Virginia Tech
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MECHANICAL ENGINEERING

2016 annual report

MESSAGE FROM THE DEPARTMENT HEAD

AZIM ESKANDARIAN

As I begin my second year as the department head, I am thrilled to share with you this 2015-16 Annual Report of the Mechanical Engineering Department of Virginia Tech. I had a very high opinion of my colleagues at the ME Department before starting in this position in August 2015, but after a year in Blacksburg (and our National Capital Region near Washington, DC) and experiencing the outstanding quality, steadfast dedication, and selfless services of our faculty and staff, I am simply full of praise and admiration for all of them and grateful to be able to serve them.

It is not surprising at all that the same quality, devotion, and enthusiasm is equally reflected in both our graduate and undergraduate students, who are making their own impressive accolades in mechanical engineering as they graduate and enter the work force. We are also blessed with a committed and supportive advisory board, primarily comprised of Hokie alumni, who not only encourage and support us to efficiently operate one of the largest and most productive ME Departments in the nation; but who challenge us to continue tackling tough problems around the world. Collectively, our faculty, students, staff, and alumni truly represent Virginia Tech's well known spirit of *UT Prosim* (that I may serve.)

Last year, our faculty developed a new strategic plan, creating a renewed vision, and shaping the future of our department. Several new initiatives are in place in pursuit of excellence and scholarship. We have redefined our graduate focus into five thrust areas, described in more detail in this report. A new departmental structure is organized to promote and cultivate specialty areas and cross disciplinary scholarship. Plans for offering a new major in Robotics and Mechatronics is in the works and is on track to be implemented next year. Many other activities are in progress to enhance the quality of our hands-on minds-on educational

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Don Taylor - Dean of the College of Engineering

Azim Eskandarian - Head of the Department of Mechanical Engineering

Rosaire Bushey - Communications & Outreach Manager - Editor

Sierra Colley - Graphic design and photography intern

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offerings and to accommodate our ever-growing student body. As a department, we also find ourselves strategically placed at the heart of Virginia Tech's Destination Areas, a cross college and multi-disciplinary approach to new programs within the university with major resources and investments.

In recognition of our outstanding faculty, last year, the department and college awarded one new faculty fellowship (John Jones III Fellowship); renewed two five-year term professorships; and is currently seeking nominations for two more faculty fellows to be awarded this year. Mechanical Engineering hosts 12 endowed faculty professorships and fellowships and our faculty and staff were the recipients of dozens of awards and certificates. Three of our students received recognition awards at graduation in May 2015.

Our students had a remarkably successful year in various competitions and projects, fielding six strong teams in national competitions as part of our experiential learning. A few of them were among our senior design projects including the Hybrid Electric Vehicle Team that competes in the EcoCAR Challenge. The team placed second nationwide in 2016, and they held the distinction of being the only team that converted a V8 engine into a hybrid system, challenging themselves and the perception of what is possible with hybrid energy vehicles.

The VT Hyperloop team, made up of 33 undergraduate students from all engineering disciplines and the Pamplin College of Business, earned fourth place at the international Hyperloop Design Competition held at Texas A&M University in January. In September, they unveiled the pod they'll take to the next round of competition in January 2017. To help them in their research, the university has agreed to build a Hyperloop test track at Virginia Tech – the first of its kind on the U.S. East Coast.

In 2015-2016, one-third of ME's forty-five senior design project teams were sponsored by industry and tackled real-life design and development problems over two semesters. This year we are adding more sponsors, with the goal to have all of our teams working on industry-sponsored challenges that incorporate new levels of expectations and opportunities for our students.

As part of our strategic direction, in full harmony with that of the college and university, the department has embarked on a strong diversity and inclusivity plan and actively works to enhance the diversity of our student body, and training our workforce to be actively engaged in the university's plan.

As part of that effort, we have admitted more female graduate students, reaching 13.94% this year. This is one of ME's strategic goals, which we cherish and take very seriously and we will continue to make strides by our proactive efforts.

I am very proud of the continued accomplishments of our faculty, students, staff, and alumni, many of which we will share with you throughout the year via the quarterly digital *Momentum* magazine. There are so many great things happening in the department it is impossible to capture them all in our digital publications, so ME is active on social media with Facebook, Twitter and Instagram channels; and we are also keeping a presence in the world of print with postcards and magazines such as this annual report.

As you read about our accomplishments, our faculty, and our students, I invite you to also read the names of the men and women - alumni and friends - whose generosity and support have allowed us to achieve, maintain, and continue to distinguish our position as one of the world's premier Mechanical Engineering programs.

INSIDE

New technologies such as those found in the Design, Research, and Education for Additive Manufacturing Systems (DREAMS) lab of Associate Professor Chris Williams, enable mechanical engineers to design, test and innovate faster than ever before.

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MECHANICAL ENGINEERING

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VT Mechanical Engineering

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FACULTY

Tenured & Tenure Track Faculty	56
Affiliate and Adjunct Faculty	38
Prof. of Practice	3
Instructional Faculty	3
Research Faculty & Scientists	7
Graduate teaching assistants	37
Graduate research assistants	166

Figures as of 2016

12%
GROWTH
University-wide, Virginia Tech experienced a 12% growth in the number of undergraduate applications for the Class of 2020 over the Class of 2019.

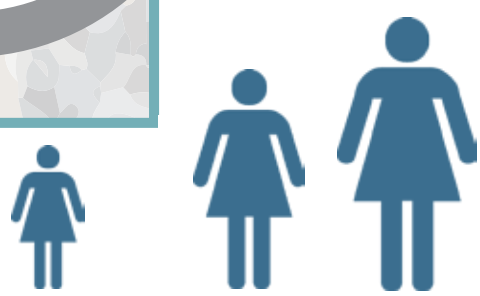
RANKS

U.S. News & World Report 2017

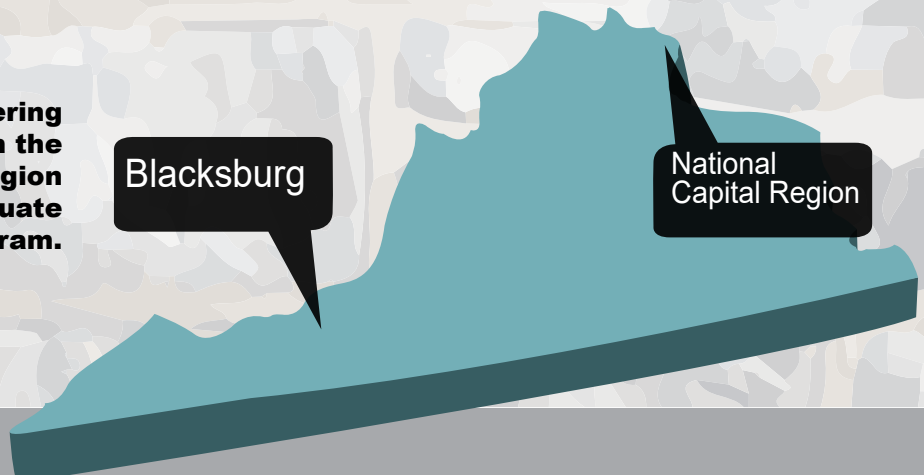
NO. **16**
GRADUATE

NO. **13**
UNDERGRADUATE

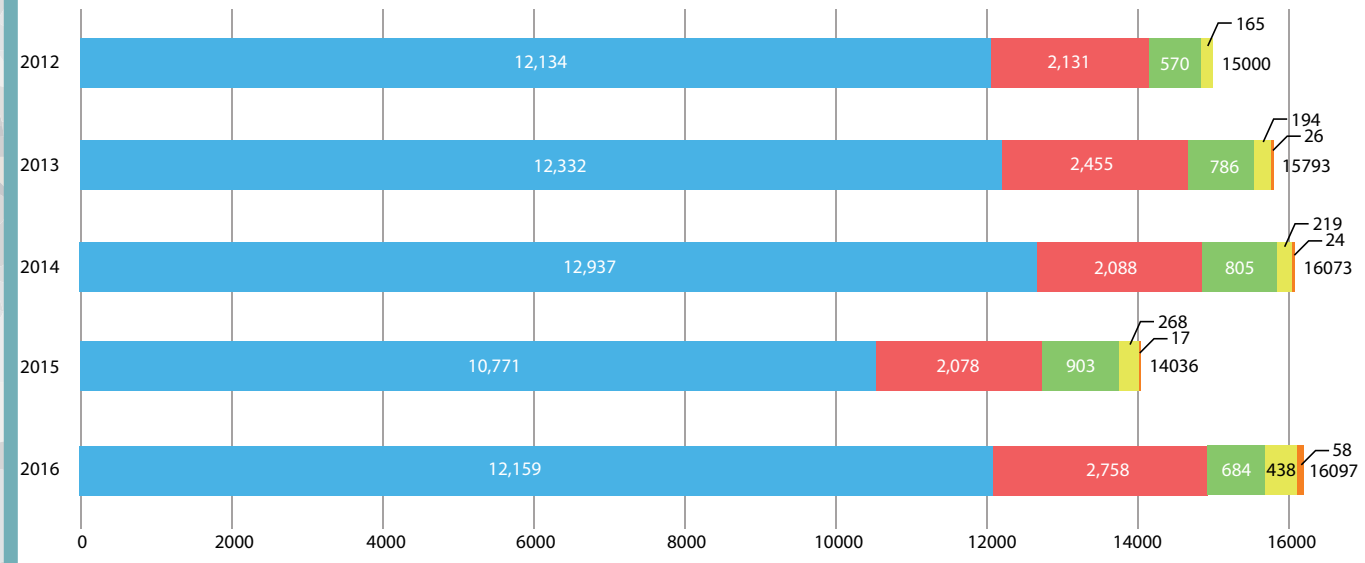
Women in VT ME graduate programs



Mechanical Engineering also has a presence in the National Capital Region through the Graduate Program.



Research Expenditures



Listed as 1,000s of dollars

Federal

Commercial

VT Foundation

Other

State

450-475*
2018

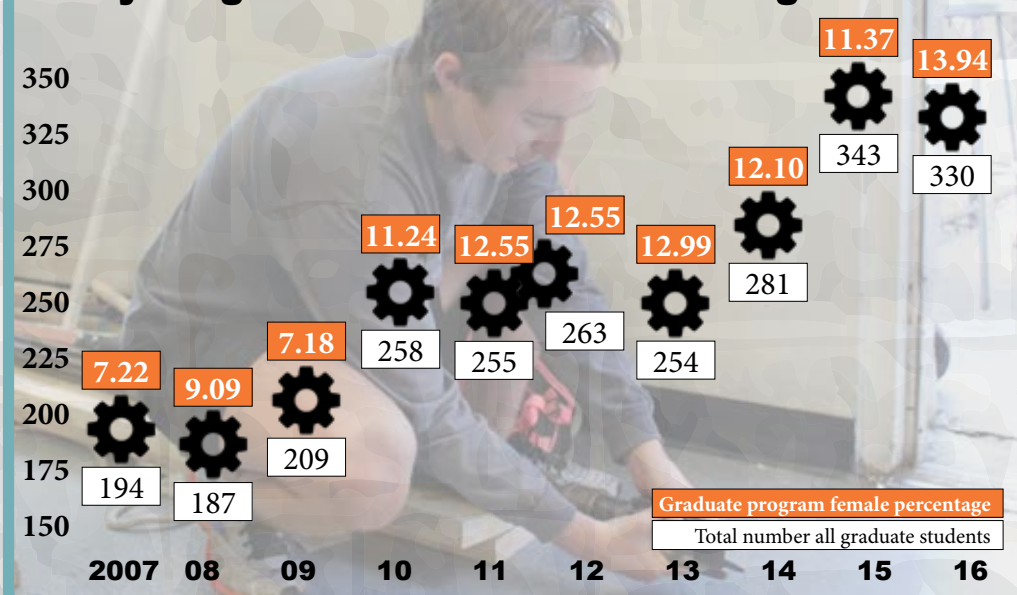
452*
2017

401
2016

380
2015

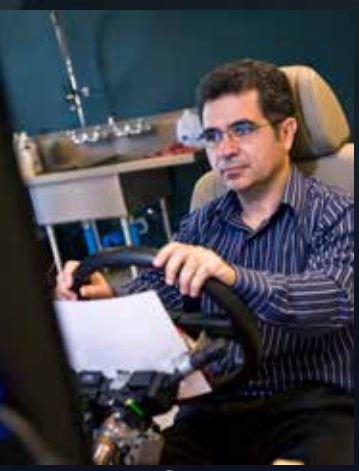
UNDERGRADUATE
Graduating class size by year (* Expected)

