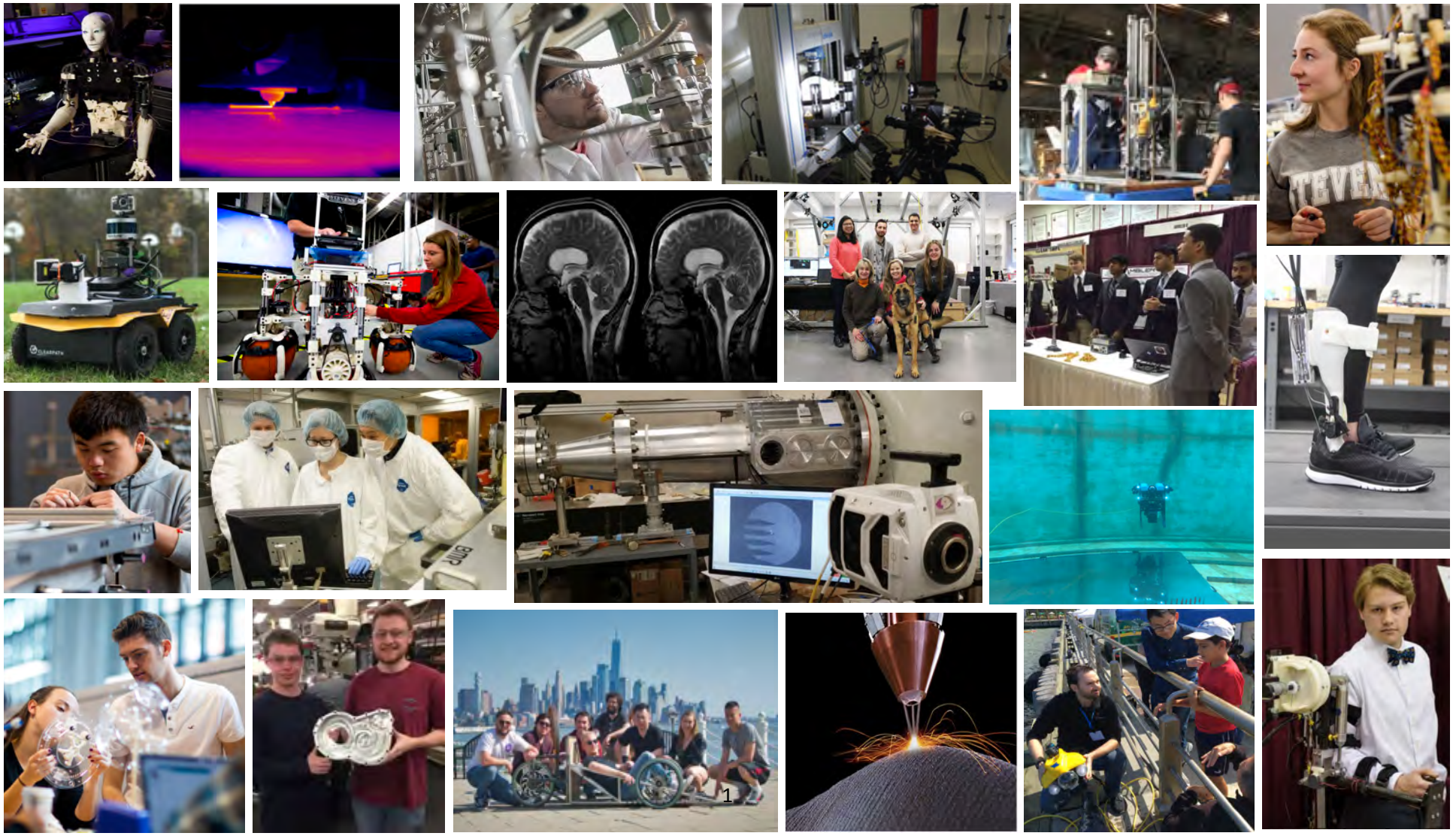
STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

DEPARTMENT OF MECHANICAL ENGINEERING
ANNUAL REPORT 2019 - 2020



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Message from the Chair

Souran Manoochehri
Professor and Department Chair
of Mechanical Engineering

The accompanying report summarizes the current state of the Mechanical Engineering Department at Stevens Institute of Technology and focuses on the Department's progress and achievements over the past year. Recently, the Department has expanded in numerous ways, focusing on research, undergraduate and graduate student enrollment and programs, and increasing the number of faculty. Our research awards have grown by 210% and our research expenditure increased by 265% over the past two years. As a highlight in 2019, we established the Center for Neuromechanics, the first of its kind in the nation with a primary focus on the mechanical behavior of the neural system.

