only after symptoms occur and after the infection has taken hold. Catheter-associated infections are the most common cause of secondary bloodstream infection with substantial mortality rates.

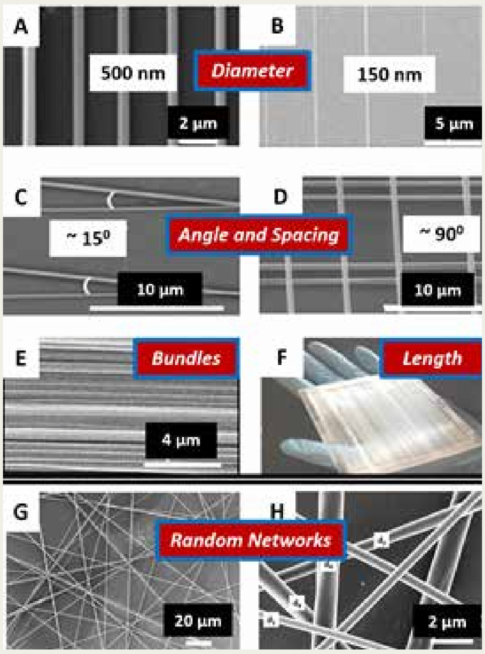
The standard for prevention of microbial adhesion and the first step to microbial biofilm formation, has been chemical modification of device surfaces using antimicrobial compounds.

Behkam is working to create a textured layer on the device that will repel microbes and keep them from forming for a longer period of time. This non-toxic physical modification of surfaces as an antifouling strategy is a relatively new area of research.

Cell migration key to wound healing, cancer metastasis

Cells use roads and paths to move around, and prefer some paths over others. This preference could help researchers create materials that will assist in understanding cell migration vital in developmental biology, wound healing, and cancer metastasis.

To make cells move, Associate Professor Amrinder Nain came up with a patented approach to build fiber networks, called Spinneret Based Tunable Engineered Parameters. Because STEP doesn't use electricity, it provides fine control of fiber spacing, fiber diameter, and fiber orientation.



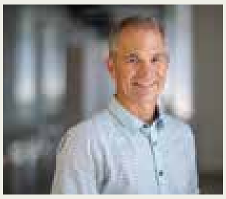
Inside the body, collagen is fibrous in nature and the individual fibers are tiny - between 30-70 nanometers in diameter. Cells don't attach to them because the cells are too large - about 20 microns. The fibers bundle together to form larger diameter structures from 200 nanometers to several microns. To give some idea on scaling, a strand of human hair varies in diameter anywhere from 50-200 microns.

"Our interest lies in looking at cell behavior and relating it with the forces the cells are exerting," Nain said. "For instance, we might look at the difference in forces between a diseased cell and a non-diseased cell, and how the forces are altered in say migration or how they respond to the addition of drugs. This is all part of what we're trying to understand." In two recent papers from 2017, Nain used the fiber networks to (i) study the protrusions formed by cancer cells, and (ii) engineer closing and non-closing wound gaps.

Amrinder Nain
Associate Professor

Research Focus: Nanotechnology, micro/nanofiber manufacturing and characterization; Advanced materials and biomaterials; Cellular dynamics and tissue engineering

Firebrand ignition of homes in wildfires

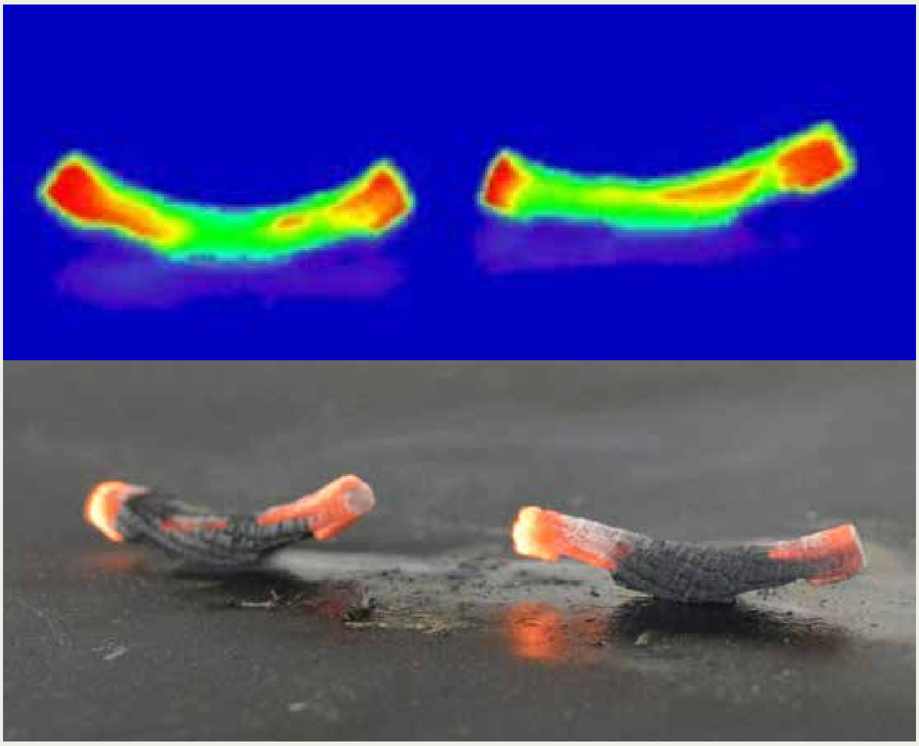


Brian Lattimer
Professor

Research Focus: Disaster resilience; Wildfires; Machine learning for physics-based predictions; Material behavior in extreme environments; Remote sensing

Firebrands are small pieces of partially burned vegetation or building material typically less than one inch long that can fly over a mile from the main part of a wildfire and ignite homes.

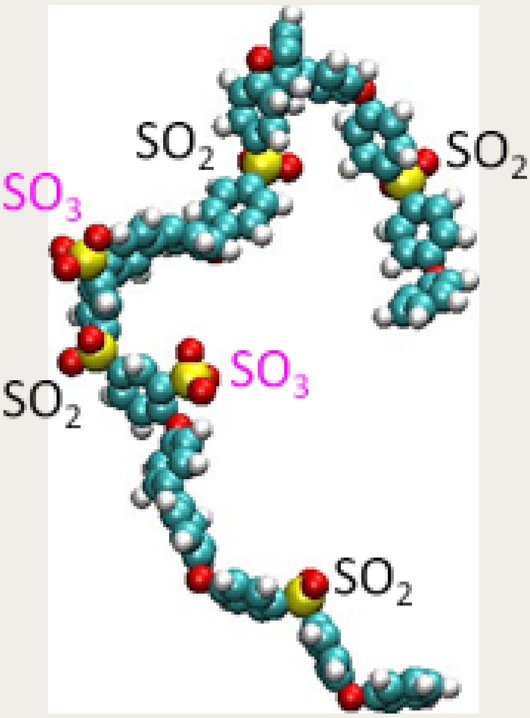
It is difficult to determine where these "spot fires" occur, which usually results in a large amount of damage before firefighters arrive to extinguish them.

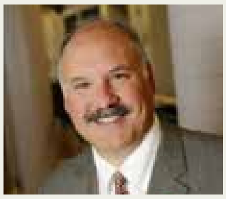


Brian Lattimer, professor in Mechanical Engineering, is a co-PI on a nearly $500,000 grant with the National Institute of Standards and Technology to understand the localized ignition of building materials by firebrands and develop models to predict the probability of ignition. The research will support the development of future material performance standards and guides in guarding homes against ignition from wildfires.

"Our group is seeking to develop a more detailed understanding of how wildfires spread and efficient ways to predict the behavior using machine learning. These efficient predictions can be used to support vegetation management to reduce wildfire severity and forecasting wildfires."

Using ionic polymers to purify water better



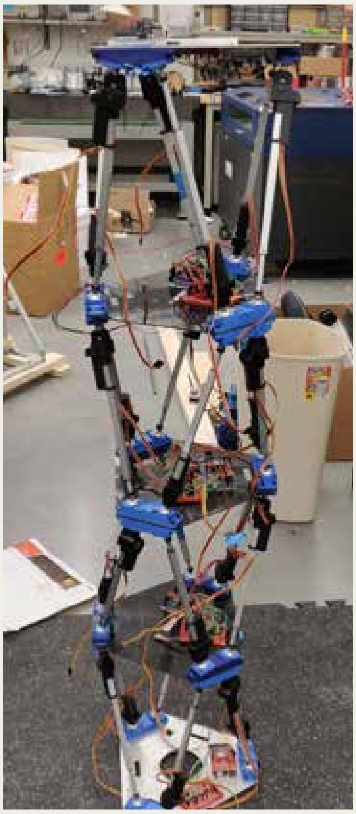


Jack Lesko
Professor

Research Focus: Sustainable materials and systems design and manufacturing; Pedagogy of the graduate student and faculty mentee/mentor relationship

Can ionic polymers replace traditional reverse osmosis membranes for more efficient and cost-effective means to purify water? New ionic polysulfones have been designed and synthesized in cooperation with Prof. Judy Riffle, Dept of Chemistry. Even when these polymers absorb 5 to 10 times the water of traditional engineering thermoplastics, their mechanical strength and durability is on par or better than dry thermoplastics polymers. This new class of ionic polysulfones also possess greater selectivity (higher salt rejection) and higher volumes of treated water at a lower energy cost.

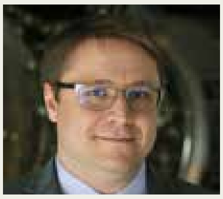
An interdisciplinary group of faculty and students in engineering, chemistry and physics has enabled this comprehensive design, synthesis, and characterization to produce and better understand property-structure relationships for this new class of polymers. Further work explores the nature of water in these polymers via molecular dynamics simulation, high volume production of these polymers and the potential fouling mechanisms for these systems.



Creating robots to build structures in space

In-space assembly by robots can transform how structures are built in space, enabling larger habitats, space telescopes, col-located Earth science instruments, and backbones for scientific and commercial use. Assistant Professor Komendera, director of the Field and Space Experimental Robotics Laboratory, has led research in ISA as a NASA researcher and as assistant professor.

In August 2019, NASA awarded a two-year, $2,500,000 Early Career Initiative grant to Langley Research Center, Virginia Tech, and Honeybee Robotics, for "Assemblers: A modular and reconfigurable manipulation system for autonomous in-space assembly." The project will apply advances in machine learning, control theory, and state estimation to expand concepts pioneered by Komendera and others at NASA. Assemblers will develop and demonstrate a lightweight, highly stiff assembly manipulation system consisting of stacked Stewart platforms, and a multi-agent task management system to manage in-space and surface construction tasks. Assemblers will be a modular architecture featuring interchangeable end-effectors for the multiple tasks required to construct complex space systems. Assemblers will also implement methods for error detection and correction using machine learning and autonomous decision-making.