10 year growth of ME Graduate Program



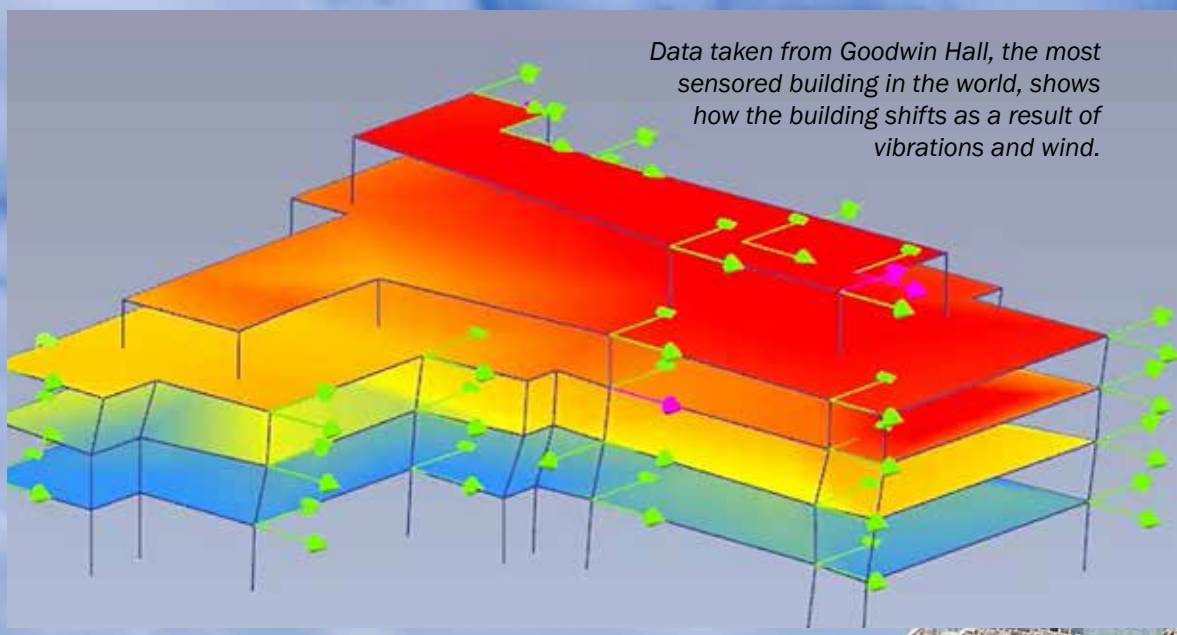
ME Thrust Areas

RADS



Professor Saied Taheri RADS Coordinator

Robotics, Autonomous & Dynamical Systems



Data taken from Goodwin Hall, the most sensored building in the world, shows how the building shifts as a result of vibrations and wind.

In 2016, Mechanical Engineering reorganized faculty and research around five Graduate Thrust Areas to more efficiently delineate how ME research areas relate to each other and how an area's research focus relates to its application potential.

AREAS OF RESEARCH AND STUDY

Acoustics and Noise Control | Dynamics | Kinematics and Mechanisms | Multibody Dynamics | System Dynamics and Control | Vibrations

The RADS Thrust Area is organized based on very strong core competencies in dynamic systems and control, supplemented by knowledge of an array of topics, including robotics, mechatronics, automotive engineering, energy harvesting, and autonomous systems. It offers deeper understanding of modeling, estimation and control of dynamical systems to STEM majors and other students with an interest in engineering, science and technology.

It will teach the students to create systems that automate manufacturing, transportation and health care; and can learn, adapt, make decisions, identify, estimate, and control systems while partially harvesting the energy it needs to function.

Applications such as those in robotics and autonomous systems which represent key areas of scientific and engineering endeavor now and in the future, will have immense societal impact, pervading all areas of society including medicine, transport, and manufacturing.

With several state-of-the-art research centers and laboratories, the cross- and multi-disciplinary re-search between faculty and students of the RADS Thrust Area and other mechanical engineering thrust areas has positively impacted the industry and helped students practice a hands-on minds-on approach. It is our intent to further this tradition by developing and expanding these inter- and multi-disciplinary areas, and pursuing knowledge through goal-oriented research. In this way mechanical engineering serves not only as an educator but also as a regional economic engine.

RESEARCH APPLICATIONS

Autonomous Vehicles and Systems | Energy Harvesting | Mechatronics | Railroad Engineering | Robotics Sensors and Actuators | Smart Structures | Structural Health Monitoring | Terramechanics | Tire Research | Vehicle Dynamics and Engineering

DMM

Dan Pletta
Professor
Mehdi Ahmadian
DMM Coordinator

Design, Materials & Manufacturing

The Design, Materials, and Manufacturing (DMM) thrust area focuses on all elements of engineering design and advanced manufacturing. Interdisciplinary interests span across areas of design methodology, design optimization, and advanced manufacturing and materials processing. Faculty and students in the DMM thrust area are discovering novel theories, tools, and technologies that will advance society through realization of more functional and economical materials, machines, and manufacturing processes across a wide variety of market applications.

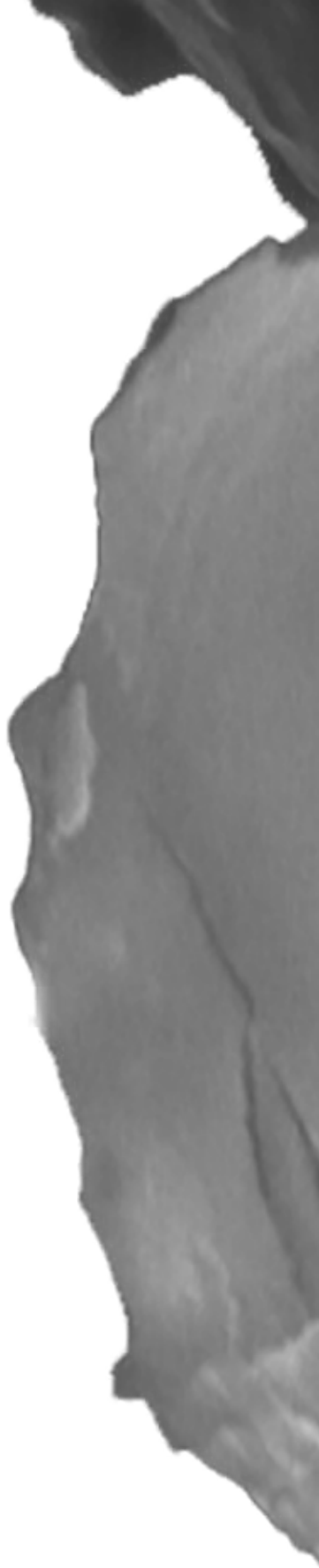
DMM faculty and students, including our affiliate faculty, conduct fundamental and applied research in areas including: mechanical design, rapid prototyping, virtual prototyping, and additive manufacturing processes. Our analytical, computational, and experimental research covers multiple scales (from nano, to micro, to macro mechanics) and multiple material systems (including polymers, metals, ceramics, composites, and biomaterials). We have state-of-the-art capabilities for experimental work in additive manufacturing and are conducting research in enhancing these processes and manufacturing methods.

Design and materials are fundamentally linked to all other areas of mechanical and nuclear engineering. Consequently, DMM has close synergy with all other ME thrust areas. Collaboration in bio-inspired materials and nano-scale modeling with BMNS, materials development for energy systems with EES, design and manufacturing automation with RADS, and nuclear materials research with NES are regularly pursued within the department. The DMM group has extensive collaboration with other departments in the College of Engineering and other colleges at Virginia Tech, as well as several industries and government agencies.

Beyond its research efforts, the DMM group plays a major role in the Department's teaching efforts, through the sophomore and senior capstone design courses, and a number of technical electives on contemporary topics related to design, materials, and manufacturing at undergraduate and graduate levels.

RESEARCH APPLICATIONS

Additive Manufacturing | Computer Aided Design (CAD) and Finite Element Analysis (FEM) | Design Optimization | Rapid Prototyping | Virtual Prototyping



This nano-scale tube is the foundational building block for a new generation of additive manufacturing processes that allow scaling of more than seven orders of magnitude - enough to allow construction at the centimeter level. This breakthrough technology paves the way for enormous advances in a variety of energy and sensor related industries.

AREAS OF RESEARCH AND STUDY

Advanced Materials Design | *Composites* | *Design Theory and Methodology* | *Machine Design* | *Mechanics of Materials* | *Meta-Materials* | *Smart Materials*

NES

Professor Alireza Haghighat NES Coordinator

Nuclear Engineering and Science

The NES Thrust Area's focus is research and education for advancement of nuclear engineering science and its application in power, security, medicine and policy. Members of NES are primarily engaged in development of computational methodologies for design and analysis of nuclear systems, establishment of experimental capabilities for understanding basic phenomenon and benchmarking of computational tools, and the study and analysis of public policy in nuclear science.

The current activities of NES includes areas such as: nuclear materials and fuel modeling and chemistry; advanced particle transport methods and codes development for real-time simulation of nuclear systems with specific application in reactor physics, reactor shielding, radiation detection design, and medical imaging; reactor thermal-hydraulics fundamentals and reactor safety analysis; and development of advanced reactor fuel cycles and designs for addressing safety, security, sustainability, and policy.

In addition to the Mechanical Engineering faculty, the NES team works with faculty members and researchers from other departments and centers such as Advanced Computing Research and Visual Computing, Materials Science and Engineering, Physics, Science and Technologies in Society, and the School of Public and International Affairs. The members have significant research collaborations with universities, government organizations, and private industry, both nationally and internationally.

Without a doubt, NES faculty is poised to contribute to advancement of safe, secure and sustainable nuclear power, design of systems for nuclear materials monitoring and detection, design of radiation diagnosis and therapy, and science-based analysis for formulation of nuclear policy.

RESEARCH APPLICATIONS

Medical Imaging | Nuclear Nonproliferation and Policy | Nuclear Surety and Safeguards | Reactor Design

AREAS OF RESEARCH AND STUDY

Nuclear Materials and Fuel | Particle Transport Methods | Radiation Detection | Reactor Physics | Reactor Safety and Thermal-Hydraulics | Reactor Shielding


NO Smoking
NO Eating
NO Drinking
CAUTION
CAUTION

EES

Professor Michael von Spakovsky EES Coordinator

Energy Engineering and Science

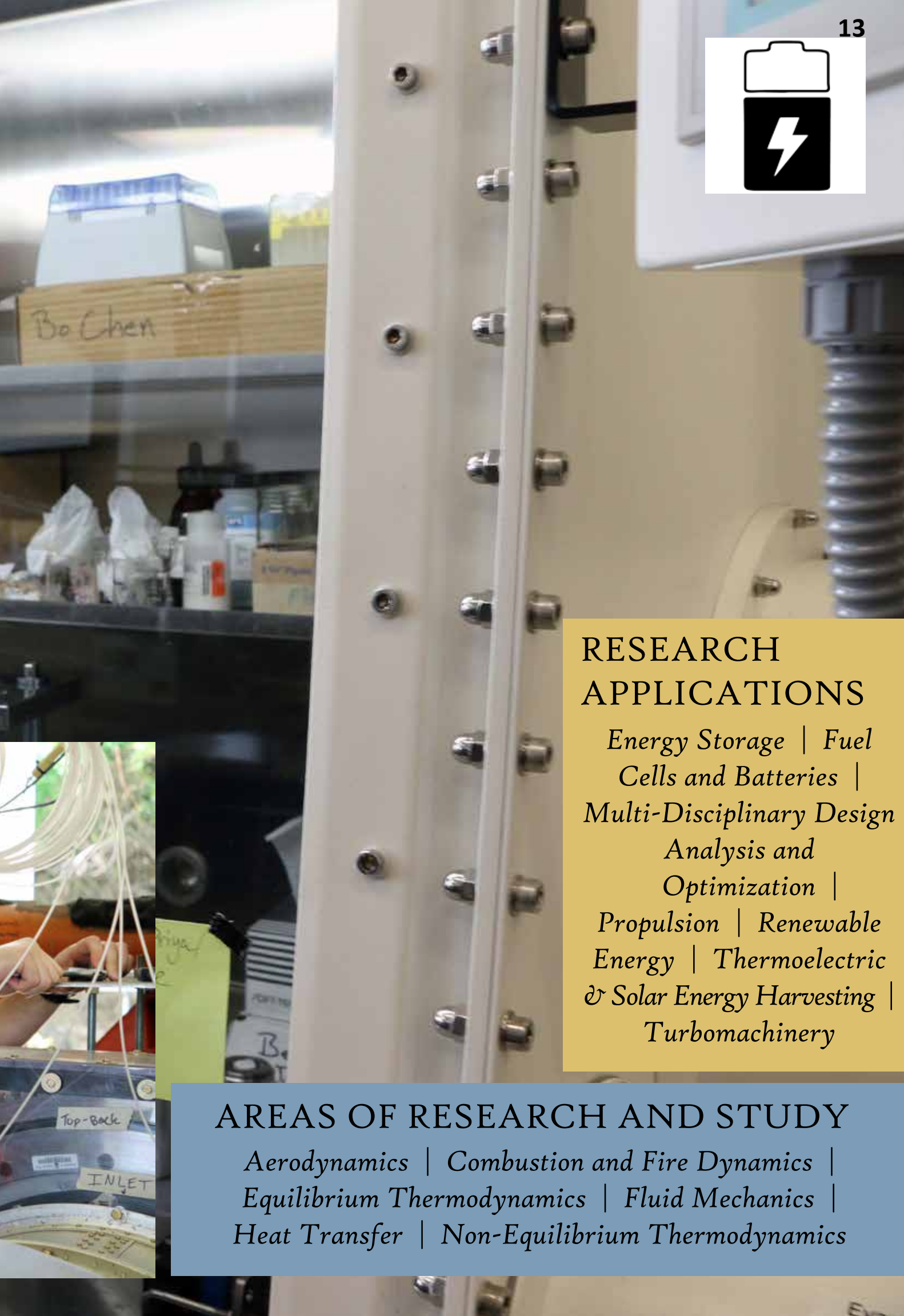
The EES Thrust Area's focus is to understand, develop, and apply the basic principles of science and engineering to the very broad field of energy. We use these principles to develop technologies for the efficient and sustainable use and conversion of energy with the goal of meeting the challenges posed by dwindling resources, rising prices, and environmental impacts.