We introduced a Robotics Master's degree and added two dual degree programs where students can earn either a Master's degree in Mechanical Engineering or Pharmaceutical Manufacturing together with an MBA degree in reduced time and cost. Additionally, we established joint degree programs with other institutions to allow their undergraduate students to pursue a Master's degree in Mechanical Engineering at Stevens. The past year saw several significant milestones in the Mechanical Engineering Ph.D. Program including a new Doctoral Student Handbook, a newly formatted Ph.D. Qualifying Exam, and a biweekly Mechanical Engineering Graduate Student Research Seminar program. During the past year, the highlights of our undergraduate program included initiating a significant curriculum revision process, establishing the Undergraduate Summer Research program, and formation of the Mechanical Engineering Student Advisory Council (MESAC). The council is a partnership between students, faculty, and the department leadership to facilitate a student-centric environment.

We believe diversity drives innovation, collaboration, and success. The Department has increased its tenure-track faculty by 30% and has hired three female tenure-track faculty among seven recent hires. The Department boasts 25 tenure and tenure-track faculty, many of whom are nationally and internationally recognized and among the prestigious list of recipients of the NSF Career and ONR Young Investigator Awards.

Though we take pride in leading a progressive platform, such as robotics and autonomous systems, bioengineering, additive manufacturing, sustainable energy, and micro-nano technology, the Mechanical Engineering Department remains dedicated to its origin offering a traditional broad-based mechanical engineering education. The year 2020 marked a momentous occasion for Stevens — the 150th anniversary of our founding as America's first college of mechanical engineering.

From its role as the birthplace of the American Society of Mechanical Engineers (ASME) and the first in the United States to offer a mechanical engineering bachelor's degree, the Department has long been a pioneer in the field of mechanical engineering. A Stevens degree in mechanical engineering has long empowered our graduates to be well-positioned for addressing the challenging social, global, economical, and ethical implications in mechanical engineering and to become first-rate engineers of the 21st century.

I am grateful for the commitment of our faculty and staff, whose tireless pursuit of excellence has made possible the achievements reported here. I am proud to be part of the Mechanical Engineering team at Stevens.

Undergraduate Studies

Reflecting on the diversity of subject matter found in the present-day practice of mechanical engineering, the Mechanical Engineering program has consistently offered undergraduates a multitude of opportunities for study and research. The following outlines the Department's major initiatives and achievements in undergraduate studies.

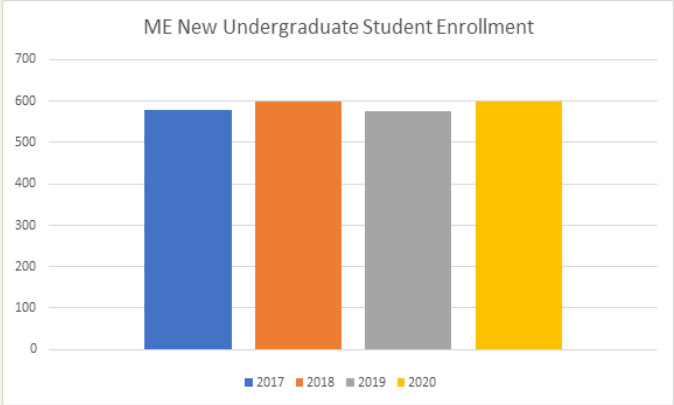
Several attributes of the mechanical engineering undergraduate program are the unique design spine which includes a "hands-on" design laboratory during each semester that culminates into an industry-level capstone senior design experience. The common-core engineering curriculum is complemented with a rigorous core mechanical engineering program that allows graduates to acquire a comprehensive knowledge of multi-disciplinary engineering principles in all disciplines combined with the fundamental and working knowledge of mechanical systems and thermal systems.