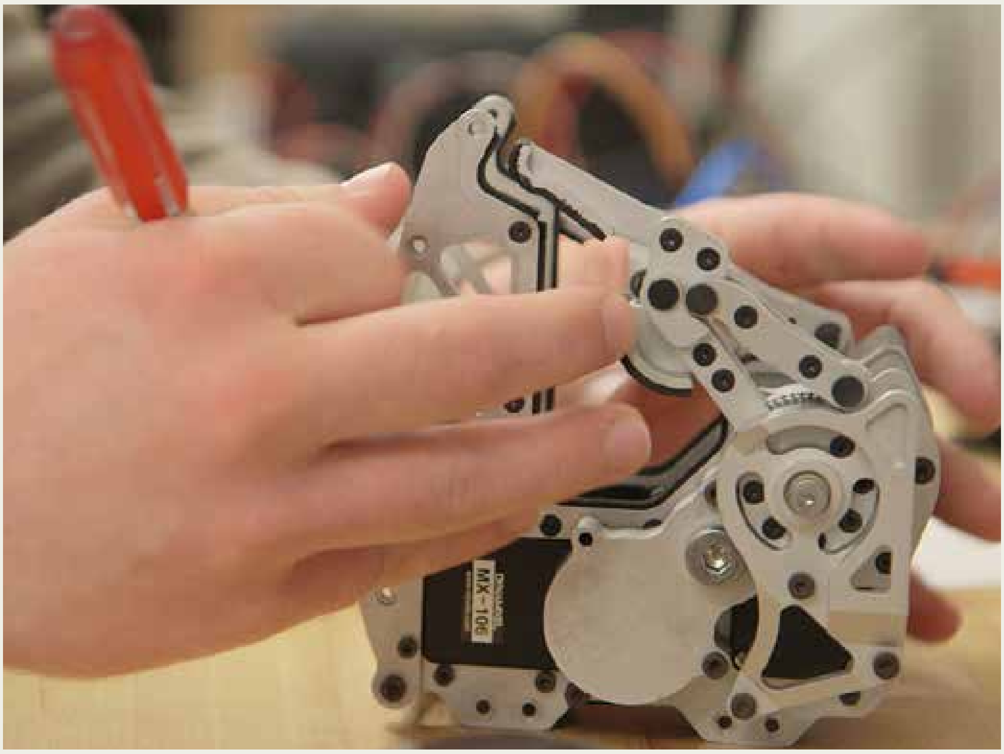
Erik Komendera
Assistant Professor

Research Focus: Autonomous assembly and construction; Space robotics; Field robotics; and Perception;

Alexander Leonessa
Professor

Research Focus: Control theory and robotics; Autonomous ground, aerial, surface, and underwater vehicles; Rehabilitation robotics, brain computer interfaces, and sensory-motor neuroprosthesis

Robotics to improve quality of life

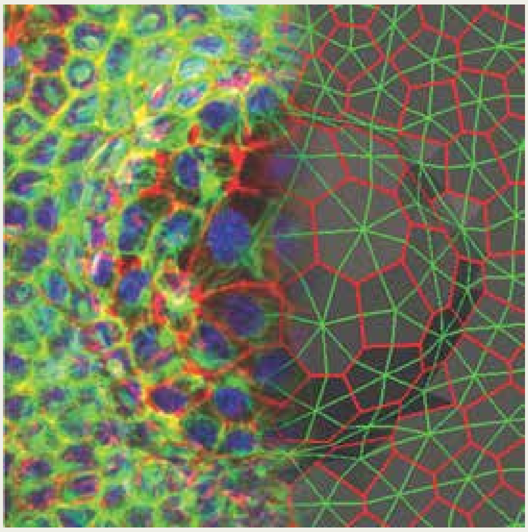


Dr. Leonessa's research focuses on the design, control and validation of robotic solutions to improve the quality of life of people with disabilities. His research spans from functional electrical stimulation to help people with paralysis, to prosthetics design, and brain computer stimulation. Over the last few years his research has mainly focused on the design of exoskeletons to aid farmers, manufacturing workers, first responders, and people with spinal cord injuries to regain the ability to complete their daily tasks.

Sohan Kale
Assistant Professor

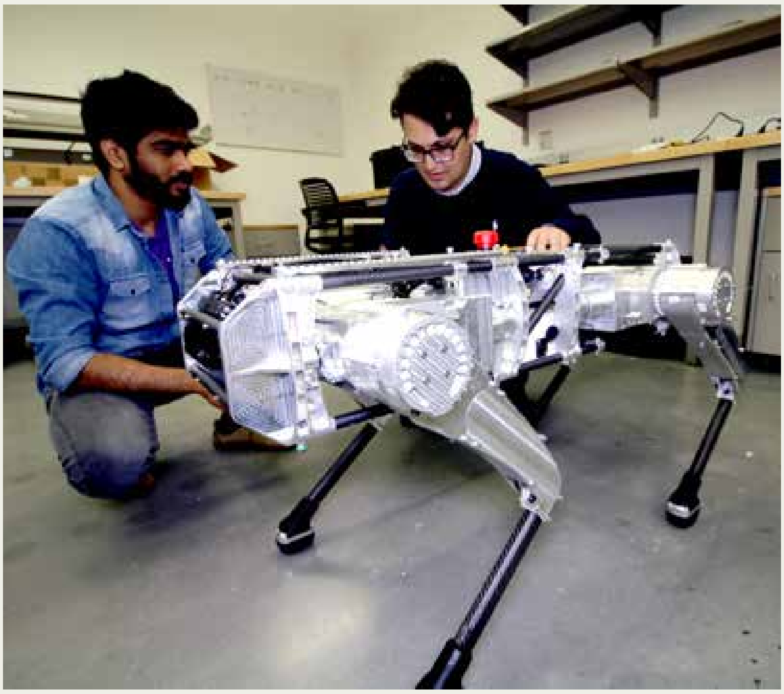
Research Focus: Mechanobiology of cells and tissues; Continuum thermomechanics; Computational mechanics; Multiscale modeling

Lab studies new 'living' engineering material



Advances in bioengineering have led to promising technologies such as organs-on-chips, organoids, and bio-robots. These multicellular engineered living systems are built from cell and tissues, that are soft, dynamic, and live out-of-equilibrium. In the recently established 'Mechanics of Living Materials Lab', we develop theoretical models and computational tools to understand the coupled bio-chemo-mechanics of this new class of 'living' engineering materials. Dr. Kale's past work was focused on mechanics of epithelial tissues. These are cohesive cellular sheets forming protective interfaces in our bodies. His theoretical modeling efforts, as a part of a collaborative team of researchers, led to the discovery of a novel behavior of epithelia termed as 'active superelasticity'. Analogous to superelastic Nickel-Titanium alloys, these biological tissues were shown to undergo extreme reversible deformations at nearly constant tensions. Current research in his lab is focused on connecting the subcellular mechanics to tissue level emergent behaviors relevant in physiology and diseases. We aim to use these multiscale computational frameworks to address fundamental questions in mechanobiology including cell motility, collective cell motion, tissue morphogenesis and growth. We aspire to use the predictive power of our computational platforms to control, manipulate, and engineer living materials.

Legged robots enable access to locations too dangerous for people



Kaveh Akbari Hamed
Assistant Professor

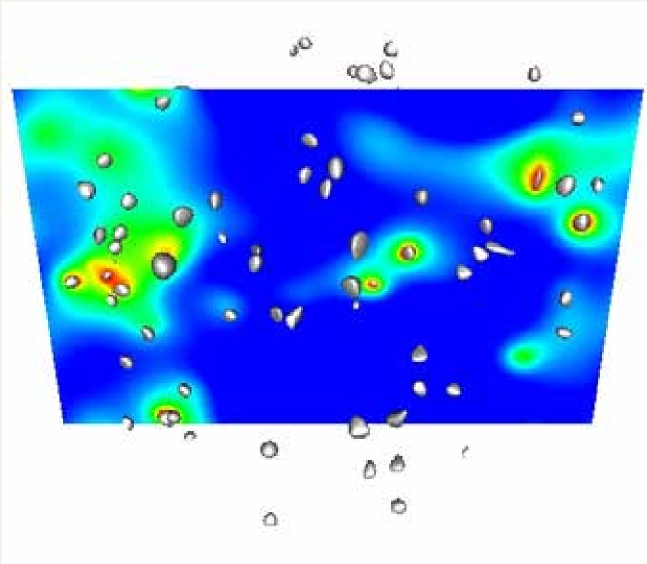
Research Focus: Control theory; Robotics; Cyber-physical systems, optimization, and hybrid dynamical systems

Assistant Professor Akbari Hamed's research aims to develop intelligent, robust, and safe feedback control algorithms for agile, robust, and dynamic locomotion of legged robots in real-world environments. More than half of the Earth's continent is unreachable to wheeled vehicles - this motivates the deployment of legged robots to enable the accessibility of these environments and thus bring robots into the real world. His research also aims to create distributed and decentralized feedback control algorithms for legged robots that cooperatively work with each other or people to achieve a variety of tasks in complex environments. The theoretical results are experimentally evaluated on advanced quadrupedal robots in his lab. The goal is to advance the control technology in deploying agile robots that can assist, or stand in for, humans in dangerous situations such as industrial accidents or natural disasters. This research is supported by NSF.

John Palmore Jr.
Assistant Professor

Research Focus:
CFD; Direct numerical simulation; High performance computing; Multiphase flows; Turbulence; Phase change

High performance computing key to study of turbulent, multiphase flows



The Palmore Research Group develops high-fidelity numerical methods to study turbulent and multiphase flows. Our primary research focus is on fluid flows related to energy and the environment. We study topics including fuel combustion (spray dynamics), fuel production (bubble column reactors), and energy conversion systems (gas turbines engines). In developing our numerical methods we rely heavily on massively parallel, high performance computing techniques to accelerate our code. As such, our work lies at the nexus of engineering, mathematics, and computer science

***Joseph* Meadows**
Assistant Professor

Research Focus:
Combustion; Heat transfer; Advanced laser diagnostics; Thermoacoustics; Pressure gain combustion

Taming supersonic jet noise

Supersonic exhaust from military aircraft produce high levels of noise, which pose an occupational health risk for personnel and unwanted noise for local communities. Development of effective noise control strategies require fundamental tools for engineering design and optimization. Theoretical noise models and computational predication tools will play an integral role in the development of noise-control systems; however, advanced experimental diagnostic techniques are required to develop theoretical models. Laboratory environments are ideal for investigating supersonic jet noise due to the ability to control individual variables.

The research will investigate the impacts of supersonic jet noise at afterburner conditions, so laboratory experiments producing boundary conditions similar to those produced by afterburners are required. The proposed research will develop a secondary combustion zone/afterburner located upstream of a supersonic nozzle and downstream of a main combustion system with the ability to generate entropy waves (i.e. temperature/density fluctuations) by acoustically driving the afterburner fuel flow rates, as well as operate without acoustically forced entropy waves. Unsteady pressure and OH* chemiluminescence measurements will be acquired within the afterburner, and sound pressure measurements, ultra-high speed rainbow schlieren deflectometry (RSD) measurements, and time-resolved Doppler global velocimetry measurements will be acquired downstream of the nozzle exit.

John Ferris
Associate Professor

Research Focus: Improving ground vehicle performance by studying vehicle system interactions with terrain surfaces; Vehicle dynamics.