Teaching and research include the following disciplines: equilibrium and non-equilibrium thermodynamics, heat transfer, fluid dynamics, aerodynamics, materials, and combustion and fire dynamics.

Applications at all scales from the microscopic to the macroscopic include: energy storage (e.g., batteries, metal hydrides, pump storage, super-capacitors, etc.), fuel cells, propulsion, turbo-machinery, renewable energy, thermoelectric and solar energy harvesting, multi-disciplinary design analysis and optimization of grid/micro-grid and high performance aircraft and stationary systems, etc.

Numerous multi- and cross-disciplinary collaborations between faculty and students exist within the EES Thrust Area and across thrust areas and new ones are always being encouraged due to the pervasiveness of energy and its impact on all mechanical engineering disciplines and applications.

Without a doubt, ENERGY is the future and through innovation, we will help to invent it.



RESEARCH APPLICATIONS

Energy Storage | Fuel Cells and Batteries | Multi-Disciplinary Design Analysis and Optimization | Propulsion | Renewable Energy | Thermoelectric & Solar Energy Harvesting | Turbomachinery

AREAS OF RESEARCH AND STUDY

Aerodynamics | Combustion and Fire Dynamics | Equilibrium Thermodynamics | Fluid Mechanics | Heat Transfer | Non-Equilibrium Thermodynamics

BMNS

Associate Professor Rolf Mueller BMNS Coordinator

Bio, Micro, and Nano Systems

AREAS OF RESEARCH AND STUDY

Biomechanics | Bioheat Transfer | Micro-Nano-Fluidics | Nano and Cell Mechanics | Nanomaterials and Processes

RESEARCH APPLICATIONS

Bioinspired Technology | Biomedical Devices | Biosensors | MEMS | Micro and Nano Fabrication | Micro-Robotics | Smart Drug Delivery

The Bio, Micro, and Nano Systems Thrust Area unites a diverse research portfolio with a wealth of interdisciplinary intersections. The biological systems research in BMNS is interdisciplinary between (mechanical) engineering and biology.

The interdisciplinary connections between these areas can take two different directions, that are not mutually exclusive: In one direction, biological systems can be used as models to inspire engineering innovation. The rationale behind this connection is to let engineering take advantage of billions of years of biological evolution to find solutions to complex, multi-dimensional problems. In the other direction, engineering methods can be applied to analyzing and manipulating biological systems. A particularly important example of this direction can be found in biomedical engineering, where engineering methods are being used to diagnose and treat disease.

Research in the micro and nano area focuses on the properties of structures, surfaces, and transport phenomena at these very small scales. Some of this research looks across different scales to consider the nano as well as the micro scale.

Example applications of this research can be found in areas such as fuel cells, where micro and nano structures can be used to increase the area of electrodes. Nano-scale structures can also be used to control energy transport, e.g. for thermal management electronics components.

Understanding the principles of fluid motion on micro- and nano scales, can have an impact on applications in areas such as electrochemistry, biochemistry, and biomedicine. Since biological systems heavily rely on all size scales from single molecules to entire ecosystems to achieve their functions, there is a strong link between the study of biological systems and micro- and nano scale structures or processes.

The members of the BMNS Thrust Area will seek to exploit these relationships to create new interdisciplinary synergies for the development of novel technologies.

Faculty and Staff

Mehdi Ahmadian
Dan Pletta Professor
PhD - State University of NY, Buffalo
Vehicle System Dynamics and Control; Smart Materials, Energy Harvesting

EES NES RADS BMNS DMM

Design, Materials & Manufacturing

Alan Asbeck
Assistant Professor
PhD - Stanford University
Wearable robotics, Biomechanics of movement, Mechatronic Systems

EES NES RADS BMNS DMM

Robotics, Autonomous, & Dynamical Systems

Francine Battaglia
Professor
PhD - Pennsylvania State University
Energy efficiency, Bubble column reactors, Fluidized bed technology

EES NES RADS BMNS DMM

Energy Engineering and Science

Javid Bayandor
Associate Professor
PhD - Royal Melbourne Institute of Technology, Australia
Aerospace structure and design

EES NES RADS BMNS DMM

Design, Materials & Manufacturing

Bahareh Behkam
Associate Professor
PhD - Carnegie-Mellon University
Micro/nanoscale systems, Biotic/abiotic interfaces, Living machines, Bio-hybrid microbiotics

EES NES RADS BMNS DMM

Bio, Micro, and Nano Systems

Pinhas Ben-Tzvi
Associate Professor
PhD - University of Toronto, Canada
Robotics, Mechatronics design, Human-robot interaction, Biomedical engineering

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Robotics, Autonomous, & Dynamical Systems

Jan Helge Bøhn
Associate Professor
PhD - Rensselaer Polytechnic Institute
Rapid prototyping, Additive manufacturing, International Engineering Education

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Design, Materials & Manufacturing

Ricardo Burdisso
Professor
PhD - Virginia Tech
Acoustics and vibrations, Structural dynamics, Aeroacoustic measurements in wind tunnels

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Robotics, Autonomous, & Dynamical Systems

Jiangtao Cheng
Associate Professor
PhD - Purdue University
Microfluidics & nanofluidics, Sustainable and renewable energy, Thermal fluid sciences

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Energy Engineering and Science

Clinton Dancey
Associate Professor
PhD - Cornell University
Thermodynamics; Flow dynamics

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Energy Engineering and Science

Weiwei Deng
Associate Professor
PhD - Yale University
Fluid dynamics of low-dimensional liquid subjects & applications in additive manufacturing

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Energy Engineering and Science

Thomas Diller
Professor
PhD - Massachusetts Institute of Technology
Heat flux sensor development and calibration

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Energy Engineering and Science

Srinath Ekkad
Rolls Royce Professor
PhD - Texas A&M University
Gas turbine heat transfer, Combustion, and cooling; Heat transfer in complex systems

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Energy Engineering and Science

Michael Ellis
Associate Professor
PhD - Georgia Institute of Technology
Fuel cell systems for building cogeneration, Fuel cell performance modeling

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Energy Engineering and Science

Azim Eskandarian
Professor & Department Head
PhD - The George Washington University
Dynamic systems and controls, Intelligent systems, Multi-body and impact dynamics

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Robotics, Autonomous, & Dynamical Systems

John Ferris
Associate Professor
PhD - University of Michigan
Automotive engineering, Stochastic modeling, Modeling and simulation

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Robotics, Autonomous, & Dynamical Systems

Chris Fuller
Samuel Langley Distinguished Professor
PhD - University of Adelaide, Australia
Structure acoustics, Active noise control, Advanced composite materials for noise reduction

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Robotics, Autonomous, & Dynamical Systems

Tomonari Furukawa
Professor
PhD - University of Tokyo, Japan
Multiphysics system analysis and design, Computational and experimental mechanics

EES NES RADS BMNS DMM

Robotics, Autonomous, & Dynamical Systems

Alireza Haghighat
Professor
PhD - University of Washington
Multi-stage response-function particle transport methodologies

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Nuclear Engineering and Science

Warren Hardy
Associate Professor
PhD - Wayne State University
Impact and injury response and tolerance properties of biological materials

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Bio, Micro, and Nano Systems

Celine Hin
Assistant Professor
PhD - Polytechnique de Grenoble, France
Theoretical research in physical metallurgy, Nuclear materials and radiation effects

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Nuclear Engineering and Science

Scott Huxtable
Associate Professor
PhD - University of California, Berkeley
Nanoscale thermal transport, Thermoelectric devices

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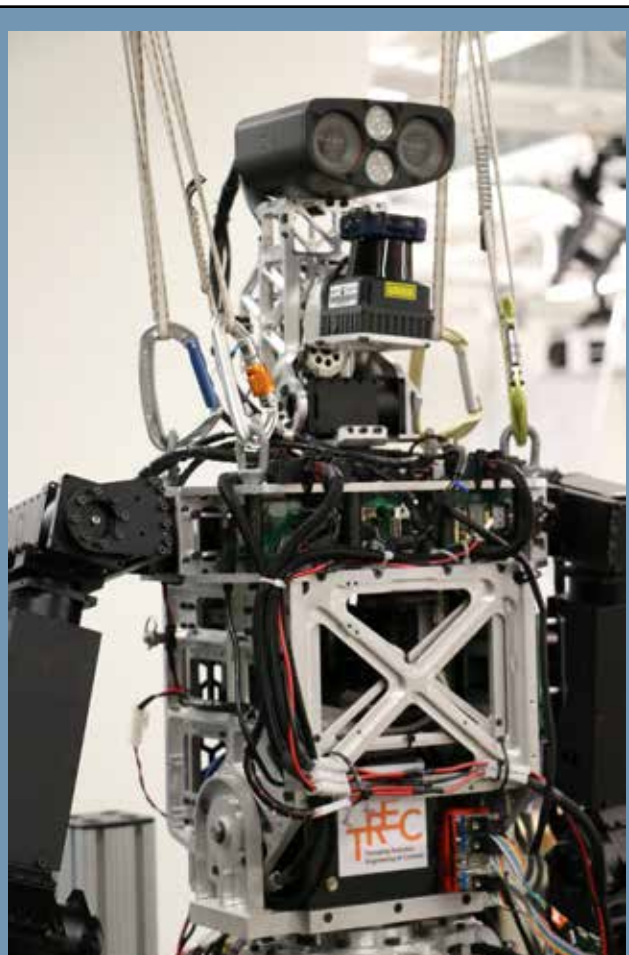
Energy Engineering and Science



Ronald Kennedy
Managing Director, CenTiRe
PhD - University of Akron
Tire mechanics, Finite element analysis

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Design, Materials & Manufacturing

Kevin Kochersberger
Associate Professor
PhD - Virginia Tech
Dynamics and control, Autonomous aerial systems, Applied aerodynamics

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Robotics, Autonomous, & Dynamical Systems

Alan Kornhauser
Associate Professor
PhD - Massachusetts Institute of Technology
Fuel cells, Multiphase flow

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Energy Engineering and Science

Mary E. Kasarda
Associate Professor
PhD - University of Virginia
Machinery and structural health monitoring, Engineering education in K-12

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Robotics, Autonomous, & Dynamical Systems

Andrew Kurdila
W. Martin Johnson Professor
PhD - Georgia Institute of Technology
Nonlinear dynamics, Control theory, Active materials and smart structures

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Robotics, Autonomous, & Dynamical Systems

John Kennedy
Professor
PhD - Clemson University
Mechanics of advanced composite materials, Engineering fibers and films, Innovative learning

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Design, Materials & Manufacturing

Alexander Leonessa
Associate Professor
PhD - Georgia Tech
Cooperative robotic systems, Control of bipedal balance and locomotion

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Robotics, Autonomous, & Dynamical Systems

Yang Liu
Assistant Professor
PhD - Purdue University
Nuclear thermal hydraulics and reactor safety, Advanced passive safety system design

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Nuclear Engineering and Science

Walter O'Brien
J. Bernard Jones Professor
PhD - Virginia Tech
Turbomachinery and turbine engines, Alternate fuel for turbine engines

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Energy Engineering and Science

Roop Mahajan
Lewis A. Hester Chair in Engineering
PhD - Cornell University
Fluid mechanics, Nanotechnology, Humanistic engineering

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Bio, Micro, and Nano Systems

Robin Ott
Associate Professor of Practice
BSME - Virginia Tech
Faculty advisor and industry partner liaison for Senior Design