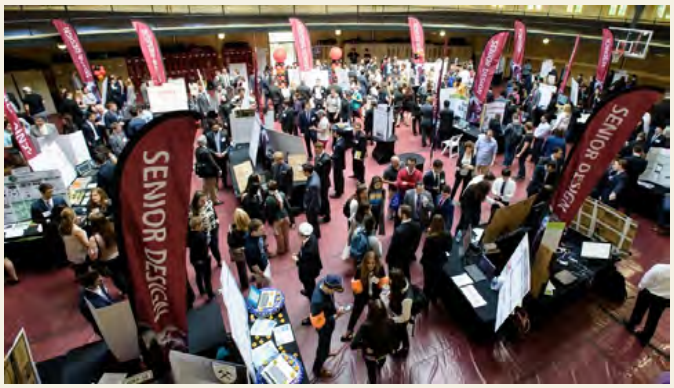
During the past year, the Mechanical Engineering faculty, in collaboration with various faculty within the School of Engineering and Science, were engaged in a significant curriculum revision process. The primary goal of the revisions were to enhance the flexibility of studies for the students, integrate various course offerings into modular course bundles with standardized credit assignments, and tightly link the design spine laboratories to their respective lecture courses. In support of Stevens fostering a culture of excellence, the Mechanical Engineering Advising Center was created. Its purpose is to provide a holistic student resource center that is committed to promoting success and maintaining the retention of its 600 undergraduate students.

During the Summer of 2020, the Department initiated an undergraduate summer research program. Its purpose was to provide a select number of mechanical engineering students the opportunity to be engaged in research under the supervision of a faculty advisor while receiving a nominal stipend.

The Mechanical Engineering Student Advisory Council (MESAC) was formed in 2019. MESAC is a collaborative partnership between students, faculty, and the Department administration to facilitate a student-centric environment within the Department through open communication. It is comprised of student representatives from each class. A professional development workshop series was established to provide students necessary tools to succeed as engineers. Following are some examples of recent workshop topics:

- MATLAB Programming and Sensor Integration
- Introduction to Scientific Research
- Industry Panel Discussion: Career Opportunities in the Time of the COVID Pandemic





2019 Innovation Expo

96% Undergraduates Secured Jobs or Graduate School Admission

Undergraduate Studies (*Cont'd*)

The Department of Mechanical Engineering educates the complete engineer and prepares students for career opportunities in such diverse areas as power generation, design of machinery, manufacturing, research and development, guidance systems, product design and development, robotics, propulsion engineering, system analysis and design, and many others. We are proud that 96% of our graduates have been successful in securing jobs or gaining admission to the top graduate schools of their choice.

Senior Design Program

Senior Design is the one-year long capstone course within the Mechanical Engineering curriculum and is an element of honor within the Department. This course is taken during senior year and extends over both semesters. The senior class is broken into approximately 30 different teams spanning areas such as biomedical, defense, robotics, and energy. Some projects are competition based. Traditionally, the Mechanical Engineering teams have found success at winning best senior design project as well as the elevator pitch competition at the Stevens Innovation Expo.

The 2020 Stevens **NASA Lunabotics team** represented the university's first foray into the NASA Remote Mining Competition. The team, an interdisciplinary group of students, was comprised of a 12-person capstone senior design team whose disciplines span mechanical engineering, electrical and computer engineering, and software engineering, with guidance provided by mechanical engineering faculty advisor Professor Mishah Salman. The team worked hard to overcome the challenge of designing and fabricating a competitive robot despite the absence of prior years' competition experience. Support and resources for the team were provided by contributions from the Stevens Mechanical Engineering Department, the Stevens Robotics Club (SRC), local chapters of IEEE and ASME, the Student Government Association (SGA), as well as generous donations from equipment vendors, corporate donors, and private donors alike.

Several Mechanical Engineering teams have won national awards. Recently, a mechanical engineering team won 2nd place in the **NASA Moon to Mars Ice Challenge,** in competition with schools such as Carnegie Mellon, MIT and the Colorado School of Mines. The challenge required students to design and build systems that extracts water from and assesses subsurface profiles of simulated lunar/Martian environments. The goal of the competition was to collect as much clean water from the simulated environment as possible and to create an accurate description of the simulation's overburden.