Improving ground vehicle performance

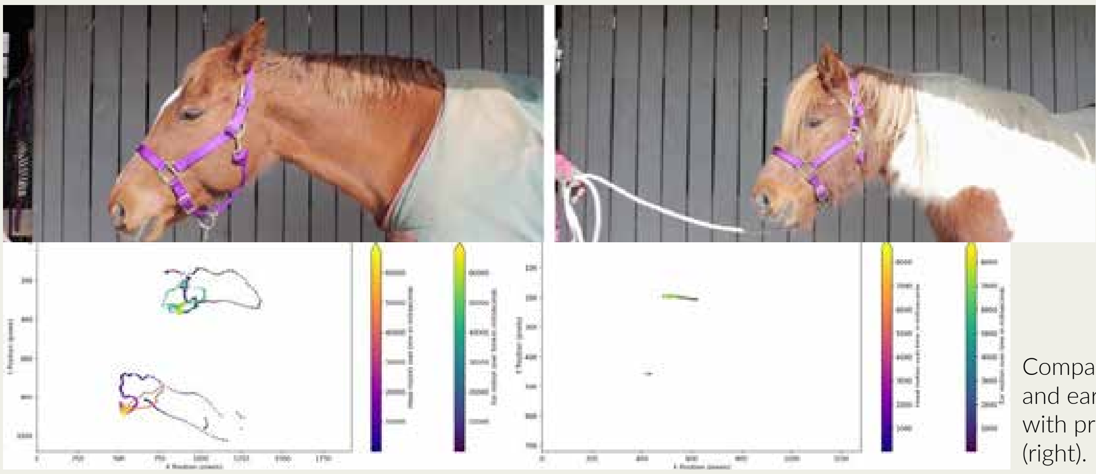
Dr. John B. Ferris has established a global reputation for his work investigating improvements to ground vehicle system performance by studying their interactions with terrain surfaces. Specifically, his research focuses on chassis design and development, vehicle dynamics, mobile mapping systems, driver-vehicle interactions, virtual proving ground development, design for reliability, customer usage and correlation, and automated vehicle development. Credentials include invited lectures throughout Europe and keynote address in Australia. He received his B.S. from Carnegie Mellon and his M.S. and Ph.D. from the University of Michigan. He began this work in 1990 for Chrysler, then DaimlerChrysler and ZF Lemförder, before joining the Virginia Tech faculty in 2005 as an Associate Professor. He has participated in dozens of sponsored research projects totaling over $11 million, with over 60 peer reviewed publications. His contributions as founder and director of the Vehicle Terrain Performance Laboratory are detailed on the lab website: www.me.vt.edu/VTPL

Researchers develop non-invasive tool to improve healthcare for horses

Mary Kasarda
Associate Professor

Research Focus: Machinery and structural health monitoring; Engineering education in K-12; Transition of US military veterans to higher education and careers; Rotor dynamics, active magnetic bearings and vibrations

A collaboration with the VT College of Veterinary Medicine has resulted in the completion of pilot work for the development of a non-invasive tool with the potential to improve the care and well-being of horses. Researchers have developed an algorithm that uses image-processing techniques to detect horse head and ear motions which may provide indications of pain, stress, or well-being. Detecting pain in horses is difficult because, as prey animals, they have mechanisms to disguise pain. Currently detecting pain in horses primarily involves invasive methods, such as heart rate monitors, drawing blood, and pressing on painful areas to elicit a response. The non-invasive technique developed by researchers uses video to quantify certain motions for analysis. Shown in the figure are sample results from two test subjects including visualization approaches for data extracted over a 10-second video. Data is presented in the form of 2-D motion of ear and head, as well as displacement, velocity, and acceleration of the head and ear motion, respectively, versus sample number (time) for both X and y directions. This approach lays the groundwork for monitoring horses with noninvasive methods and without the presence of humans in applications such as post-operative monitoring, foaling, evaluation of performance horses in competition and/or training, and providing quantitative data for research on animal welfare.



Comparison of a video with head and ear motion (left) vs. a video with primarily just ear motion (right).

Juliana Duarte
Assistant Professor

Research Focus:
Nuclear safety analysis; Thermal-hydraulic systems; Experimental & computational two-phase flow; Boiling & condensation phenomena; Advanced light water reactor; Small modular reactors;

Testing fiber optics as a safety sensor for light water reactors

Assistant Professor Duarte's research focuses on an experimental program to apply advanced instrumentation and data analysis to better understand the post-critical heat flux (CHF) heat transfer, including transition boiling, the minimum film boiling temperature, and film boiling heat transfer regime.

The work will improve the understanding of multi-phase problems and help develop semi-empirical correlations to improve the modeling currently used in CFD and thermal-hydraulic system codes. Duarte is also interested in the heat transfer performance of accident tolerant fuels, particularly, in the surface effect on the critical heat flux and minimum film boiling temperature at nuclear reactor operating conditions. Her group is testing the applicability of fiber optics to measure the quenching temperature, an important safety parameter for light water reactors. "Optical fiber sensors act almost as a continuous sensor measuring temperature at each ~1 millimeter". Preliminary data will be presented in the American Nuclear Society Winter Meeting in November. Duarte said she hopes that high-pressure experiments using fiber optics will provide unique data to investigate these complex two-phase heat transfer phenomena.

This study is part of a $450,000 three-year Faculty Development Grant funded by the U.S. Nuclear Regulatory Commission

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Exoskeleton helps people with impairments complete tasks

Alan Asbeck
Assistant Professor

Research Focus:
Designing flexible human interfaces for mechanical & electrical systems, understanding human biomechanics and the body's internal control strategy, & creating sensors and control systems for wearable robots.

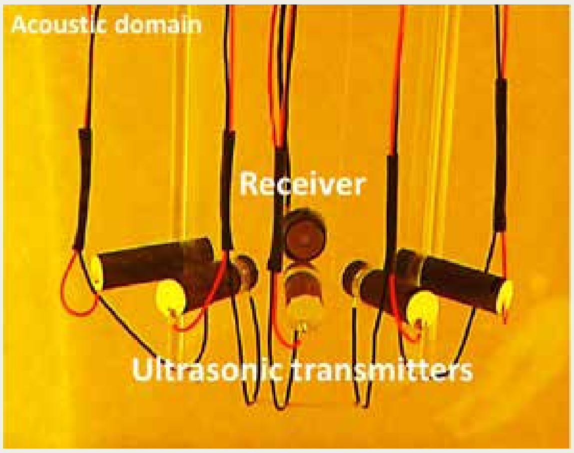
Many individuals have to perform repetitive arm movements or lift heavy boxes every day as part of their jobs. Still others have arm impairments or weakness which make it difficult to lift their arms and perform everyday tasks such as combing their hair or buttoning a shirt. To help all of these individuals, the Assistive Robotics Lab led by Dr. Asbeck is investigating new arm exoskeleton designs that can support the weight of a person's arm or a heavy box. These patent-pending designs were investigated by Dr. Asbeck's senior design team last year, with the result winning the Design Prize in the 2019 DEBUT Challenge. Currently, two students from that team are working with Dr. Asbeck on their Master's degrees, further improving the designs and investigating how the exoskeletons affect the body

An ultrasonic solution for wireless powering of biomedical implants

Shima Shahab
Assistant Professor

Research Focus:
To design a new generation of smart autonomous biomedical systems that lead to new medical diagnostics and treatments.

Contactless ultrasonic power transfer (UPT) is a new technology that eliminates impracticalities associated with wired electrical connections. In biomedical implants (e.g. cardiac pacemakers and wireless networks of sensors such as artificial retina and cancer detectors), the UPT concepts are the biocompatible methods which are effective at larger distances and offer frequency-wise flexibility. This technology, which is based on the reception of acoustic waves at ultrasonic frequencies by piezoelectric receivers, can be used to wirelessly charge low to high-power electronics. MInDS Laboratory investigates the use of acoustic holograms to create multifocal pressure patterns and power an array of piezoelectric receivers. The technical approach based on the combination of the nonlinear acoustic field with transmitter and receiver electroelastic nonlinearities, verified with controlled experiments, are studied to explore and understand the effects of various parameters on the coupled system for performance enhancement of UPT. We also perform a system-level investigation of through-wall high-power UPT dynamics to lay the foundation for its implementation in next-generation acoustic-based wireless devices including enclosed electronic devices operating in armor or other environments, such as autonomous unmanned aerial and underwater vehicles. State-of-the-art experiments and mathematical models of UPT focus on the transmitter, receiver, medium, geometric and material parameters.



This project was awarded by NSF.

Heat transfer: Metal foams as heat sinks

Roop Mahajan
Lewis A. Hester Chair Professor

Research Focus:
Advanced electronic cooling; Two-phase flows; Porous media synthesis and application of graphene, derivatives and composites; Biomedical devices; Emerging and Black Swan technologies

With the increasing demand for higher performance and progressive miniaturization of electronic packages, power densities and the attendant thermal dissipation requirements continue to escalate. Innovative thermal solutions are needed to ensure reliable operation at the device and die (chip) level. To this end, Professor Mahajan and his research team in the Department of Mechanical Engineering have embarked upon a multi-pronged, interdisciplinary research that explores novel thermal interface materials and highly porous metal foams as heat sinks. According to Professor Mahajan, his team focuses not only enhancing our understanding of the underlying physics of the transport phenomena in such devices, but equally importantly on the end goal of developing engineering solutions.

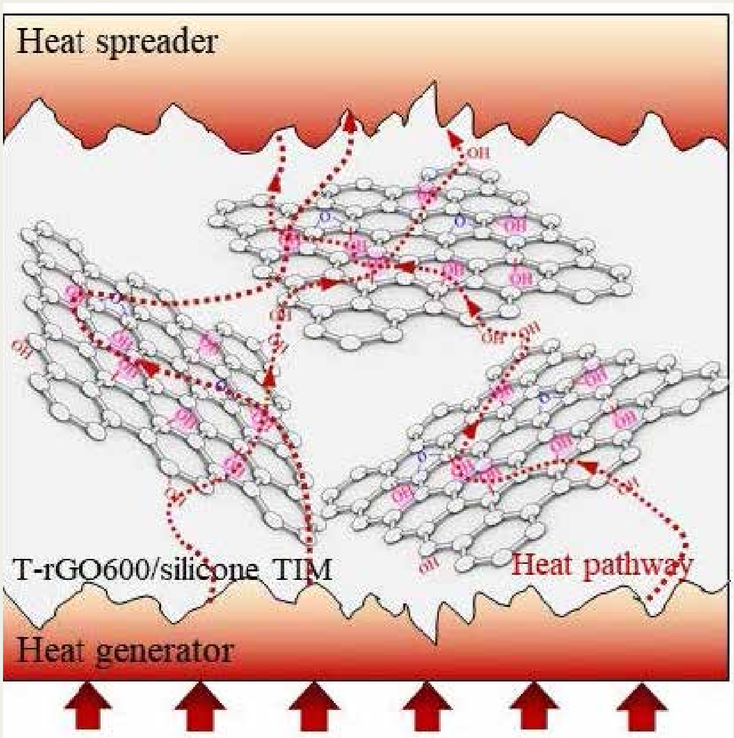


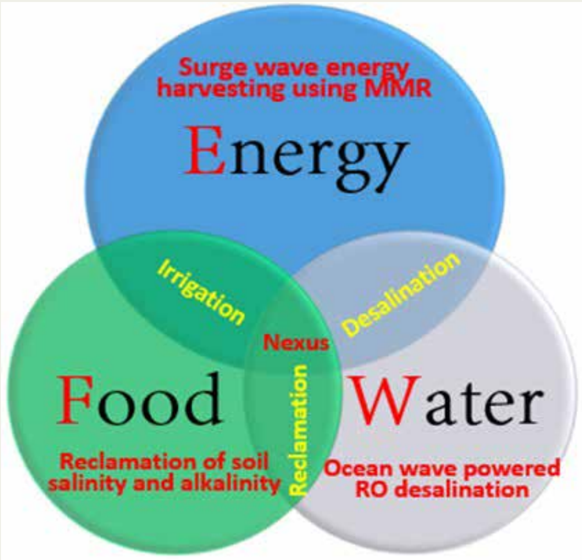
Illustration of heat pathways of graphene/silicone Thermal Interface Material composites in between heat generator and heat spreader.