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Design, Materials & Manufacturing

Reza Mirzaeifar
Assistant Professor
PhD - Georgia Institute of Technology
Computational mechanics of materials, Smart materials and structures, Materials design

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Design, Materials & Manufacturing

Rolf Mueller
Associate Professor
PhD - University of Tuebingen, Germany
Bioinspired technology, Analysis of biodiversity in biological form and function

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Bio, Micro, and Nano Systems

Amrinder Nain
Associate Professor
PhD - Carnegie-Mellon University
Nanotechnology, Micro/nanofiber manufacturing and characterization, Biological scaffolds

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Bio, Micro, and Nano Systems

Douglas Nelson
Professor
PhD - Arizona State University
Energy use in vehicles, Design of hybrid and electric vehicle powertrains

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Energy Engineering and Science

Wing Ng
Christopher C. Kraft Endowed Professor
PhD - Massachusetts Institute of Technology
Unmanned aerial vehicles, Propulsion

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Energy Engineering and Science

Robert G. Parker
L.S. Randolph Professor
PhD - University of California, Berkeley
Dynamics and stability of high-speed, gyroscopic systems, Nonlinear vibrations

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Robotics, Autonomous, & Dynamical Systems

Mark Paul
Professor
PhD - University of California, Los Angeles
Nonlinear dynamics, Nonequilibrium physics, Pattern formation

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Energy Engineering and Science

Mark Pierson
Associate Professor of Practice
PhD - Virginia Tech
Nano-nuclear applications and radioisotope batteries, Nuclear fuel cycle

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Nuclear Engineering and Science

Ranga Pitchumani
George R. Goodson Professor
PhD - Carnegie-Mellon University
Energy systems, Energy/water nexus, Electric grid integration of renewable energy

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Energy Engineering and Science

Shashank Priya
Robert E. Hord Jr. Professor
PhD - Pennsylvania State University
Multi-functional materials, Energy, Bio-inspired systems, Energy harvesting and storage

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Energy Engineering and Science

Rui Qiao
Associate Professor
PhD - University of Illinois, Urbana-Champaign
Fluid dynamics, Heat transfer

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Energy Engineering and Science

Corina Sandu
Professor
PhD - University of Iowa
Multibody dynamic systems, On/Off road wheeled and tracked vehicle dynamics

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Robotics, Autonomous, & Dynamical Systems

Michael J. Roan
Associate Professor
PhD - Pennsylvania State University
Acoustics materials development and testing, Statistical signal processing

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Robotics, Autonomous, & Dynamical Systems

Steve Southward
Associate Professor
PhD - Michigan State University
Ground vehicle chassis and suspension performance, Adaptive signal processing and control

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Robotics, Autonomous, & Dynamical Systems

Danesh Tafti
William S. Cross Professor
PhD - Pennsylvania State University
Computational fluid dynamics in dynamic geometries, Turbulence modeling

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Energy Engineering and Science

Pablo A. Tarazaga
Assistant Professor
PhD - Virginia Tech
Structural mechanics, Dynamics and control, Smart infrastructure, Power/Energy harvesting

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Robotics, Autonomous, & Dynamical Systems

Saied Taheri
Professor
PhD - Clemson University
Tire and vehicle dynamic modeling and simulation, Intelligent tire development

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Robotics, Autonomous, & Dynamical Systems

Zhiting Tian
Assistant Professor
PhD - Massachusetts Institute of Technology
Nanoscale heat transfer, Thermoelectrics

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Energy Engineering and Science

Brian Vick
Associate Professor
PhD - North Carolina State University
Thermal radiation and radiometry, Blood perfusion

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Energy Engineering and Science

Alfred L. Wicks
Associate Professor
PhD - Michigan Tech
Autonomous ground vehicles, Hybrid power systems, Mechatronics/sensors

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Robotics, Autonomous, & Dynamical Systems

Linda W. Vick
Associate Professor of Practice
PhD - Virginia Tech
Instructor, Undergraduate academic and career advisor, Advising

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Design, Materials & Manufacturing

Christopher B. Williams
Associate Professor
PhD - Georgia Tech
Additive manufacturing materials, Design for manufacturing, Design methodology

EES NES RADS BMNS DMM

Design, Materials & Manufacturing

Michael von Spakovsky
Professor
PhD - Georgia Institute of Technology
Theoretical and applied non-equilibrium thermodynamics, Kinetic theory

EES NES RADS BMNS DMM

Energy Engineering and Science

Xiaoyu (Rayne) Zheng
Assistant Professor
PhD - Boston University
Hierarchical multifunctional materials and systems, Biomedical micro-devices

EES NES RADS BMNS DMM

Design, Materials & Manufacturing

Robert L. West
Associate Professor
PhD - University of Missouri, Columbia
Nonlinear finite element analysis, Mechanical/structural design optimization

EES NES RADS BMNS DMM

Design, Materials & Manufacturing

Lei Zuo
John R. Jones III Faculty Fellow
PhD - Massachusetts Institute of Technology
Energy harvesting - small and large scale

EES NES RADS BMNS DMM

Robotics, Autonomous, & Dynamical Systems

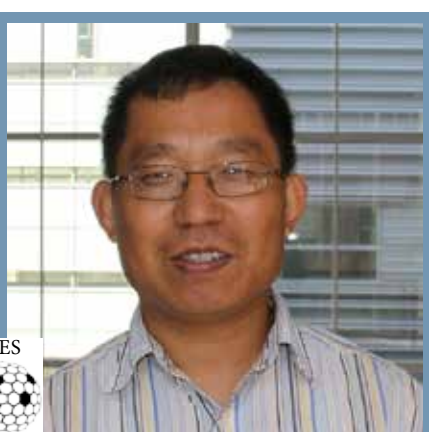
Rosaire Bushey
Administrative/Professional Faculty
MA - Seton Hall University & Southern New Hampshire University
Department Communications Manager

EES NES RADS BMNS DMM

Melissa Williams
Administrative/Professional Faculty
BS - Bluefield College
Department Operations Manager

EES NES RADS BMNS DMM

New Faculty AY 2016-2017



NES

Jinsuo Zhang
PhD: Zhejiang University, China
Focus area: Nuclear Engineering

BMNS

Ling Li
PhD: 2014, MIT
Focus Area: Bio-inspired design, tough glass laminate

EES

Zheng Li
PhD: 2011, SUNY, Binghamton
Focus area: Energy storage materials and systems

Affiliate Faculty

Mechanical Engineering
James Robert Mahan - Professor Emeritus

Biomedical Engineering and Mechanics
Romesh Batra - Clifton C. Garvin Professor
Lissett Bickford - Assistant Professor
Guohua Cao - Assistant Professor
Scott Case - Professor
Raffaella De Vita - Associate Professor
Rafael Davalos - Associate Professor
Clay Gabler - Associate Department Head
Sunghwan (Sunny) Jung - Assistant Professor
Muhammad Hajj - Prof. & Dir. of Research and Graduate Studies
John Robertson - Research Professor
Jake Socha - Assistant Professor
Mark Stremler - Associate Professor
Mark Van Dyke - Associate Professor

Civil and Environmental Engineering
Christopher Moen - Associate Professor

Chemical Engineering
William Ducker - Professor

Electrical and Computer Engineering
Masoud Agah - Professor, Electrical and Computer Engineering

Aerospace and Ocean Engineering
William Davenport - Prof. & Assist. Dept. Head for Lab. Facilities
Lin Ma - Professor
Todd Lowe - Assistant Professor
Michael Philen - Associate Professor
Gary Seidel - Assistant Professor
Craig Woolsey - Assistant Department Head for Graduate Studies

Engineering Science & Mechanics
Shane Ross - Associate Professor
Wallace Grant - Kevin P. Granata Faculty Fellow, Emeritus
Shane Ross - Associate Professor

Industrial and Systems Engineering
Maury Nussbaum - H.G. Prillaman Professor
Bob Sturges - Professor

School of Education
Brenda Brand - Associate Professor

Institute for Critical Technology and Applied Science
Stefan Duma - Professor, Director of ICTAS

VT/Wake Forest Center for Injury Biomechanics
Costin Untaroiu - Research Associate Professor

Collegiate Partner Universities
William Copenhaver - Visiting Professor, USAF Research Laboratory
Dan Inman - Clarence "Kelly" Johnson Professor and Department Chair, Aerospace Engineering, University of Michigan
Don Leo - Dean, College of Engineering, University of Georgia
Hank Yochum - Director, Margaret Jones Wyllie '45 Engineering Program Department of Engineering and Physics, Sweet Briar College

Adjunct Faculty

Brian Lattimer - Vice president, R&D, Jensen Hughes
Magdalena Caro, Staff scientist, Los Alamos National Laboratory
Sankaranarayanan Vengadesan, Professor, Dept. of Applied Mechanics, IIT Madras

Instructors

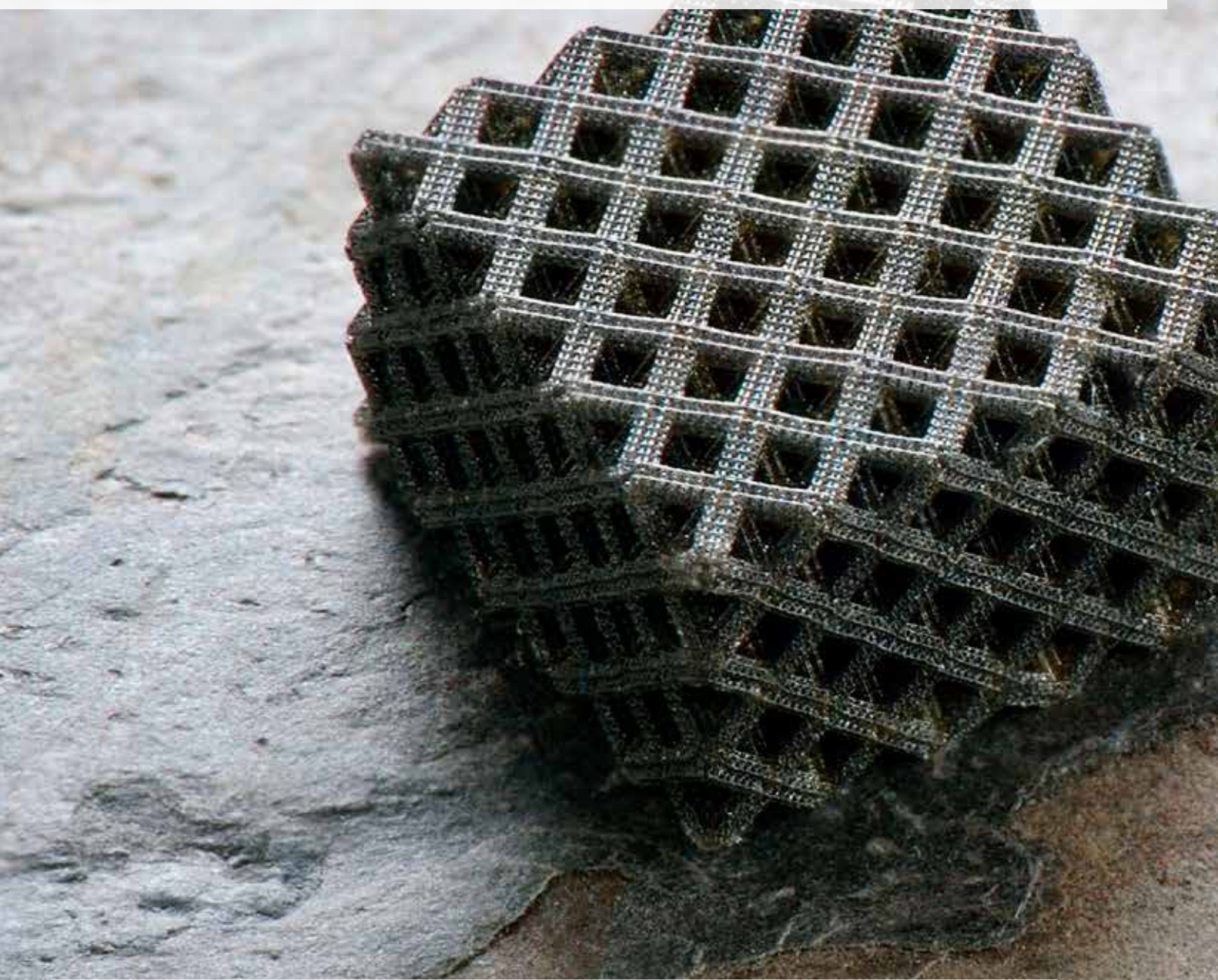
Matt Rice
Rick Clark
Charles Smith

Staff

Jamie Archual - Computer systems engineer
Annette Ben-Tzvi - Graduate academic advisor
Amanda Collins - Program support technician, HR/ Payroll
Horatio Cowan - Lab manager
Sarah Deisher - Undergraduate academic advisor
Cathy Hill - Graduate program coordinator
Kimberly Hobbs - Program support technician
Beth Howell - Program manager
Diana Israel - Program support technician
Ashlin Jackson - Program support technician
Liz Kersteter - Program support technician, VAL
Timothy Kessinger - Machine shop supervisor
Sue Miller - Office assistant
Phillip Long - Laboratory mechanic
Casey Lucas - Laboratory instrument maker
Brandy McCoy - Executive Assistant to the department head
Lauren Mills - Program support Technician, CEHMS
Ben Poe - Senior computer systems engineer
Bill Songer - Lab instrument maker
Johnny Underwood - Equipment and facilities specialist
Sara Vallejo - Program support technician, CVeSS
Heather Whedbee - Undergraduate academic advisor
Lance Yelton - Program support technician