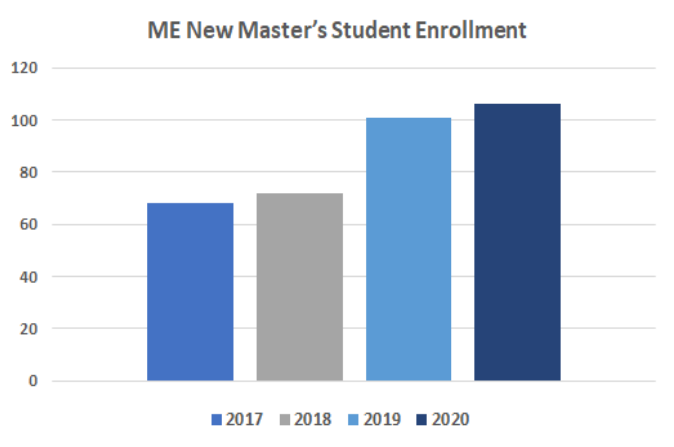
NASA Lunabotics Team

NASA Ice Challenge Team

Graduate Studies

Master's Degree

The following illustrates the Department's key accomplishments and mission in graduate studies. It is notable to highlight that the enrollment number of master's students increased from 68 in 2017 to 101 in 2020, representing a steady increase of 56%.



New Master's Degrees, Joint Degrees and Certificate Programs

Master of Engineering in Robotics Program is intended to address the multidisciplinary nature of the field of robotics. It can be considered as a terminal degree or as preparation for the Ph.D. program. The program exposes students to both the mathematical foundations of robotics and to relevant hands-on laboratory projects in robotics and mechatronics. The curriculum spans a spectrum of multidisciplinary topics including the physical and mathematical modeling, analysis, and design principles needed to understand the geometry, kinematics, and dynamics of robotic systems, and the sensors, actuators, algorithms, computing, and energy resources needed to accomplish relevant, real-world tasks that may be tele-operated, automated, fully autonomous, or performed in cooperation with humans.

MEng(ME)-MBA, the dual ME-MBA degree is designed for students to gain a deep technical knowledge in Mechanical Engineering and management practices. This dual degree program will give engineering students strong business management skills to complement their engineering degree, accelerating their growth into management positions and opening up a more diverse selection of career choices. The students will earn two separate Master's degrees.

MS(PME)-MBA, this dual degree program provides a deep technical knowledge in Pharmaceutical Manufacturing and management practices. A Master of Science degree coupled with an MBA provides a great mixture of education and creates a well-rounded employee. This dual degree will give engineering/science students strong business management skills to complement their engineering/science degree. The students will earn two separate Master's degrees.

The Joint Master's Program with Xidian University, Xian, China, was created in summer 2019 and began with 12 students. Three new joint Master programs were developed in collaboration with the Mechanical Engineering Department. The three programs include "4+1" and "4+2" programs which allow undergraduate students from Xidian University to obtain a Master degree at Stevens, and a "2+1" program which will allow students from Xidian University to obtain dual master degrees from both Xidian University and Stevens.

Graduate Studies *(Cont'd)*

Stevens-Montclair State University "3+2" Program allows undergraduates students who majored in physics at Montclair State University to pursue a Master in Engineering degree in Mechanical Engineering by spending two years at Stevens to take undergraduate level bridging courses and graduate level courses.

Stevens-Seton Hall University "3+2" Program allows undergraduates students who majored in physics at Seton Hall University to pursue a Master in Engineering degree in Mechanical Engineering by spending two years at Stevens to take undergraduate level bridging courses and graduate level courses.