Lei Zuo
Professor, John R. Jones III Faculty Fellow

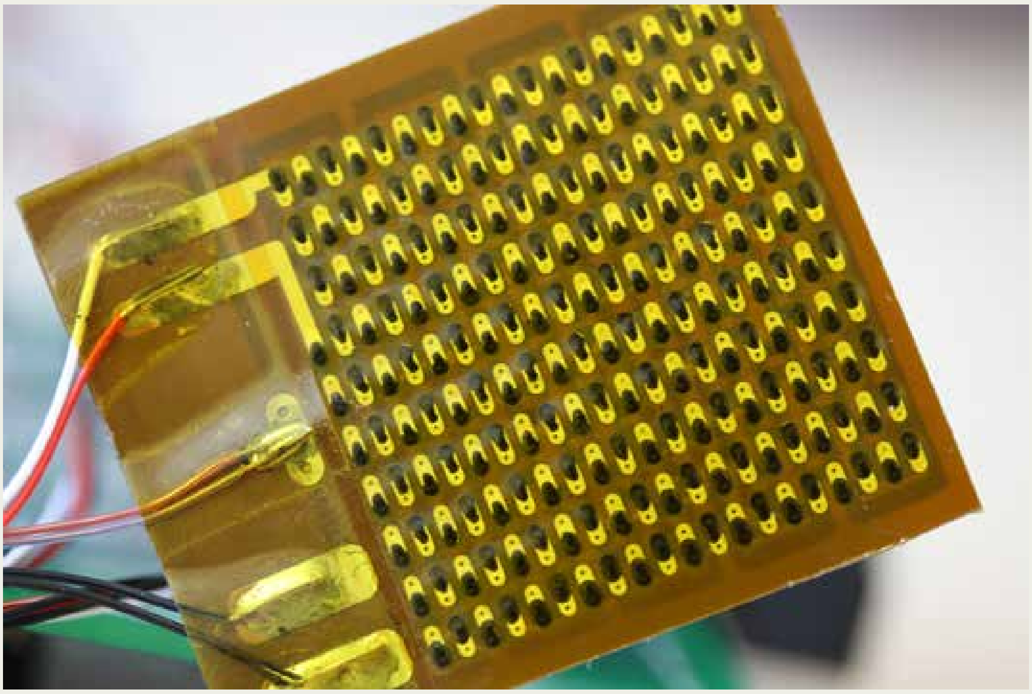
Research Focus:
Ocean wave energy harvesting (EH); EH vehicle shock absorbers; Thermoelectric energy generators for vehicle applications; EH from railway vibrations

Self-sustaining Food/Energy/Water system for saline coastal regions

In this US-China collaborative project, five researchers in multidisciplinary areas from Virginia Tech, Wuhan University of Technology in China, and Nanjing Agricultural University in China will team up to create a self-sustainable FEW System in saline coastal regions. This system will be realized through the integration of three areas of innovation: 1) Wave energy-based seawater desalination systems, 2) sustainable reclamation of saline-sodic-alkaline soils, and 3) a nexus of ocean energy, freshwater, and coastal agriculture. Specific research tasks include: 1) Modeling and design of a novel ocean wave surge energy converter and an ocean wave energy powered desalination system; (2) Modeling of coastal salt-soil-water balance dynamics and optimizing soil reclamation management and agriculture irrigation specific to coastal regions; and (3) Development of a supply-demand model for the FEW System to estimate the optimal operation conditions for each system, followed by conducting field tests and verification. If successful, the proposed research will convert traditional coastal agriculture from a freshwater- and energy-consuming practice into a self-sustainable, environmentally friendly practice that balances ecosystems.



Non-invasive Thermal Interrogation



Non-Invasive Thermal Interrogation (NITI) is a form of non-destructive testing that uses simultaneous combinations of surface heat flux and surface temperature signals. When these measurements are combined with signal processing algorithms, such as parameter estimation routines or other techniques, they can be used to non-invasively determine the internal temperature and properties of different objects and systems. Consequently, NITI has many practical applications in the biomedical, industrial, and wearable arenas.

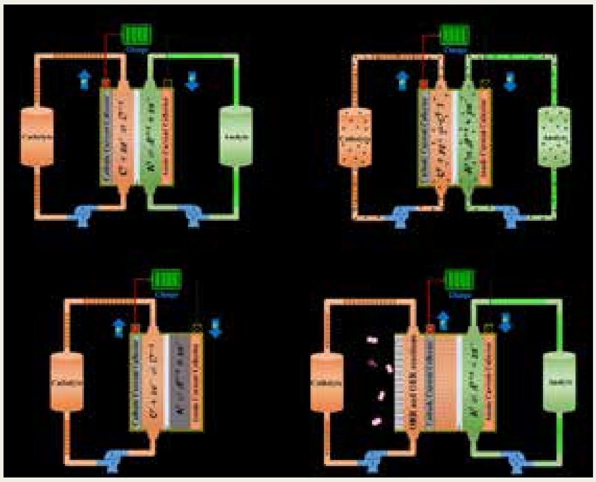
Thomas Diller
Professor

Research Focus:
Development and use of new instrumentation for measuring heat transfer. Applications include high-temperature unsteady flows, such as found in gas turbine engines, re-entry vehicles, and combustion environments

Electric storage: Safe, low-cost, scalable, long-lived and energy-dense

Zheng Li
Assistant Professor

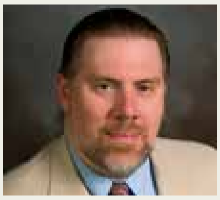
Research Focus:
Energy storage design and manufacturing; Battery recycling design and automation; Energy storage materials structure-property-performance relationships



The rapidly dropping cost of wind and solar electricity generation, as illustrated by levelized costs of electricity (LCOE) that are now competitive with fossil fuel generation, highlights the need for low-cost electrical storage that can transform intermittent renewable power into predictable and dispatchable electricity generation, and potentially base-load power. Such a revolutionary outcome will require energy storage with costs well below the trajectory of current technology, while also being safe, scalable, long-lived, and sufficiently energy dense for widespread deployment, including in space-constrained environments.

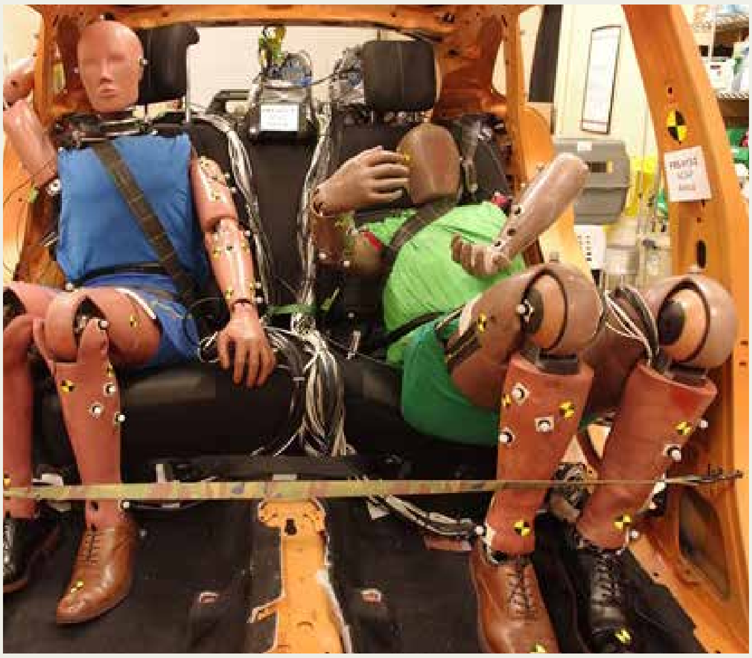
Virginia Tech researchers will team up with MIT, Form Energy, Inc. and Sepion Technologies, Inc. to develop a long-duration energy storage system that takes advantage of the low cost and high abundance of sulfur in a water-based solution. Prof. Zheng Li is co-PI of this project funded by US DOE Advanced Research Projects Agency–Energy (ARPA-E).

Rear seat crash testing improves safety



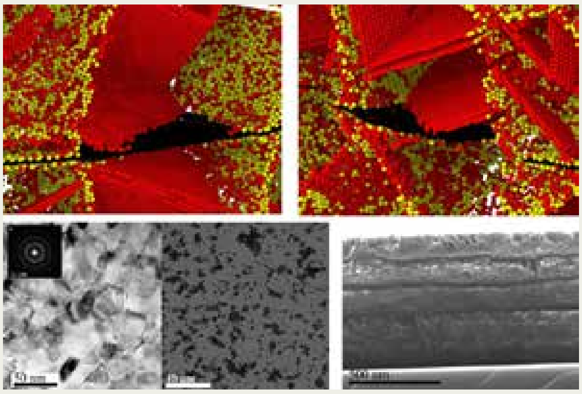
Warren Hardy
Associate Professor

Research Focus:
Impact and injury response and tolerance properties of biological materials; Macro and micro mechanisms of trauma; Automotive crash testing



Configurations of the Hybrid III (left) and THOR (right) dummies after an NCAP test on a crash sled. The THOR has slipped under the seatbelt, or "submarined".

Current U.S. occupant protection regulatory dynamic test for frontal impacts, and the NCAP frontal test do not include the evaluation of occupant safety for rear seat occupants. The hypothesized propensity of occupants to sit in the rear of ADS-DVs (Automated Driving Systems-Driverless Vehicles) could have a considerable adverse effect on occupant injuries and fatalities. The fact that the risk of injury in frontal collisions is higher for occupants in rear seats than for front seats warrants consideration of improved rear-seat safety performance and evaluation. The study, conducted in the Center for Injury Biomechanics (CIB), examines the safety performance of second-row seating. The vehicles are turned into crash sled bucks by removing the powertrain and suspension, and reinforcing the passenger compartment. The bucks are mounted to the CIB's ServoSled and subjected to NCAP crash pulses. Two Anthropomorphic Test Devices (ATDs) are positioned in rear seating locations. The ATD responses are compared to that of Post Mortem Human Surrogates. This study is examining the expected incidences and outcomes of rear-seated occupants in an ADS-DV with conventional seats, and is assessing candidate injury criteria for rear-seated occupants for FMVSS No. 208 frontal crash testing.



Designing and fabrication of novel metal-graphene composites

Reza Mirzaeifar
Assistant Professor

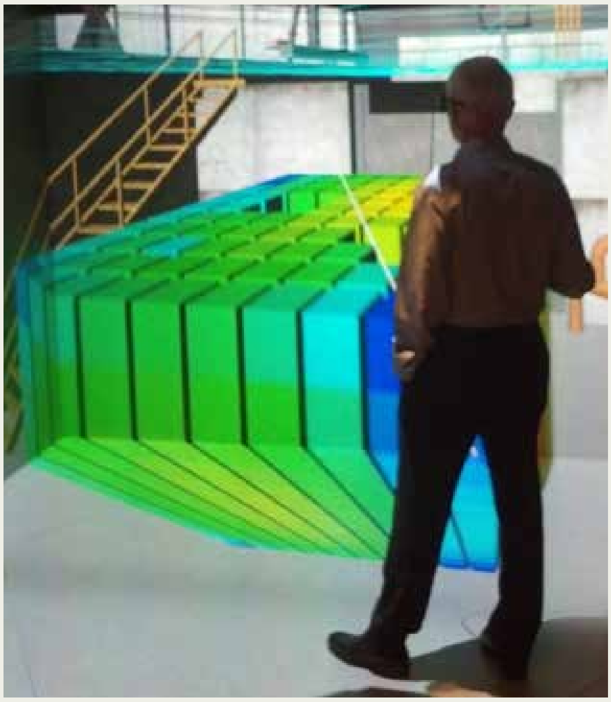
Research Focus: Computational and experimental mechanics of materials; Multiscale analysis; Natural hazards mitigation; Shape memory alloys

Designing and manufacturing materials, particularly metals, which are concurrently strong, ductile, and defect tolerant is still a challenging research, despite decades of much effort that has been made on solving this long-standing problem. The challenge mostly originated from the fact that improving one of these properties is invariably compromised by losing the other two. We are using cutting-edge computational and experimental methods for designing and fabricated novel Metal-Graphene composites to overcome this challenge. Our methodology introduces relatively easy-to-fabricate nanolayered metal composites with superior mechanical properties. Atomistic-scale deformation mechanisms, and mechanics of hindering the dislocations propagation by graphene nanoplatelets with different configurations in the nanocrystalline metallic matrix are investigated computationally. Molecular dynamics findings are utilized to engineer the nanostructure of metal matrix composite. Designed composites are fabricated by electron beam evaporation, and monolayer particles of graphene are embedded into the metallic matrix. The study is a part of a $360,000 grant obtained as a Young Investigator Program award from AFOSR.