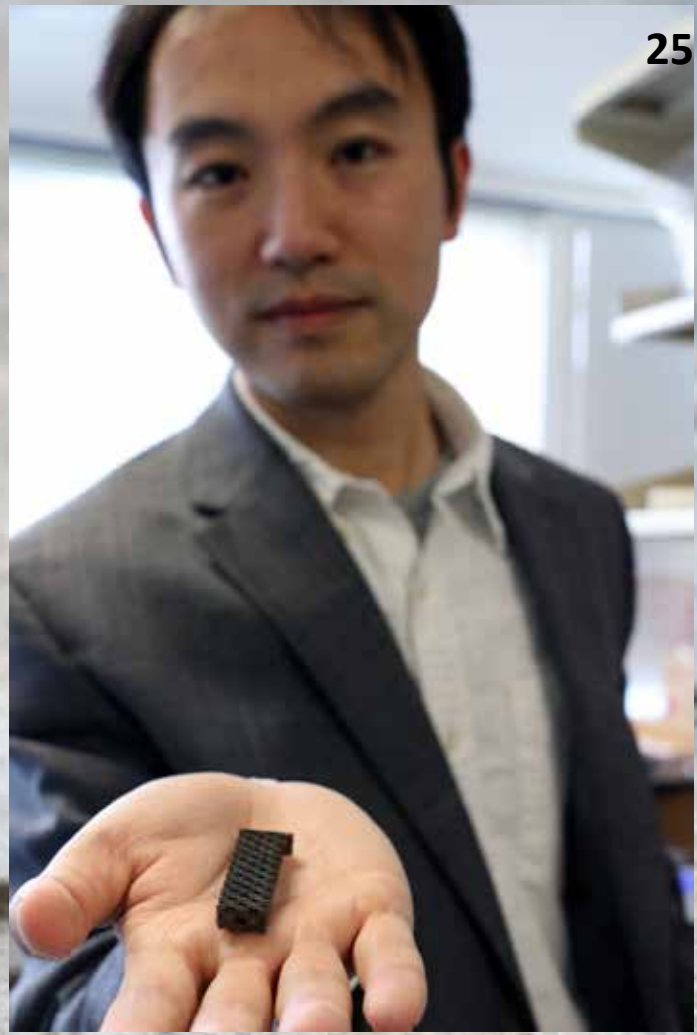
ME Research Laboratories

Virginia Tech Mechanical Engineering is comprised of more than 30 Laboratories, and 9 Centers. Its faculty and students also take part in research in many of the university's seven institutes. The following is a sample of the diversity of ME's laboratory experiences.



ADVANCED MANUFACTURING AND METAMATERIALS

Run by the research group of Assistant Professor Xiaoyu 'Rayne' Zheng, the lab conducts research at the intersection of 3D fabrication technologies and 3D architected mechanical metamaterials. The aim of the lab's research is to advance the next generation of additive manufacturing technologies and design tools. In July 2016, Zheng was featured in the journal *Nature Materials*.



Nanostructured materials achieve unprecedented scalability

Assistant Professor Xiaoyu “Rayne” Zheng has published a study in the journal *Nature Materials* that describes a new process to create lightweight, strong, and super-elastic 3-D printed metallic nanostructured materials with unprecedented scalability, a full seven orders of magnitude control of arbitrary 3-D architectures.

These multiscale metallic materials have displayed super elasticity because of their designed hierarchical 3-D architectural arrangement and nanoscale hollow tubes, resulting in more than a 400 percent increase of tensile elasticity over conventional lightweight metals and ceramic foams.

The approach, which produces multiple levels of 3-D hierarchical lattices with nanoscale features, could be useful anywhere there’s a need for a combination of stiffness, strength, low weight, and high flexibility — such as in structures to be deployed in space, flexible armors, lightweight vehicles, and batteries, opening the door for applications in aerospace, military, and automotive industries.

Natural materials, such as trabecular bone and the toes of geckos, have evolved with multiple levels of 3-D architectures, spanning from the nanoscale to the macroscale. Human-made materials have yet to achieve this delicate control of structural features.

The process Zheng and his collaborators use to create the material is an innovation in a digital light 3-D printing technique that overcomes current tradeoffs between high resolution and build volume, a major limitation in scalability of current 3-D printed microlattices and nanolattices.

AUTONOMOUS SYSTEMS AND INTELLIGENT MACHINES LABORATORY

Under the direction of Professor Azim Eskandarian, the ASIM researches controlling multiple robotic and vehicle systems to operate autonomously or semi-autonomously. Research uses intelligence created by sensors, sensor fusion, connectivity through communications, and advanced controls, and learning algorithms. The lab also learns from biological systems and human brain functions through signal processing to mimic intelligent motor control and understand cognitive behavior for human task control. A current application focus is on using these methods for advanced driver assistance systems.

ADVANCED PROPULSION AND POWER LABORATORY

Under the direction of Professor Srinath Ekkad and Professor Todd Lowe (Aerospace and Ocean Engineering), the APPL is a state-of-the-art facility dedicated to the study of jet propulsion, gas turbine engines, and other propulsion systems. Research focuses on analysis, design and diagnostics. The facility houses a number of test cells to accommodate a variety of engines and components; and incorporates laser research and calibration equipment and a workshop.

Deepam Maurya

Shashank Priya

NBT-based ceramics promising alternative to lead-based piezoelectric materials

Working with Shashank Priya, the Robert E. Hord Jr. Professor of Mechanical Engineering and Associate Director for Scholarship and Research at the Institute for Critical Technology and Applied Science (ICTAS), post-doctoral researcher Deepam Maurya has been looking to find an alternative to lead-based piezoelectric ceramic materials since earning his doctoral degree from Virginia Tech in 2012. Lead zirconate titanate, known as PZT, is one of the world's most often used piezoelectric ceramic materials – and is made up of more than 50 percent lead.

While PZT components are normally very small, the numbers of these lead-based products is staggering; and finding a suitable replacement will yield enormous economic and environmental benefits.

Lead toxicity has caused a growing demand around the world for the elimination of lead from many consumer items such as cell phones, auto focus cameras and fuel injectors.

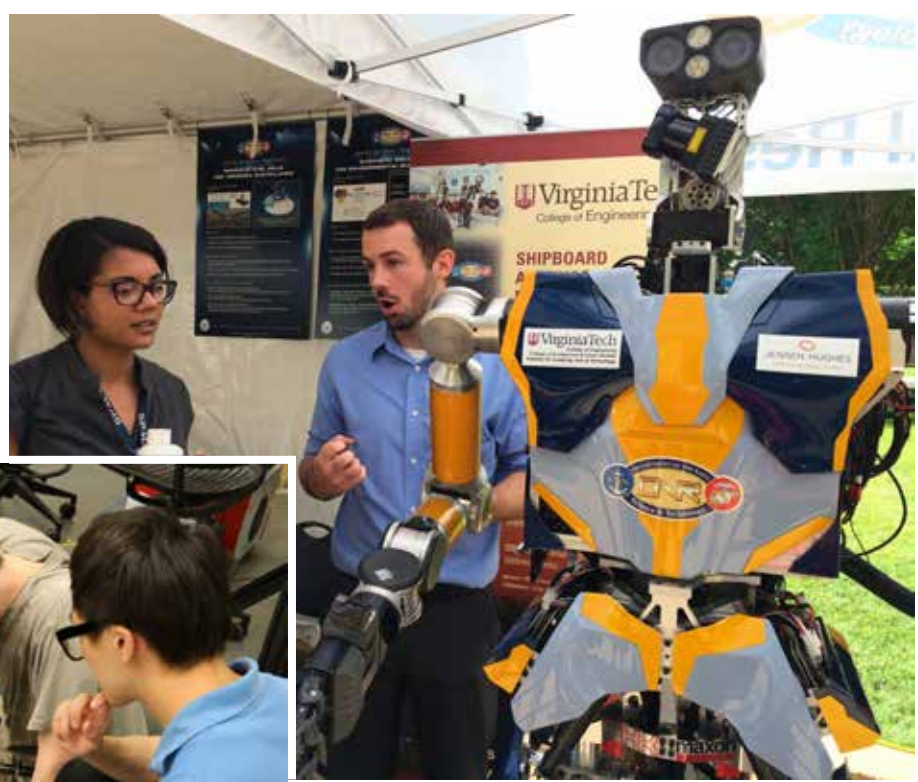
"We've discovered we can achieve similar properties such as high piezoelectric response and high temperature stability in a lead-free material."

The patented lead substitute, which Maurya calls 'NBT-based ceramics' is a significant improvement over previous compounds as the mixture. When combined with a special synthesis process that aligns the grains in the ceramic along a preferred crystallographic direction this material exhibits excellent temperature stability, giant electric field induced strain, and ultra-low hysteresis. In short, it achieves the optimum combination of most of the relevant electromechanical parameters necessary to be a viable alternative to traditional PZT.

The pair had a paper published on their work in 2015 that can be found in Scientific Reports.

MECHANICAL ENGINEERING ROBOTICS LABORATORY

The lab was founded to study cutting edge mechanics and controls in order to create robotic platforms to change the way the world perceives robotics. Professor Tomonari Furukawa and his team believe through design and development they can revolutionize the role of robots in both disaster response scenarios and in the interaction as part of daily life.



SMART INFRASTRUCTURE LABORATORY

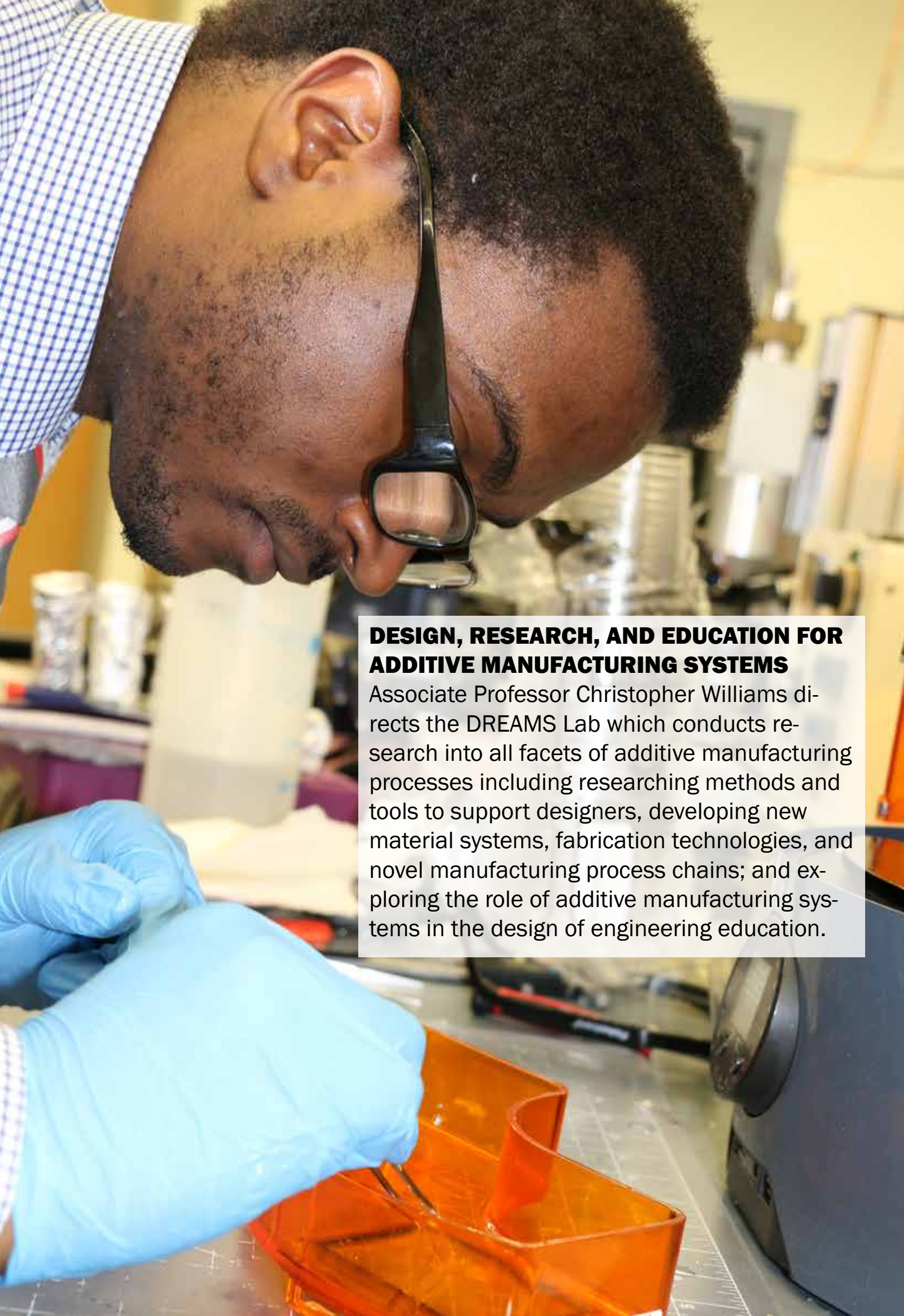
Using the fully-sensored 160,000 square feet of Goodwin Hall as a test-bed, the SMART Infrastructure Lab is a multidisciplinary masterpiece. Director and Assistant Professor Pablo Tarazaga enjoys partnerships with faculty from a variety of engineering, science, music, visual arts, and education disciplines. Creating terrabytes of data daily, the facility is providing a wealth of knowledge on the power of Big Data and creating smarter infrastructure.

SPINNERET BASED TUNABLE ENGINEERING PARAMETERS LABORATORY

The STEP Lab was founded by Associate Professor Amrinder Nain in 2009 to manufacture mechanistically tunable polymeric nanofibers using a non-electrospinning technology. The lab takes an interdisciplinary approach to research by working with multiple departments and institutes within the university. Current research includes studies of cancer cell protrusion, single and collective cell migration, and formation of cancer leader cells.

RAILWAY TECHNOLOGIES LABORATORY

Designed to explore and implement technologies enabling U.S. railroad companies be more efficient and competitive in their operations, the RTL was established in 2004 as an Association of American Railroads affiliated laboratory. Today, the laboratory allows state-of-the-art research in rail vehicle dynamics, railway component design and development, and analytical evaluation of various systems for rail applications.



DESIGN, RESEARCH, AND EDUCATION FOR ADDITIVE MANUFACTURING SYSTEMS

Associate Professor Christopher Williams directs the DREAMS Lab which conducts research into all facets of additive manufacturing processes including researching methods and tools to support designers, developing new material systems, fabrication technologies, and novel manufacturing process chains; and exploring the role of additive manufacturing systems in the design of engineering education.

ADVANCED MATERIALS AND TECHNOLOGIES LABORATORY

Professor Rangu Pitchumani's lab focuses on issues pertaining to the design and manufacturing science of advanced materials, with an emphasis on developing an understanding of the physical phenomena governing their fabrication through theoretical and experimental investigations. This understanding is applied toward practical development, design, optimization, and control of the materials.

VEHICLE TERRAIN PERFORMANCE LABORATORY

The mission of the VTPL is to improve vehicle system performance by studying interactions between vehicles and the terrain they traverse. Using state-of-the-art laser technologies, the lab can validate theoretical and computational work with experimental data to include scanning a complete terrain topology in 3D. Data is used to create simulations and models to predict vehicle responses such as handling, mobility, durability, and reliability.

MULTIPHASE FLOW AND THERMAL-HYDRAULICS LABORATORY

As part of the Nuclear Engineering program, Assistant Professor Yang Liu's lab performs experimental and computational studies on multiphase flow and reactor thermal-hydraulics. Research activity includes developing advanced instruments and models, and experimental studies. Issues related to reactor safety such as air treatment in the emergency core cooling system, passive safety systems, and spent fuel pool safety are among the topics covered.

ROBOTICS AND MECHATRONICS LABORATORY

The objectives of the RML are to conduct advanced fundamental and applied research, educate graduate and undergraduate students in the fields of robotics and mechatronics, transfer university-based technology to the market place, and collaborate with industry to serve their needs. Associate Professor Pinhas Ben-Tzvi leads the laboratory which engages with students, collaborators, government, and industry partners.

Potential of ocean waves a siren call for energy engineers

The ocean shows Lei Zuo, associate professor of mechanical engineering, the potential for abundant cheap, clean energy.

In the United States, where 53 percent of the population lives within 50 miles of the coast, energy potential from ocean waves could make up 64 percent of the electricity generated from all sources in the country in 2010.

That potential has Zuo excited, and he's not alone. The U.S. Department of Energy (DOE) recently confirmed a $2 million grant for Zuo to produce a prototype new generation of ocean wave generator.

"Virginia Tech is the best in the nation in the fields of energy harvesting and power electronics," he said. The current project with DOE will see Zuo teamed with professors Robert Parker from mechanical engineering and Khai Ngo, the Bradley Department of Electrical and Computer Engineering at Virginia Tech; the National Renewable Energy Laboratory in Golden, Colorado; the Resolute Marine Energy company; and THK North America.

The innovation at the heart of Zuo's plan, is the Mechanical Motion Rectifier, a novel power take-off that uses the up and down and back and forth oscillation of wave energy and turns it into a unidirectional rotation to drive the generator. The design, which also uses a ball screw and highly efficient power electronics, will be placed in a metal or composite housing, which is placed in the water in the same way as a buoy. Energy generation begins almost immediately as the waves move the buoy and the components inside.

Compared to other renewables, ocean wave energy generates greater returns. A square meter of solar gives about 1.5 kilowatts; a square meter of wind generates about one kilowatt; and a meter of ocean wave front, power generation can be between 10 and 100 kilowatts.

ENERGY HARVESTING AND MECHATRONICS RESEARCH LABORATORY

The John R. Jones III Faculty Fellow, Associate Professor Lei Zuo, directs the lab which focuses on research designed to make the best use of natural power potential and the potential power that can be generated from man-made structures and equipment. Research includes energy harvesting of: Ocean waves; wind vibrations of tall buildings; Vehicle shock absorbers; railway track vibrations; and the development of thermoelectric energy generators for vehicles.

UNMANNED SYSTEMS LABORATORY

Lab director, Associate Professor Kevin Kochersberger works with his team to conduct air and ground vehicle research and testing. Using rotary and fixed-wing aircraft to carry specialized sampling and sensing payloads, the lab engages in algorithm development, hardware design and fabrication, and flight testing. In addition, the lab is home to two undergraduate autonomous vehicle competition teams.

VIBRATIONS, ADAPTIVE STRUCTURES AND TESTING LABORATORY

The VAST Lab is part of the Center for Intelligent Material Systems and Structures. Led by Assistant Professor Pablo Tarazaga, the lab facilities include a high-bay ceiling to facilitate the testing of large structures, a 12x12-foot isolation bed, a two-ton crane, and an environmental chamber for temperature and pressure control experiments. Lab studies aid in the development of adaptive structures and smart materials.

INTELLIGENT TRANSPORTATION LABORATORY

The ITL is nearly unique in its ability and mission to improve road transportation safety through the development and application of sensors, actuators, and control systems. Professor Saied Taheri leads the Research and Development lab for tire-vehicle dynamics and control studies which helps improve the safety of the future road transportation system by simulating tire-vehicle handling and ride performance using control algorithms and measured road data.

ADVANCED VEHICLE DYNAMICS LABORATORY

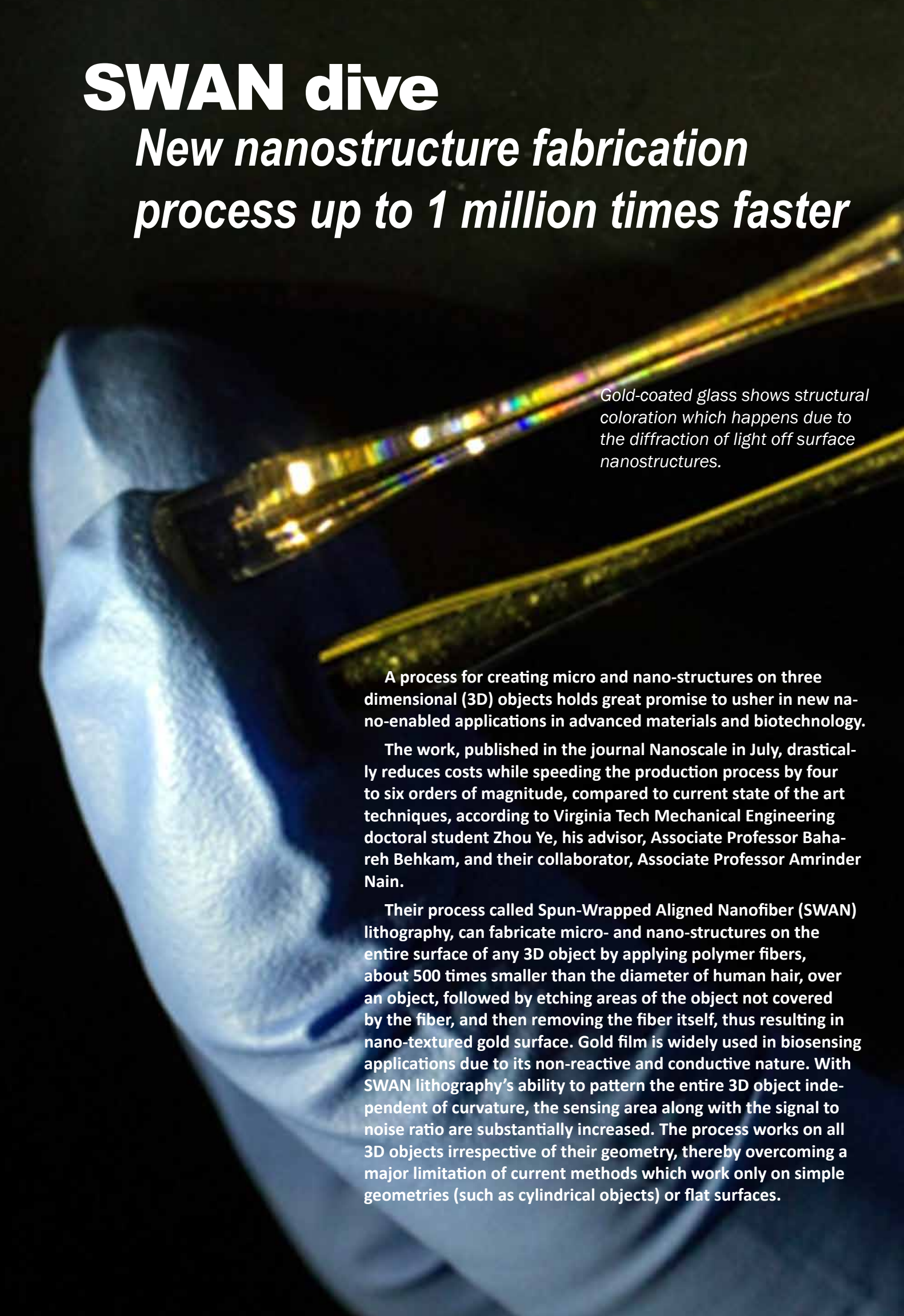
Established in 1995 by Professor Mehdi Ahmadian, the AVDL has been under the direction of Professor Corina Sandu since 2004. As part of the Center for Vehicle Systems and Safety, the lab has obtained more than $2 million in funding to aid research into vehicle dynamics and control. Working with corporate sponsors, the lab provides an environment for undergraduate and graduate students to work on solutions to real-world problems affecting industry.

COMPUTATIONAL RESEARCH FOR ENERGY SYSTEMS AND TRANSPORT LABORATORY

Under the direction of Associate Professor Francine Battaglia, the team of the CREST Lab focuses on research to understand and apply fundamental knowledge to solve problems in the fluid and thermal sciences using computational fluid dynamics (CFD). Recent primary research involves building energy and efficient energy utilization, alternative energy production, turbulent and reacting multiphase flows, and combustion.

SWAN dive

New nanostructure fabrication process up to 1 million times faster



Gold-coated glass shows structural coloration which happens due to the diffraction of light off surface nanostructures.

A process for creating micro and nano-structures on three dimensional (3D) objects holds great promise to usher in new nano-enabled applications in advanced materials and biotechnology.

The work, published in the journal Nanoscale in July, drastically reduces costs while speeding the production process by four to six orders of magnitude, compared to current state of the art techniques, according to Virginia Tech Mechanical Engineering doctoral student Zhou Ye, his advisor, Associate Professor Bahareh Behkam, and their collaborator, Associate Professor Amrinder Nain.