Alireza Haghighat
Professor

Research Focus: Development of advanced particle methods; Development of advanced particle transport codes; Development of collaborative virtual reality systems for scientific computing

Project develops code for Virtual Reality simulation for nuclear system



Alireza Haghighat leads a project on the development of a novel RAPID code system for simulation of nuclear system in real time and using a novel virtual reality environment. This work has received significant attention by the international nuclear community. Over the past year, this project has achieved a number of accomplishments including: development and benchmarking of a novel kinetics (tRAPID) algorithm and its benchmarking, development of a detector response function (DRF) and its benchmarking using reactor pressure vessel dosimetry and spent fuel cask problems, further benchmarking of RAPID methodology using the International criticality handbook, further analysis of the RAPID's burnup algorithm, development a novel of control rod algorithm and its benchmarking using the Jozef Stefan Institute's TRIGA reactor system, and performance of control rod experiments for the benchmarking of the tRAPID algorithm.

An MOU between the Jozef Stefan Institute of Slovenia and Virginia Tech has resulted in the use of the JSI's TRIGA reactor for benchmarking, exchange of scholars between the JSI's reactor physics section and Haghighat's group, a 2-week short course on 'Particle Transport Theory and Methods,' and two workshops on RAPID, and development of an MOU with the Ljubljana University of the exchange of educational and research collaborations.

UNDERGRADUATE RESEARCH & PROJECTS

MECHANICAL ENGINEERING UNDERGRADUATE STUDENTS TAKE PART IN A TWO-SEMESTER SENIOR DESIGN PROJECT BEFORE GRADUATION. MANY PROJECTS ARE SPONSORED BY INDUSTRY.

Competition Teams

There are dozens of undergraduate teams that take part in competitions - here are how three of our teams did this year.

agBOT 1st Place

Back-to-Back agBOT titles in ‘18-’19

For the second time in two years, Virginia Tech’s agBOT team came home from Indiana with a first-place trophy.

The 4th annual agBOT competition, hosted by Purdue University’s College of Agriculture and Gerrish Farms was held in West Lafayette, Indiana May 16-18, consisted of two separate competitions: a weed and seed event and a competition to design an autonomous system that can collect, store, and prepare a soil sample for analysis.

The team, made up of 35 students from mechanical engineering, electrical and computer engineering, and computer science, all in the College of Engineering, were divided into five sub-teams.

Working with faculty advisor Alexander Leonessa, professor of mechanical engineering, Guo and the team upgraded the autonomous ATV they used to win the watermelon harvesting challenge at agBOT in 2018 with obstacle avoidance technology and created a towed vehicle that was a self-contained laboratory.

HEVT 2nd Place

Year 1 - EcoCAR Mobility Challenge

The Hybrid Electric Vehicle Team took second place during year one of the four-year EcoCAR Mobility Challenge. The team also received second place for propulsion system integration, and tied for first on their architecture selection report. The first year challenge asked teams to conceptualize and design the technology they will use in their vehicles.

The Advanced Vehicle Technology Competition series, has 12 universities applying advanced propulsion, electrification, and SAE Level 2 automation to a 2019 Chevrolet Blazer. A Level 2 rating is considered partial automation, with automated functions in acceleration and steering, but with a human engaged with dynamic driving and monitoring the environment at all times. The U.S. Department of Energy, General Motors Corporation and MathWorks sponsor the competition.

Formula SAE - 14th

Team takes big jump

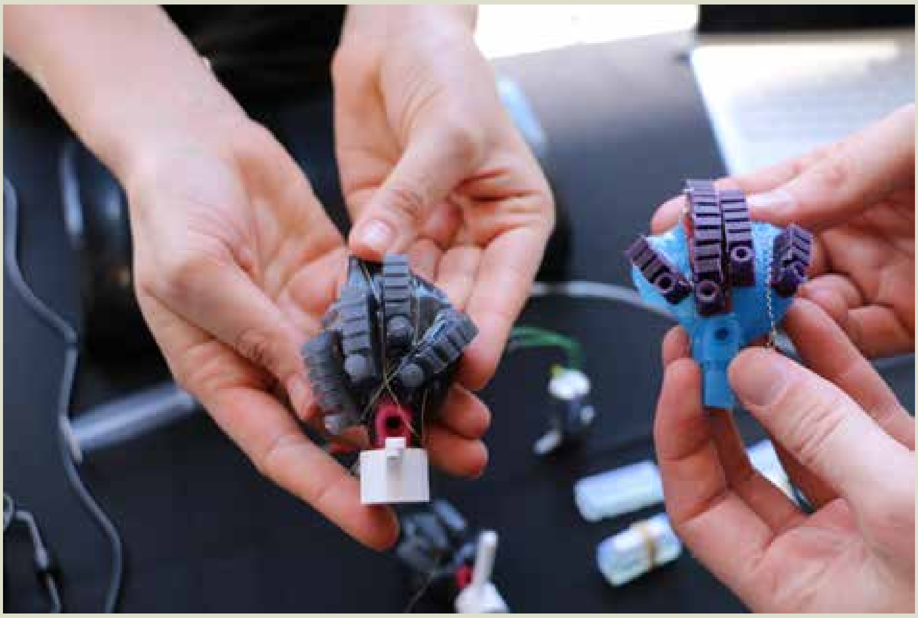
Senior Design

A highlight of the undergraduate mechanical engineering program is the two-semester senior design capstone senior design project. The projects translate to an average of 300 out-of-classroom hours per student over the course of the academic year.

In Spring 2019, 46 teams with more than 400 undergraduate mechanical engineering majors designed, created prototypes, refined their work, and built custom devices incorporating the required parameters for the work.

Seventeen teams were sponsored by corporate partners including Meyer Sound, Harris, BWXT, Boeing, Quality of Life Plus, Philip Morris and others.

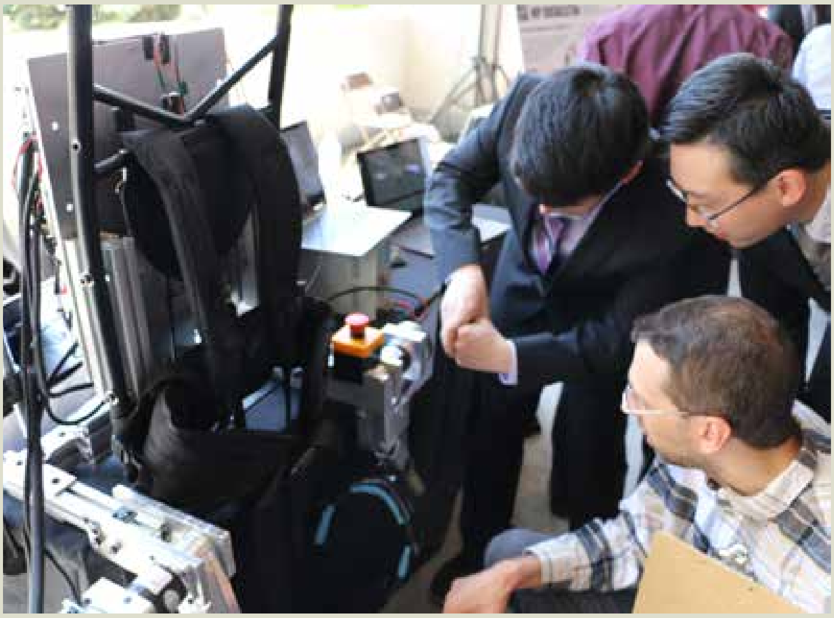
As part of the capstone, students present their work as individual groups and at the Senior Design Expo that is open to the public and the media.

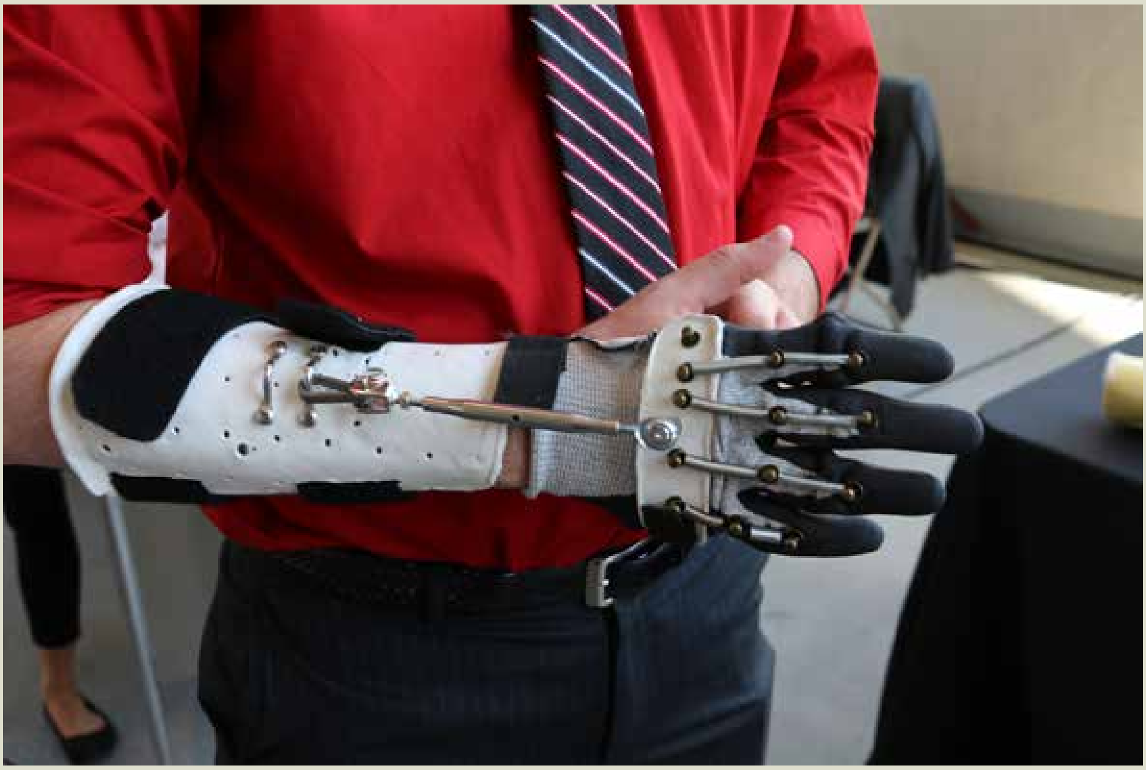


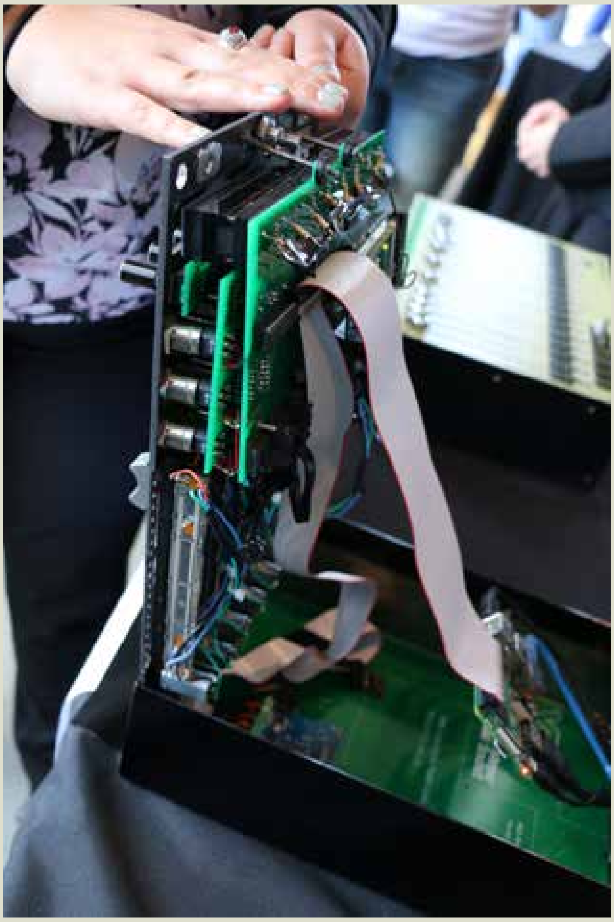
Left: 3-D printed flexible actuators help mimic ear movements on a robotic bat.