Their process called Spun-Wrapped Aligned Nanofiber (SWAN) lithography, can fabricate micro- and nano-structures on the entire surface of any 3D object by applying polymer fibers, about 500 times smaller than the diameter of human hair, over an object, followed by etching areas of the object not covered by the fiber, and then removing the fiber itself, thus resulting in nano-textured gold surface. Gold film is widely used in biosensing applications due to its non-reactive and conductive nature. With SWAN lithography's ability to pattern the entire 3D object independent of curvature, the sensing area along with the signal to noise ratio are substantially increased. The process works on all 3D objects irrespective of their geometry, thereby overcoming a major limitation of current methods which work only on simple geometries (such as cylindrical objects) or flat surfaces.

MICRO/NANOSCALE BIOTIC/ABIOTIC SYSTEMS ENGINEERING LABORATORY

Begun in 2009, founding director Associate Professor Bahareh Behkam leads a team with research interest at the interface between biological and synthetic systems (bio-hybrid engineering) at the micro and nano scales. Current activities include developing bio-hybrid engineered systems for sensing, actuation, communications, and control; and studying mechanisms of adhesion, motility and sensing in cells or unicellular organisms.

In addition to its ability to pattern complex-shaped objects, SWAN lithography also has three additional characteristics that, in the words of Behkam, "make the potential for the process, expansive." The first is that SWAN lithography can be applied to wide variety of object shapes of varying curvatures, and be done at both micro- and nano-scales, something electron beam lithography (EBL) and focused ion beam milling (FIB) can't do," Behkam said. "Second, we have reduced the costs considerably; and finally, the time it takes to texturize an object is orders of magnitude faster compared to other methods." Behkam contends the current commercially available systems for creating nano structures typically take 10,000 to 1 million times as long. That means what SWAN lithography can do in one minute, the others would spend 166 hours or 694 days to accomplish.

With cost, utility and speed issues solved, the obvious question remains as to what SWAN lithography cannot achieve?

"Really, it allows us to explore a large variety of application areas. We are especially interested in health care-related technologies," Behkam said. "We are working to engineer nano components that work with biologic components. For example, in implantable medical devices, microbial infections are not only associated with increased mortality but are also significant contributors to the emergence of antibiotic resistance traits. With increased life expectancy, we are likely to see an increase in the use of short and long-term implantable biomedical devices. This represents a growing unmet medical need to counter microbial biofilm-associated infections. Current treatment for biofilm-associated infections typically involve a combination of surgical replacement of the implant, and long-term antibiotic therapy, which incurs high health care costs and remains controversial because compelling evidence of their effectiveness is lacking. SWAN lithography enables engineering of micro/nano-scale topological cues on the surface of medical implants to mitigate biofilm formation, allowing a far superior function and safety"

In addition to medical applications, the SWAN lithography process also allows functionality to be built into other products, including nano sensors for photonic and plasmonic applications.

Currently, Behkam and her team are speaking with industry to further develop the patent-pending technology and bring it to the next step for wide-scale use in everything from camera lenses and aircraft wings, to ship hulls, solar panels, and biomedical devices and implants.

NUCLEAR SCIENCE AND ENGINEERING LABORATORY

Located in Arlington, Virginia, the NSEL is engaged in research and education in application areas of nuclear science and engineering to include Power, Medical, Security and Safeguards. In addition to internal collaborations, the lab also works with Georgia Tech, Penn State, and the U.S. Naval Academy on joint research projects, educational opportunities, and in the sharing of resources and facilities. The lab is directed by Professor Alireza Haghighat, an American Nuclear Society Fellow.

VIBRATIONS AND ACOUSTICS LABORATORIES

The Vibrations and Acoustics Lab was formed in 1985 to educate and carry out fundamental research and applications in acoustics and vibrations and to support its use in industry. Today, the lab is led by Samuel Langley Distinguished Professor Chris Fuller and students are working in a variety of fields including Active structural acoustic control, Active vibration control of aircraft interior noise, Experimental studies of supersonic inlet noise, and many more.

MECHATRONICS LABORATORY

With a focus on 'Creating Practical Solutions,' the Mechatronics Lab uses integrating sensors and microcontrollers in applications both military and medical. Founded in 2005 with the DARPA Grand Challenge, the lab continues to compete. Associate Professor Al Wicks leads the lab of undergraduate and graduate students working on both applied autonomy projects as well as pediatric medical devices.

ZT GROUP

Assistant Professor Zhiting Tian leads this lab focusing on understanding and engineering nanoscale thermal transport in hard and soft materials for energy applications and other uses. The lab uses equipment such as atomistic simulations and laser-based measurements to carry out their research. The group is currently working on a Nano Engineered Thermoelectric Systems for Lightweight Portable Primary/Secondary Power Sources for DARPA.

UNDERGRADUTE SENIOR DESIGN

HANDS-ON, MINDS-ON PROJECTS PROVIDE REAL-WORLD APPLICATION FOR MECHANICAL ENGINEERING STUDENTS.

2
SEMESTERS

15
CORPORATE SPONSORS

45
PROJECTS

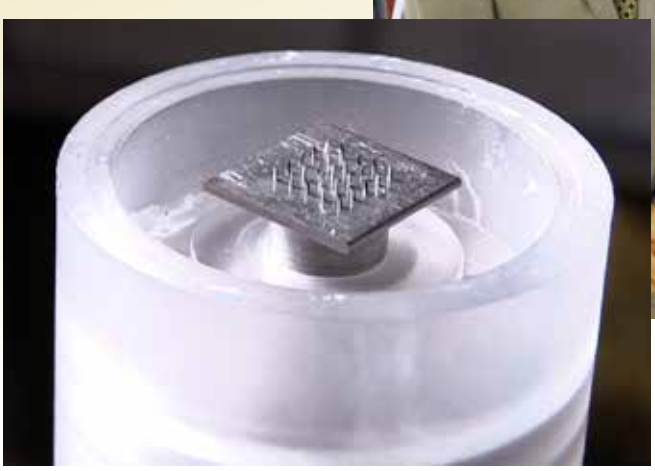
From solving water infrastructure issues in Malawi, to making a safer rear bumper for U.S. semi tractor trailer trucks, students in the Mechanical Engineering Senior Design capstone project work together to get it done. From design, build, test, and prototype to outreach, presentations, financials and more, ME students can expect to be challenged in a way that will make them more valuable to industry recruiters.

A team shows a drone equipped to provide food aid to remote or stranded individuals.

More than 800 people visited the 2016 Senior Design Expo held in April inside and outside the Squires Student Center. Industry sponsors participated as judges as well as engineers from GM, UPS, Canon, Volvo Construction, BWXT, Graham White, and Ford.

For 2017, 52 teams will design projects and class enrollment jumps from 360 to 419 students. Industry sponsorship increased to 15 (up from 5 in 2015), and faculty are embracing the support of *Ut Prosim* (That I May Serve) projects, by advising eight humanitarian/philanthropic projects.

Senior Design team members are ready to talk about their Minimally Invasive Transdermal Device (below) which makes skin biopsies easier and allows the site to heal more quickly.



A team looks at a Squad Mission Support System vehicle donated by Lockheed Martin. The team developed an autonomous loading/unloading device for the vehicle.

Taking on a challenge close to the roots of Virginia Tech as an agricultural college, a Senior Design team came up with an inexpensive and easy-to-use method for elderly or disabled farmers to climb into modern tractors.

Wayne Carter, Daniel Carrasco, Andrew Pitt, Sean Gardner, and Kristine Adriano (missing, Brian Smith)stand next to an improved bumper meant for large tractor trailer trucks. The bumper is designed to help reduce the severity of collisions by limiting or preventing under-ride from vehicles impacting tractor trailers from the rear. The students were invited to present their design to the Insurance Institute for Highway Safety in May.

Judges stop to look at a robot created for NASA's 2016 Robotic Mining Competition. The Virginia Tech team placed 9th out of 45 competitors. The university has signed on to compete in the competition again in 2017.

A project design that allowed for computer controlled and automated cataract surgery was a huge demonstration hit at the expo.

Engineers help Malawi infants

In summer 2015, Virginia Tech mechanical engineering graduate student Ashley Taylor, a native of Fort Chiswell, Virginia, was on a transatlantic flight home from her third trip to Malawi. She was unable to rest, still thinking about what she had seen.

While touring the neonatal ward at Domasi Rural Hospital in southern Malawi, her group had discovered that doctors faced a big problem in keeping infants alive – keeping them warm.

Lack of reliable, consistent electricity meant that some babies died during cold nights in the neonatal unit.

Knowing that mechanical engineering principles could underpin a solution, Taylor had a thought: A group of undergraduate students could tackle the issue of neonatal hypothermia.

Before the plane had landed, Taylor had her advisor, Kevin Kochersberger, associate professor of mechanical engineering, on board to help. Together, they set in motion the development of a passive warming device they later called the “baby pod.”

The next year saw Taylor mentoring six undergraduates who adopted the baby pod for their senior design project. Employing only materials readily available and inexpensive in Malawi, the team devised a prototype built primarily from PVC pipe with chicken-feather insulation.

Because a group of Ugandan mothers was available to give quick feedback, the team turned to them for its first test. The mothers gave thumbs up but noted the pod’s lack of beauty and suggested it be covered in fabric, so Taylor’s group made the change.

Unfortunately, when Taylor returned to Malawi this past July to unveil the pod, the negative reaction jolted her. Because of the pod's shape and use of chitenge — the local fabric — what immediately came to Malawian minds was a child's coffin.

Humbled by the misstep, the team scrapped the design and intensified the gathering of community feedback. Based on local suggestions, the pod became a basket-like device with a natural look.

Taylor said a key lesson was learning how crucial it is to incorporate the community in the design process, to "make sure that we’re not just parachuting in with a cool solution, but that it is a community-led thing.”

> ***I think that Virginia Tech is really working on expanding that definition and making sure we don’t put a box around the definition of what people think engineers are.***

Taylor, whose master’s degrees in mechanical engineering and public health come from Virginia Tech, is currently working on her doctoral degree in the Department of Engineering Education.

Taylor’s work in Malawi has not only immersed her in international development projects that help women, but also enabled her to be a role model for younger women in the male-dominated field of mechanical engineering.

An engineer with a focus on public health, Taylor said she has faced her share of detractors who don’t believe she fits the mold of what an engineer “should” be. “I think that Virginia Tech is really working on expanding that definition and making sure we don’t put a box around the definition of what people think engineers are.

"As a female in engineering, I learned that I have to be authentic about what I’m passionate about,” Taylor said. “It’s important to know yourself, know what you’re excited about, and really chase after that. If we’re not authentic, we’re doing a disservice not only to ourselves, but also the world in which we live.”

Melissa McKeown

The Baby Pod: A Passive Infant Warming System

Hamdan Alhosani, Michael Bokulic, Jared Daubenspeck, Nickolas England, Mark Healy, Ellen Hollingsworth

Virginia Tech, Department of Mechanical Engineering

Faculty Advisors: Dr. Lissett Bickford, Dr. Kevin Kochersberger

Graduate Advisor: Ashley Taylor

Background:

Many infants in developing countries are **born prematurely**, causing them to have **numerous health problems**. Medical clinics in these countries have very **few resources** and limited staff, therefore infants are not monitored properly and **don't receive the needed care**.

Pediatric Ward at Domasi Rural Hospital

Domasi Rural Hospital in Malawi, Africa has voiced a need for a warming system that will reduce the risk of **neonatal hypothermia.**

Problem Statement:

To design, construct, and implement a **passive warming system** to reduce heat loss and help retain a newborn's body temperature within a **healthy range of 36.1 to 37.9 °C**.

Objectives:

The final device should be:

- Affordable
- Made from local resources in Malawi
- Able to maintain the infant's core body temperature within a healthy range
- Easy to clean, repair, and use

Design Data:

Baby Sack:

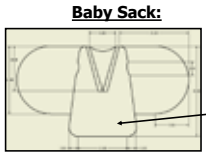
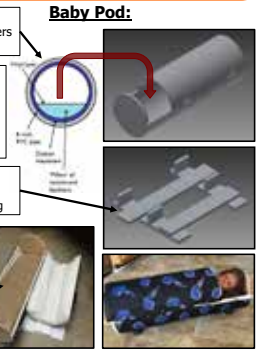


Diagram of insulation layers within PVC

Vinyl layer is attached in bottom of sack for minimal fluid leakage

Baby Sack wrapped around infant will then be placed in the PVC Pod

Baby Pod:



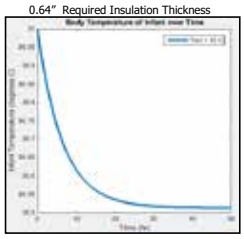
Anti-rolling device to stabilize the pod's motion while opening and closing

PVC Pod is 24 inches long with an 8 inch diameter to give the infant room to move

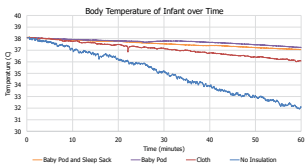
Product Evaluation and Testing:

$$q_{pod} = \frac{k(T - T_s)A_{body}}{dx} - \varepsilon\sigma(T^4 - T_{air}^4)A_{body} = mc_p\frac{dT}{dx}$$

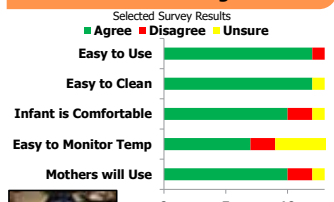
0.64" Required Insulation Thickness



Setup of Testing – two water bottles with an external temperature of 38 °C were used to simulate infant's heat



Feedback from Uganda:



92% said they **would use the device**

Prototype sent for demonstration in Uganda

Future Direction:

Compared to current warming solutions within Domasi Rural Hospital, the Baby Pod improves the ability of newborn infants to maintain a healthy body temperature.

Recommendations for continued design:

- Reduce weight
- Attach anti-rolling mechanism to PVC
- Aesthetic improvement

Acknowledgements:

The team would like to thank Dr. Andy Muelenaer, Jim McGill, and Humphries Gwedemule (hospital administrator at Domasi) for their informational assistance. A special thanks to Global Health Educators directors Drs. Mark and Judy Gustafson, as well as Raven Sullivan, who collected initial feedback from clinical staff in Magale, Uganda.

Top: A team poster presents its passive infant warming system designed for premature babies in developing countries. Above left: Ashley Taylor in Malawi with the original baby pod design. After input from a group of Ugandan mothers, the pod was given good grades for how it worked but poor marks for design, which they said looked too much like a coffin. With local input and feedback a new design was created to look more like a natural basket. Taylor is an ME graduate who is currently working on a doctoral degree in Engineering Education. She was a graduate advisor for the baby pod team. Above right: the Senior Design team that developed the baby pod: Jared Daubenspeck, Michael Bokulic, Nickolas England, Ellen Hollingsworth, Mark Healy and Hamdan Alhosani, all members of the class of 2016.

Student Competition Teams

Virginia Tech has been taking part in the EcoCAR Challenge and its predecessors for more than 20 years and consistently achieving success with undergraduate students designing and building a variety of automobiles. The latest creation, the Camaro hybrid, placed 2nd overall in 2016, the second year of a four-year competition dubbed EcoCAR3. The team also placed second in 2015.

Sixteen universities compete in the competition using a stock 2016 Chevrolet Camaro to integrate hybrid-electric designs in an effort to reduce environmental impact. The EcoCAR3 competition also asks teams to retain the muscle and performance of the iconic Camaro brand. Of the competition teams, only Virginia Tech used a V-8 (taken from a Chevrolet Silverado) in their design.

Students created a detailed mechanical design for a post-transmission motor which was built by and with the help of InMotion, a team sponsor. About half the team's graduating seniors took positions with General Motors.

Myles Regan, Regan Digital Images

Year 2 Results

2nd place overall
Best Initial Vehicle Integration
Communications Program (2nd place)
Best Communications Outreach Presentation
Vehicle Design Report (2nd place)
AVL DRIVE Award (2nd Place)
Siemens PLM Software Excellence Award (2nd Place)
dSPACE Embedded Success Award (3rd Place)
Best Final Vehicle Integration
Best Mechanical Systems Presentation
Best Media Relations Report
Most Creative Outreach Event
Best Vehicle Safety Binder

Co-Advisor: Robert Parker

Hyperloop

A team of undergrads taking on the world - and coming in 4th. That's what the Hyperloop team did in 2016 when they traveled to Texas A&M and went head to head with the best in the world. More than 100 teams competed in Elon Musk's hyperloop design event. Teams are now building their pods for testing at a Space-X facility in 2017.

Virginia Tech's team will use an on-board propulsion system to help propel their magnetically levitated pod to more than 400 mph - fully testing their magnetic braking in the process.

The Hyperloop team's success has resulted in media and sponsor interest with companies like Hy-Test, Cooley LLP, ECE Funding, Futek, Howard Aviation, Huntsman, Hyperloop One, Orbital ATK, Performance Associates, Build LAB, E.V. Roberts, ANSYS, Hofmann Balancing Solutions, Lake Shore Cryotronics, Lockheed Martin, Procter and Gamble, Rogers Company, Shickel Corp., Solidworks, GoFundMe, SBB, SEC, Express Prototyping, ExOne, Southwest Specialty Heat rat, TechPad, VT Fire, and the Virginia Tech Departments of Aerospace and Ocean Engineering, Mechanical, Engineering and Biomedical Engineering and Mechanics.

Rally

Advisor: John Ferris

The VT Rally team made its mark in the highly competitive rally racing series, finishing 10th in the Laughlin Desert Classic Unlimited Sportsman Class. The team is sponsored by Ford, Altec, Allfirst LLC, CDE Global, Valley Crane, Hooker Harness, Walker Evans, Mishimoto, Royal Purple, Tool Planet.com, Weddle Transmissions, The VT Transportation Institute, VT Student Engineer's Council, and the VT Mechanical Engineering Dept.

As part of Baja SAE, the team designs and builds a single seat off-road vehicle for SAE-sanctioned competition. The 2015-2016 was sponsored by Fontaine Modification, the Student Engineer's Council, Precision Castparts Corp., Toyota, Procter and Gamble, Addie Swearingen Foundation, Rockwell Collins, Nord-Lock, Liebherr Mining Equipment, Collision Plus, Signarama NRV, Textron, SE&M, QA1, Southwest Specialty Heat Treat, and the VT Mechanical Engineering Department.

Baja

Advisor: John Kennedy

Advisor: Bob West

Formula

Each year the Formula teams design, build and race a brand new vehicle. In 2016-2017, both ICE and Electric formula teams will be building new vehicles simultaneously. The 2015-2016 vehicles are above with the electric car at the left and the ICE vehicle to the right.

Formula SAE is the largest of the 13 competition teams within the Ware Lab facility with about 200 students, nearly all undergraduates, participating with the traditional and electric versions of the formula cars.

2017 marks the first time the Formula teams will be building two different cars for different competitions in the same year. The teams will construct a internal combustion formula car and an electric vehicle.

Each May the team competes with 120 other schools at a competition put on by the American Society of Automotive Engineers at the Michigan International Speedway. In 2015, the Virginia Tech team placed 6th in the event.

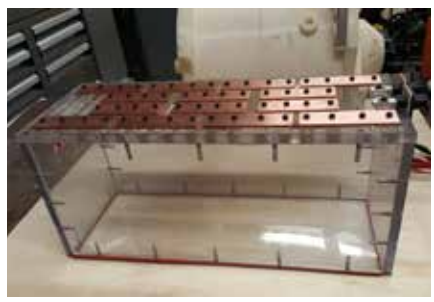
Formula sponsors include: GM, Huntsman, Student Engineer's Council, Ford, Toyota, CFA, ATI, SVHEC, Precision Castparts Corp., General Dynamics, C.R. Onsrud, SE&M, Simulia, Kolmorgen, Airtech, Lockheed Martin, Calspan, Miltera, MathWorks, ExxonMobil, Stratasys, CD-adapco, The Virginia Tech College of Engineering Ware Laboratory, and many others.

BOLT

Advisor: Rick Clark

Battery Operated Land Transport or BOLT, is Virginia Tech's version of an electric motorcycle. The first BOLT vehicle, the Mk. I, became reality in 2012 and became the fastest 75 class bike in the western hemisphere. In 2014 the Mk. II placed first in the all electric category of the American Historic Racing Motorcycle Association eMotoRacing sprint race. In March 2016 the team raced (and won) with the Mk. II while simultaneously beginning designs for the Mk. III.

The Mk. III design promises a faster bike, using additive manufacturing techniques to prototype and design custom parts for the next generation BOLT.



The custom battery box, above, holds 64 cells and was designed using additive manufacturing prototyping tools. The bike, left, will be built throughout the new academic year.

GrandTouring

Advisor: Steve Southward

The Virginia Tech Grand Touring team began in August 2014 with the goal of turning a $500 used BMW into a race car to compete in endurance races like the Optima Batteries ChumpCar series.

Virginia Tech has been a pioneer within the ChumpCar organization to increase university participation. Students apply value engineering principles and technical knowledge from their courses to make a race worthy vehicle as part of their Senior Design project.

A special thanks to all the men and women who support the Mechanical Engineering program throughout the year. Your donations supporting scholarships, fellowships, endowments, equipment, and general operating funds, allow us to maintain cutting-edge educational programs, research equipment, and faculty. On behalf of the thousands of students who have benefited from your continued generosity,

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In 1872 William Addison Caldwell became the first student to enroll at Virginia Tech armed with determination and an unshakable confidence in the future. Caldwell Society members exhibit the same confidence in the university by making significant contributions in support of students, faculty, and programs.

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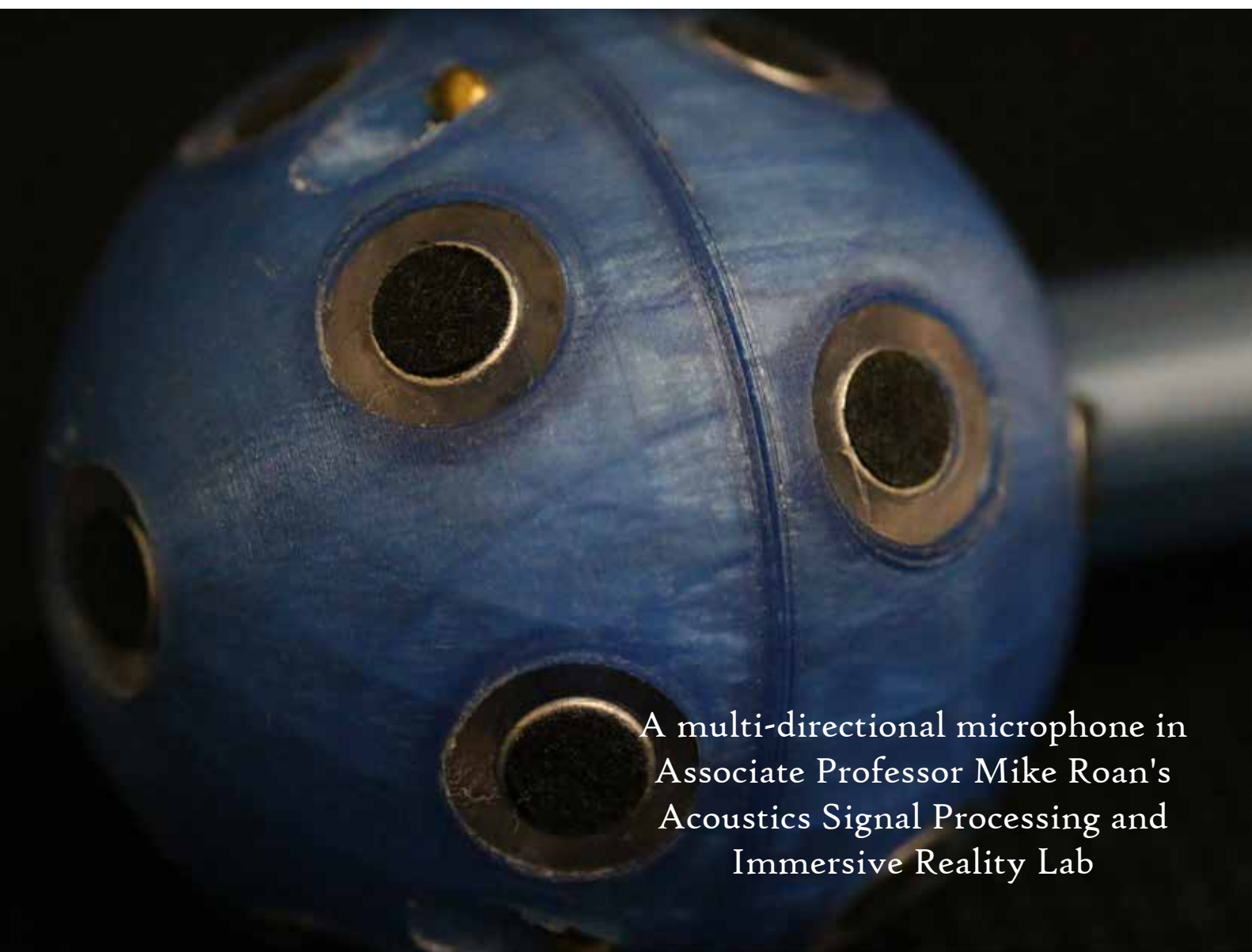

A multi-directional microphone in Associate Professor Mike Roan's Acoustics Signal Processing and Immersive Reality Lab