Below left: An individual hemodialysis treatment machine

Below: A hip exoskeleton designed to help amputees with gait issues







Clockwise from top: A hand brace to allow flexing of wrist and hand to combat spasticity - a contraction of muscles, sponsored by QL+; The BOLT electric motorcycle team; the Baja competition team; and a human-computer interface for live sound control

Clockwise from top left: A fixed wing UAV sponsored by Harris Corp.; A flexible automated mobility vehicle sponsored by General Motors; An optical microscopy-compatible bioreactor; an automated reconfigurable microphone array sponsored by NASA; and a spike board designed for a double leg amputee sponsored by QL+.

FACULTY

WITH 68 FULL-TIME FACULTY AND MORE THAN 30 AFFILIATE, ADJUNCT, AND TEACHING FACULTY, THE MECHANICAL ENGINEERING DEPARTMENT HAS EXPERIENCED RESEARCHERS ACROSS A VAST ARRAY OF FIELDS

PINAR ACAR

ASSISTANT PROFESSOR

DESIGN, MATERIALS & MANUFACTURING

MEHDI AHMADIAN

DAN PLETTA PROFESSOR

DESIGN, MATERIALS & MANUFACTURING

KAVEH AKBARI HAMED

ASSISTANT PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

ALAN ASBECK

ASSISTANT PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

OUMAR BARRY

ASSISTANT PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

BAHAREH BEHKAM

ASSOCIATE PROFESSOR

BIO, MICRO AND NANO SYSTEMS

PINHAS BEN-TZVI

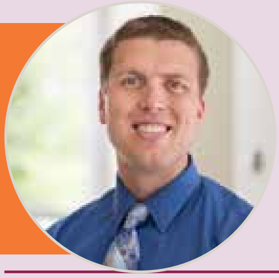
ASSOCIATE PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

JAN HELGE BØHN

ASSOCIATE PROFESSOR

DESIGN, MATERIALS & MANUFACTURING



JONATHAN BOREYKO

ASSISTANT PROFESSOR

BIO, MICRO AND NANO SYSTEMS

RICARDO BURDISSO

PROFESSOR & ASSOC. DEPT. HEAD FOR STRATEGIC INITIATIVES

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ASSOCIATE PROFESSOR

ENERGY ENGINEERING AND SCIENCE

CLINTON DANCEY

ASSOCIATE PROFESSOR & ASSOC. DEPT. HEAD FOR UNDERGRADUATE PROGRAMS

ENERGY ENGINEERING AND SCIENCE

THOMAS DILLER

PROFESSOR

ENERGY ENGINEERING AND SCIENCE

JULIANA DUARTE

ASSISTANT PROFESSOR

NUCLEAR ENGINEERING AND SCIENCE

MICHAEL ELLIS

ASSOCIATE PROFESSOR

ENERGY ENGINEERING AND SCIENCE

AZIM ESKANDARIAN

DEPT. HEAD & NICHOLAS AND REBECCA DES CHAMPS CHAIR

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ASSOCIATE PROFESSOR

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CHRIS FULLER

SAMUEL LANGLEY DIS-TINGUISHED PROFESSOR OF ENGINEERING

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CELINE HIN

ASSOCIATE PROFESSOR

NUCLEAR ENGINEERING AND SCIENCE

SCOTT HUXTABLE

ASSOCIATE PROFESSOR

ENERGY ENGINEERING AND SCIENCE

new faculty

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MANAGING DIRECTOR, CenTiRe

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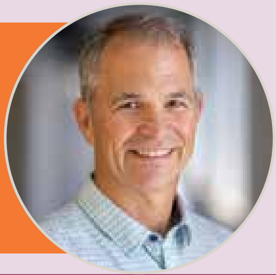
ANDREW KURDILA

W. MARTIN JOHNSON PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

new faculty



BRIAN LATTIMER

PROFESSOR

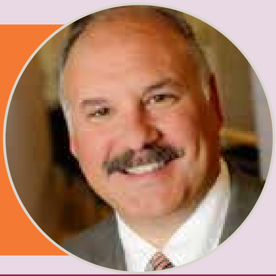
ENERGY ENGINEERING AND SCIENCE

ALEXANDER LEONESSA

PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

new faculty



JACK LESKO

PROFESSOR & ASSOC. DEAN FOR RESEARCH & GRADUATE STUDIES

DESIGN, MATERIALS & MANUFACTURING

LING LI

ASSISTANT PROFESSOR

BIO, MICRO AND NANO SYSTEMS

ZHENG LI

ASSISTANT PROFESSOR

ENERGY ENGINEERING AND SCIENCE

YANG LIU

ASSOCIATE PROFESSOR

NUCLEAR ENGINEERING AND SCIENCE

RY LONG

ASSISTANT PROFESSOR OF PRACTICE

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ROOP MAHAJAN

LEWIS A. HESTER CHAIR PROFESSOR

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JOSEPH MEADOWS

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AMRINDER NAIN

ASSOCIATE PROFESSOR

BIO, MICRO AND NANO SYSTEMS

DOUGLAS NELSON

PROFESSOR

ENERGY ENGINEERING AND SCIENCE

WING NG

ALUMNI DISTINGUISHED PROFESSOR & CHRISTOPHER C. KRAFT ENDOWED PROFESSOR

ENERGY ENGINEERING AND SCIENCE

ROBIN OTT

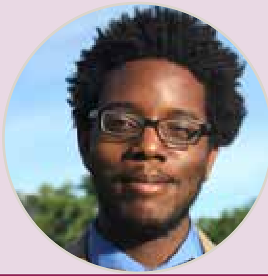
ASSOCIATE PROFESSOR OF PRACTICE

DESIGN, MATERIALS & MANUFACTURING

JOHN PALMORE JR.

ASSISTANT PROFESSOR

ENERGY ENGINEERING AND SCIENCE



ROBERT PARKER

L.S. RANDOLPH PROFESSOR

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

MARK PAUL

PROFESSOR

ENERGY ENGINEERING AND SCIENCE

MARK PIERSON

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RANGA PITCHUMANI

GEORGE R. GOODSON PROFESSOR

ENERGY ENGINEERING AND SCIENCE

RUI QIAO

PROFESSOR, JOHN R. JONES III FACULTY FELLOW

ENERGY ENGINEERING AND SCIENCE

SHIVAKUMAR RANGANATHAN

COLLEGIATE ASSOCIATE PROFESSOR

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MICHAEL ROAN

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CORINA SANDU

PROFESSOR & ASSOC. DEPT. HEAD FOR GRADUATE STUDIES

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

new faculty

SHIMA SHAHAB

ASSISTANT PROFESSOR

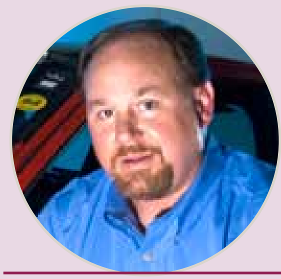
ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

CHANGMIN SON

ROLLS-ROYCE COMMONWEALTH PROFESSOR

ENERGY ENGINEERING AND SCIENCE

new faculty



STEVE SOUTHWARD

ASSOCIATE PROFESSOR

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DANESH TAFTI

WILLIAM S. CROSS PROFESSOR

ENERGY ENGINEERING AND SCIENCE

new faculty

SAIED TAHERI

PROFESSOR & DIRECTOR, CenTiRe

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PABLO TARAZAGA

ASSOCIATE PROFESSOR, JOHN R. JONES III FACULTY FELLOW

ROBOTICS, AUTONOMOUS & DYNAMICAL SYSTEMS

ALEXANDRINA UNTAROIU

ASSISTANT PROFESSOR

ENERGY ENGINEERING AND SCIENCE

BRIAN VICK

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LINDA VICK

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MICHAEL VON SPAKOVSKY

ROBERT E. HORD JR. PROFESSOR

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ROBERT WEST

ASSOCIATE PROFESSOR

DESIGN, MATERIALS & MANUFACTURING

AL WICKS

ASSOCIATE PROFESSOR

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PROFESSOR, CHAIR OF GRADUATE STUDIES

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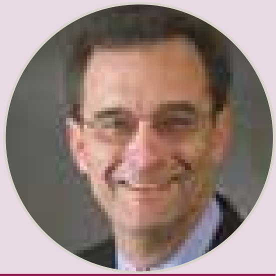

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JOSEPH SCHETZ

FRED D. DURHAM ENDOWED CHAIR PROFESSOR

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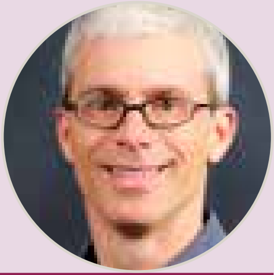

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MARK VAN DYKE

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BIOMEDICAL ENGINEERING & MECHANICS

CRAIG WOOLSEY

PROFESSOR

AEROSPACE AND OCEAN ENGINEERING

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CATHY HILL
GRADUATE PROGRAM COORDINATOR

BETH HOWELL
PROGRAM MANAGER

DIANA ISRAEL
SR. PROGRAM SUPPORT TECHNICIAN

ALLISON JONES
PROGRAM CO-ORDINATOR, NORTHERN VIRGINIA CENTER

TIMOTHY KESSINGER
MACHINE SHOP SUPERVISOR

HOPE LEWIS

OFFICE ASSISTANT

PHILLIP LONG

LABORATORY INSTRUMENT MAKER

CASEY LUCAS

LABORATORY INSTRUMENT MAKER

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EXECUTIVE ASSISTANT TO DEPT. HEAD

LAUREN MILLS

SR. PROGRAM SUPPORT TECHNICIAN, CEHMS

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SR. PROGRAM SUPPORT TECHNICIAN, CVESS

BEN POE

SR. COMPUTER SYSTEMS ENGINEER

MIRIAM SNYDER

SR. PROGRAM SUPPORT TECHNICIAN

BILL SONGER

LABORATORY INSTRUMENT MAKER

ALIDA SPAULDING

SR. PROGRAM SUPPORT TECHNICIAN

JOHNNY UNDERWOOD

EQUIPMENT AND FACILITIES SPECIALIST

HEATHER WHEDBEE

UNDERGRADUATE ACADEMIC ADVISOR

MELISSA WILLIAMS

OPERATIONS MANAGER - AP FACULTY

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BUSINESS DEVELOPMENT MANAGER, MORTENSON CONSTRUCTION

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RESEARCH ENGINEER, U.S. AIR FORCE RESEARCH LABORATORY

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PROGRAM DIRECTOR, ENGINEERING AND TECHNOLOGY PROGRAMS, AEROJET ROCKETDYNE

KEITH VAN HOUTEN

MANAGER, ACTIVE SAFETY & AUTOMATED DRIVING PERFORMANCE SIMULATION GROUP, GM CENTER FOR AUTONOMOUS VEHICLE DEVELOPMENT

ED ZANONI

SR. MANAGER CORE TECHNOLOGIES, PHILADELPHIA DESIGN CENTER, BOEING COMPANY

FACULTY RECOGNITION

Wing Ng, Christopher C. Kraft Endowed Professor, added the title of **Alumni Distinguished Professor** to his resume, and he was also elected as a **Fellow to the American Institute of Aeronautics and Astronautics**.

Michael von Spakovsky, was named the Robert E. Hord Jr. Professor of Mechanical Engineering.

Alan Kornhauser was named Associate Professor, Emeritus.

Walter O'Brien was named Professor Emeritus (posthumously).

Roop Mahajan was presented the Distinguished Alumnus Award for Excellence in a Career from Punjam Engineering College, Chandigarh, India.

Christopher Williams, was presented the University Graduate Alumni Advising Award.

Azim Eskandarian, became the Editor-in-Chief of IEEE Transactions on Intelligent Transportation Systems.

Xiaoyu 'Rayne' Zheng earned the Journal of Materials Research Paper of the Year, and the Office of Naval Research Young Investigator Award.

Bob Mahan released a book, The Monte Carlo Ray-Trace Method in Radiation Heat Transfer and Applied Optics. It is Mahan's second book on radiation heat transfer.

Doug Nelson, received an award from General Motors and organizers of the EcoCAR Mobility Challenge for his 25 years of service to Advanced Vehicle Technology Competitions.

Romesh Batra was named on two patents and received the 2019 US Association for Computational Mechanics' Belytschko Medal for outstanding computational work for analyzing Adiabatic Shear Bands.

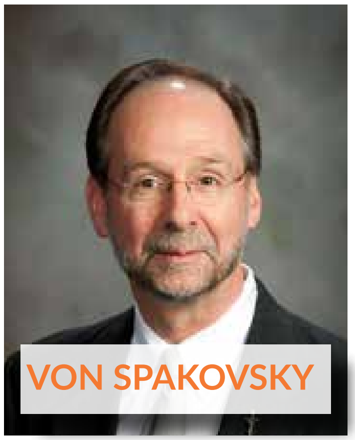
STUDENT RECOGNITION

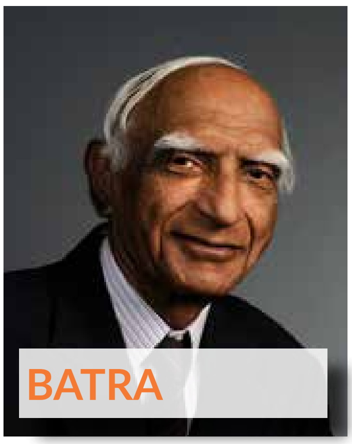
The Carroll F. Hartlove Service Award was presented to undergraduates: **Rachel Iwicki, Andrew Farley,** and **Chris Selig.**

The David R. Shorb Memorial Honor Award: **Chris Selig**

The Outstanding Scholar Award: **Brianna Friedman**

The Torgersen Graduate Student Research Award: **Sheyda Davaria**





2019 College of Engineering Dean's Awards

Pinhas Ben-Tzvi
Excellence in Teaching

John Ferris
Excellence in Service

Mary Kasarda
Excellence in Service

Christopher Williams
Excellence in Research

Ling Li
Outstanding New Assistant Professor

Xiaoyu 'Rayne' Zheng
Outstanding New Assistant Professor

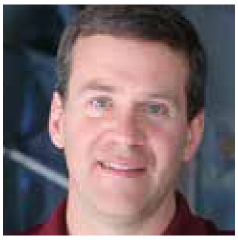
Jiangtao Cheng
Faculty Fellow

Scott Huxtable
Certificate of Teaching Excellence

ME Staff Awards

Beth Howell
Diversity Ally Certification

Annette Ben-Tzvi
Diversity Advocate Certification



Lance Yelton
Leadership Certificate Completion

Shaking tables - The US Naval Surface Warfare Center at Dahlgren loaned a one-ton shaker table to the Advanced Vibrations and Acoustics Lab. The table can apply vibrational forces of up to 2,000 kilograms and shake objects at frequencies as high as 4,000 hertz. The equipment positions Virginia Tech to play a central role in the ongoing movement to develop international standards of environmental testing.

SELECT PUBLICATIONS

PATENTS, PEER-REVIEWED JOURNALS, CONFERENCE PROCEEDINGS, INVITED TALKS, AND MORE - A PARTIAL LIST OF PUBLICATIONS FROM SOME OF THE MORE THAN 100 FACULTY, AFFILIATE FACULTY, ADJUNCT FACULTY, AND INSTRUCTORS SERVING MECHANICAL ENGINEERING

PINAR ACAR

Journal Papers

P. Acar, "Uncertainty Quantification for Ti-7Al Alloy Microstructure with an Inverse Analytical Model (AUQLin)", Materials, Vol. 12, No. 11, 1773, 2019; doi: 10.3390/ma12111773

P. Acar, "Machine Learning Approach for Identification of Microstructure-Process Linkages", AIAA Journal, accepted, 2019; doi: 10.2514/1.J058244

(invited) R. Catania, A. Diraz, D. Maier, A. Tagle and P. Acar, "Mathematical Strategies for Design Optimization of Multi-Phase Materials", Mathematical Problems in Engineering, Vol. 2019, Article ID 4024637, 2019; doi: 10.1155/2019/4024637

(invited) P. Acar, "Multi-Scale Computational Modeling of Lightweight Aluminum-Lithium Alloys", Heliyon, Vol. 5, No. 3, e01225, 2019; doi: 10.1016/j.heliyon.2019.e01225

A. Paul, P. Acar, W. Liao, A. Choudhary, V. Sundararaghavan, A. Agrawal, "Microstructure Optimization with Constrained Design Objectives using Machine Learning-Based Feedback-Aware Data-Generation", Computational Materials Science, Vol. 160, pp: 334-351, 2019; doi: 10.1016/j.commatsci.2019.01.015

P. Acar, "Eliminating mesh sensitivities in microstructure design with an adjoint algorithm", Finite Elements in Analysis and Design, Vol. 154, pp: 22-29, February 2019; doi: 10.1016/j.finel.2018.10.001

P. Acar and V. Sundararaghavan, "Do Epistemic Uncertainties Allow for Replacing Microstructural Experiments with Reconstruction Algorithms?", AIAA Journal, Vol. 57, No. 3, pp: 1078-1091, 2019; doi: 10.2514/1.J057488

P. Acar and V. Sundararaghavan, "Stochastic Design Optimization of Microstructural Features using Linear Programming for Robust Material Design", AIAA Journal, Vol. 57, No. 1, pp: 448-455, 2019; doi: 10.2514/1.J057377

P. Acar, "Crystal Plasticity Model Calibration for Ti-7Al Alloy with a Multi-Fidelity Computational Scheme", Integrating Materials and Manufacturing Innovation, Vol. 7, No. 4, pp: 186-194, 2018; doi: 10.1007/s40192-018-0120-0

P. Acar, "Reliability Based Design Optimization of Microstructures with Analytical Formulation", Journal of Mechanical Design, Vol. 140, No. 11, 111402, 2018; doi: 10.1115/1.4040881

Conference Proceedings and Meeting Presentations

P. Acar, "Uncertainty Quantification for Microstructural Features of Additively Manufactured Materials", 15th U.S. National Congress on Computational Mechanics, 28 July-1 August 2019, Austin, TX, USA.

P. Acar, "A Machine Learning Approach for Crystal Plasticity Modeling of Ti-7Al Alloy under Uncertainties", 5th World Congress on Integrated Computational Materials Engineering (ICME 2019), 21-25 July 2019, Indianapolis, IN, USA.

P. Acar, "Multi-Fidelity Crystal Plasticity Modeling of Titanium-Aluminum Alloys", 16th Pan-American Congress of Applied Mechanics, 20-23 May 2019, Ann Arbor, MI, USA.

P. Acar, "A Machine Learning Approach for Process Optimization of Polycrystalline Materials", 148th TMS Annual Meeting & Exhibition, 10-14 March 2019, San Antonio, TX, USA.

M. Ghodrati, P. Acar and R. Mirzaeifar, "A Generalized Nature-Inspired Optimization Method: Additively Manufactured Materials with Superior Mechanical Performance", 148th TMS Annual Meeting & Exhibition, 10-14 March 2019, San Antonio, TX, USA.

P. Acar and V. Sundararaghavan, "Uncertainty Quantification in Microstructural Reconstruction of Additively Manufactured Materials", 148th TMS Annual Meeting & Exhibition, 10-14 March 2019, San Antonio, TX, USA.

P. Acar, "A Transductive Learning Approach for Identification of Microstructure-Process Linkages", AIAA Science and Technology Forum (AIAA SciTech), 7-11 January 2019, San Diego, CA, USA.

P. Acar and V. Sundararaghavan, "Uncertainty Quantification and Stochastic Optimization for Spatially Varying Composite Fiber Paths", AIAA Science and Technology Forum (AIAA SciTech), 7-11 January 2019, San Diego, CA, USA.

P. Acar, "Integrating an Analytical Uncertainty Quantification Approach to Multi-Scale Modeling of Nanocomposites", ASME International Mechanical Engineering Congress & Exposition (IMECE), 11-14 November 2018, Pittsburgh, PA, USA.

A. M. Roy, S. Ganesan, P. Acar, S. Gentry, A. Trump, J. Allison, K. Thornton, V. Sundararaghavan, "Phase-field Approach Coupled with Crystal Plasticity for Three-Dimensional Static Recrystallization in Ti-7Al Alloys and Comparison with Experiment", Materials Science & Technology Technical Meeting and Exhibition, 14-18 October 2018, Columbus, OH, USA.

MEHDI AHMADIAN

Kothari, K., Dixit, J., and Ahmadian, M., "Effect of Variation of Angle of Attack on Adhesion-Creepage Behavior Using Virginia Tech –Federal Railroad Administration (VT – FRA) Roller Rig," Proceedings of the 2018 AREMA Annual Conference, Chicago, IL, September 16 – 20, 2018.

Ghodrati, M., Ahmadian, M., Mirzaeifar R., "Investigating the rolling contact fatigue in rails using finite element method and cohesive zone approach," Proceedings of the 2018 Joint Rail Conference, Pittsburgh, PA, April 18-20, 2018.

Jazizadeh, F. K., Afzalan, M., and Ahmadian, M., "Determining Track Condition from Onboard Data in Revenue Service through Machine Learning: Fondest Hopes, Wildest Dream," Big Data in Railroad Maintenance Planning 2018, Newark, DE, December 13 – 14, 2018.

Neighborgall, C., Mast, T., Peterson, A. W., and Ahmadian, M., "Qualitative Assessment of Rail Lubricity," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Tan, Y., Chen, Y., Peterson, A. W., and Ahmadian, M., "Monitoring and Detecting Fouled Ballast using Forward Looking Infrared Radiometer (FLIR) Technology," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Radmehr, A., and Ahmadian, M., "VT-FRA Roller Rig: Designed and Commissioned to Serve the Railroad Industry," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Afzalan, M., Jazizadeh, F. K., and Ahmadian, M., "Towards Automated Monitoring of Track Using Machine Learning," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Mast, T., Neighborgall, C., Peterson, A. W., and Ahmadian, M., "The Application of Laser Technology for Railroad Top of Rail (TOR) Friction Modifier Detection and Measurements," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Dama, N., Jain, A., and Ahmadian, M., "Advanced Modeling of Railway Ballast for Improving Railroad Tamping Operation," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Jazizadeh, F. K., Afzalan, M., and Ahmadian, M., "Developing Machine Learning Methods for Facilitated Track Condition Assessment using Repeated Inspection Data," The First Annual Symposium on Railroad Infrastructure Diagnosis and Prognosis Symposium, University of Nevada, Las Vegas, NV, October 16 – 17, 2018.

Chen, Y., Peterson, A. W., and Ahmadian, M., "A Case Study on Lateral Characteristics of Trucks with Double and Triple Trailers," SAE Commercial Engineering Congress and Exhibition, Rosemont, IL, September 11 – 13, 2018.

Chen, Y., Peterson, A. W., and Ahmadian, M., "Development of a Simulation Model for Evaluating Lateral Characteristics for Trucks with Double and Triple Trailers," SAE Commercial Engineering Congress and Exhibition, Rosemont, IL, September 11 – 13, 2018.

Chen, Y., Peterson, A. W., and Ahmadian, M., "A Simulation-based Comparative Study on the Low-speed Offtracking of Long Combination Vehicles," SAE Commercial Engineering Congress and Exhibition, Rosemont, IL, September 11 – 13, 2018.

Chen, Y., Peterson, A. W., and Ahmadian, M., "Achieving Pneumatic Antiroll Bar through Re-designing a Commercial Airspring Suspension for Semi-truck," SAE Commercial Engineering Congress and Exhibition, Rosemont, IL, September 11 – 13, 2018.

Peterson, A. W., and Ahmadian, M., "Design and Implementation of a Shaft-mounted Steering Robot for Repeatable and Limit-steer Testing of Commercial Vehicles," SAE Commercial Engineering Congress and Exhibition, Rosemont, IL, September 11 – 13, 2018.

Hosseinian, A. H., Melzi, S., and Ahmadian, M., "Integrated Vehicle Dynamics System through Coordinating Active Aerodynamics Control, Active Rear Steering, Torque Vectoring, and Hydraulically Interconnected Suspension," International Journal of Automotive Technology, accepted, in print.

Ahangarnejad, A. H., Melzi, S., Ahmadian, M., "Numerical comparison of two methods for integration of active rear steering, torque vectoring and hydraulically interconnected suspension," International Journal of Vehicle Systems Modelling and Testing, accepted, in print.

Ghodrati, M., Ahmadian, M., Mirzaeifar R., "Studying the Effect of Tangential Forces on Rolling Contact Fatigue in Rails Considering Microstructure," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

Radmehr, A., Tajaddini, A., Marquis, B., and Ahmadian, M., "Virginia Tech-Federal Railroad Administration Roller Rig Measurement Capabilities and Baseline Measurements," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

Radmehr, A., Kothari, K., and Ahmadian, M., "Evelauting the Effect of Natural Third Body Layers on Friction Using the Virginia Tech Roller Rig," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

Neighborgall, C., Mast, T., Peterson, A. W., Ahmadian, M., and Holton, C., "Development of Laser/LED-based Instrument for Optical Detection of Railroad Top-of-rail (TOR) Friction Modifiers and Lubricity Conditions," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

Afzalan, M., Jazizadeh, F. K., and Ahmadian, M., "A Machine Learning Approach for Track Condition Assessment Through Repeated Historical Data Analysis," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

Tan, Y., Chen, Y., and Ahmadian, M., "Monitoring and Detecting Fouled Ballast using Forward-Looking Infrared Radiometer (FLIR) Aerial Technology – Possibilities and Limitations," Proceedings of the 2019 Joint Rail Conference, Snow Bird, UT, April 10 – 12, 2019.

KAVEH AKBARI HAMED

K. Akbari Hamed, V. R. Kamidi, W-L. Ma, A. Leonessa, and A. D. Ames, "Hierarchical and safe motion control for cooperative locomotion of robotic guide dogs and humans: A hybrid systems approach," IEEE Robotics and Automation Letters, In Press, August 2019, doi: 10.1109/LRA.2019.2939719

K. Akbari Hamed, B. Safaee, and R. D. Gregg, "Dynamic output controllers for exponential stabilization of periodic orbits for multi-domain hybrid models of robotic locomotion," ASME Journal of Dynamic Systems, Measurement, and Control, In Press, July 2019, doi:10.1115/1.4044618

K. Akbari Hamed and R. D. Gregg, "Decentralized event-based controllers for robust stabilization of hybrid periodic orbits: Application to underactuated 3D bipedal walking," IEEE Transactions on Automatic Control, vol. 64, no. 6, pp. 2266-2281, June 2019

J. C. Horn, A. Mohammadi, K. Akbari Hamed, and R. D. Gregg, "Hybrid zero dynamics of bipedal robots under nonholonomic virtual constraints," IEEE Control Systems Letters, vol. 3, issue 2, pp. 386-391, January 2019

K. Akbari Hamed, W. Ma, A. D. Ames, "Dynamically stable 3D quadruped walking with multi-domain hybrid system models and virtual constraint controllers," American Control Conference (ACC), pp. 4588-4595, Philadelphia, PA, USA, July 2019

W-L. Ma, K. Akbari Hamed, and A. D. Ames, "First steps towards full model based motion planning and control of quadrupeds: A hybrid zero dynamics approach," IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), In Press, June 2019

ALAN ASBECK

Patents:

Method and Mechanisms for Providing Gravity Compensation to a Human or Robot Arm – Asbeck A., Bolkhovitinov A.; US Patent App. 62/828,285 (2019) [provisional patent thus far, a full patent application is in process]

Papers:

Alemi M., Geissinger J., Simon A., Chang S. E., and Asbeck A., "A Passive Exoskeleton Reduces Peak and Mean EMG During Symmetric and Asymmetric Lifting," Journal of Electromyography and Kinesiology, 47:25-34, 2019. DOI: 10.1016/j.jelekin.2019.05.003

Yang H., Greczek B., Asbeck A., "Modeling and Analysis of a High-Displacement Pneumatic Artificial Muscle with Integrated Sensing," Frontiers in Robotics and AI 5(136), 2018.

Conference Papers:

Yang, H., Asbeck A., "A New Manufacturing Process for Soft Robots and Soft/Rigid Hybrid Robots," IEEE Int. Conf. on Intelligent Robots and Systems (IROS), Oct. 2018.

ROMESH BATRA

Anup Pydah, Romesh C. Batra, Beam-Based Vibration Energy Harvesters Tunable Through Folding, ASME J. Vibration and Acoustics, 2019, Vol. 141, Art. No. 011003

Arka P. Chattopadhyay, Romesh C. Batra, Free and Forced Vibrations of Monolithic and Composite Rectangular Plates With Interior Constrained Points, J. Vibration and Acoustics, 2019, Vol. 141, Art. No. 011018

Y. Q. Zhao, Y. Zhou, Z. M. Huang, R. C. Batra, Experimental and Micromechanical Investigation of T300/7901 Unidirectional Composite Strength, Polymer Composites, 40, 2639-2652, 2019

J. Fariborz, R. C. Batra, Free vibration of bi-directional functionally graded material circular beams using shear deformation theory employing logarithmic function of radius, Composite Structures 210 (2019) 217-230

G.J. Nie, Anup Pydah, R.C. Batra, Torsion of bi-directional functionally graded truncated conical cylinders, Composite Structures 210 (2019) 831-839

G.Gopinath, R.C. Batra, Sensitivity of responses of three Micro-Mechanics approaches to changes in unit cell configuration and inclusion shape, Composite Structures 213 (2019) 118-132

Bikramjit Mukherjee, David A. Dillard, Romesh C. Batra, On preferential debonding during demolding of a sandwiched elastomeric layer, International Journal of Solids and Structures 170 (2019) 123–141

L. Yuan, R.C. Batra, Optimum first failure load design of one/two-core sandwich plates under blast loads, and their ultimate loads, Composite Structures, Vol. 224, Art. No. 111022, 2019.

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Valerio Mascolino, Alireza Haghighat, Nicholas Polys, "A Virtual Reality System (VRS) for RAPID," Nuclear Energy for New Europe (NENE), Portoroz, Slovenia, Sept 9-12, 2019

Invited key note speaker:

"High Fidelity Neutronics Software, uncertainty quantification, and Research Reactors,", Nuclear Energy for New Europe (NENE), Portoroz, Slovenia, Sept 9-12, 2019

"RAPID & VRS-RAPID –A new paradigm for solving radiation transport problems," Baltimore Washington Health Physics Society meeting, Bethesda, MD, Sept 17, 2019.

Invited talks:

"RAPID Code Formulation, Benchmarking, and Its VRS," PHYTRA4 – The Fourth International Conference on Physics and Technology of Reactors and Applications. Marrakech, Morocco, September 17-19, 2018.

"Computational Particle Transport Theory and Achieving Solutions in Real Time," Colloquium of the Faculty of Mathematics and Physics, University of Ljubljana, Slovenia, Jan 14, 2019.

Invited short courses:

"Particle Transport Methods and Application," Jozef Stefan Institute, Ljubljana, Slovenia. Participants included the institutes' research scientists and PhD students. Jan 7-18, 2019.

"Particle transport methods and VT3G's methodologies and codes," for PhD students and faculty of the Applied Mathematics and Mechanical Engineering of the Federal University of Rio Grande du Sul, Brazil, March 11-14, 2019

Invited workshops:

"MRT Methodology and RAPID code system," PHYTRA4 – The Fourth International Conference on Physics and Technology of Reactors and Applications. Marrakech, Morocco, Sept 17-19, 2018.

"RAPID Code System and its VRS Environment," Nuclear Energy for New Europe (NENE) Conference, Portoroz, Slovenia, Sept 9-12, 2019

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ERIK KOMENDERA

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Doggett, W.R., Dorsey, J., Teter, J., Paddock, D., Jones, T., Komendera, E.E., Bowman, L., Taylor, C. and Mikulas, M., 2018. Persistent Assets in Zero-G and on Planetary Surfaces: Enabled by Modular Technology and Robotic Operations. In 2018 AIAA SPACE and Astronautics Forum and Exposition (p. 5305).

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ALEXANDER LEONESSA

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TODD LOWE

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Sandu, C. – "Vehicle Modeling and Real-Time Parameter Estimation for Systems affected by Uncertainties", invited panelist talk for the "Uncertainty with CAE Development" session, Conf. of the SAE Chassis Design and Vehicle Dynamics (CDVD) Committee, SAE Commercial Vehicle Engineering Congress (COMVEC), Sept. 11-13, 2018, Rosemont, IL, USA.

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Robert Williams ('99)
James and Shannon Winebrenner
Bruce ('68) and China Zimmerman

American Operations Corporation
Beach Chemical & Paper Co.
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Jerry ('65) and JoAnn Leedy
James ('80) and Pamela Rives ('80)
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Ford Motor Company
Pratt & Miller Engineering & Fabrication

$10,000-$24,999
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Nicholas ('61) and Rebecca Des Champs
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