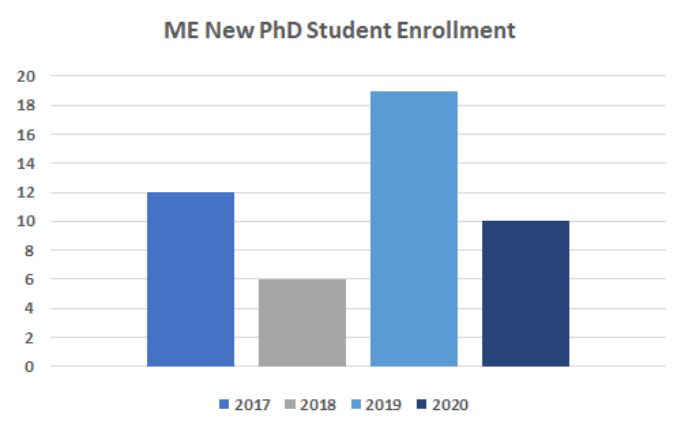
The Department has established a new **Graduate Certificate in Biomechanical Engineering** that provides students with a strong quantitative foundation in continuum soft tissue mechanics, medical device design, imaging and instrumentation that will help them advance their careers in both academia and industry. Students will learn about methods and applications within mechanical sciences that are relevant for biomechanical systems.

Ph.D. Program

The enrollment numbers of Ph.D. students are on the rise, increasing from 12 in 2017 to 19 in 2019. The 2020 enrollment number has been impacted by deferment of applicants to the 2021 start as a result of the pandemic. Our Ph.D. program has the highest selectivity for admission in history.

The past year saw several significant milestones in the **Mechanical Engineering Ph.D. Program.** These milestones were spurred by the inaugural appointment of Associate Professor Robert Chang to the newly created Department administrative position of Ph.D. Program Coordinator. The Ph.D. Program Coordinator works as a liaison between the SES Doctoral Committee and the Mechanical Engineering Department to provide clear guidance related to substantive issues in the program as well as to propose enhancements to the program and the doctoral student experience. The Ph.D. Program Coordinator role oversees the progress of all enrolled Ph.D. students hinged on timely communication with students about progress, administration of any qualifying exams or requirements, and provides support for the Ph.D. student recruitment, along with consultation with the Department and Graduate Chairs on Ph.D. admission and fellowship decisions.

84% Master's in Mechanical Engineering Secured Jobs



Graduate Studies *(Cont'd)*

Among the highlights of the enhanced program is the articulation of the Mechanical Engineering Doctoral Student Handbook. The handbook describes the updated Department policies and requirements that govern the Mechanical Engineering Ph.D. Program. It has proven to serve as a vital resource that assists each Ph.D. student in understanding the program expectations. Additionally the Department adopted and administered a newly formatted Ph.D. Qualifying Exam. The exam is highlighted by a written exam featuring the flexibility of an "a la carte" mode of selecting topics, along with an oral exam that encompasses a literature review and outlook on a topic pertinent to the student's chosen research domain.

The Department launched a biweekly Mechanical Engineering Graduate Student Research Seminar program. The Graduate Student Research Seminar has been a venue to promote a sense of community among graduate students, as well as to encourage research integration and potential collaborations across the multidisciplinary research labs in the Department. Student attendees are exposed to a variety of research projects and activities in order to enrich their academic experience while student presenters are able to professionally develop their presentation skills and discussion of research topics in a public forum.

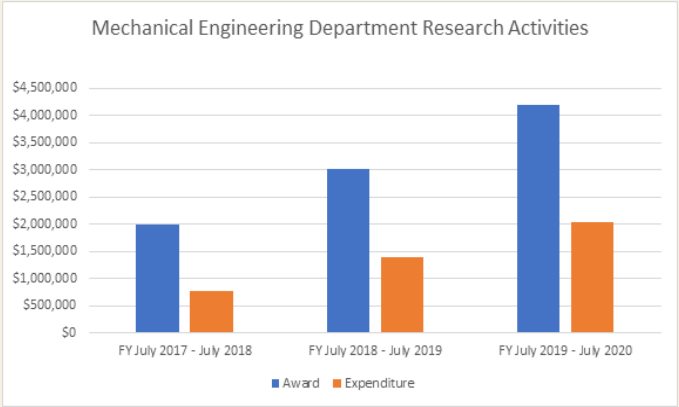
Mechanical Engineering Graduate Student Research Seminar

Sponsored Research

Research activity has thrived, with a 210% increase in awards and a 265% increase in expenditure. Mechanical Engineering Faculty, in coordination with post-doctoral associates and graduate and undergraduate students, constantly seek to expand the field of mechanical engineering by conducting state-of-the-art research.

Examples of Mechanical Engineering faculty research success include:

Associate Professors Brendan Englot and Nick Parziale each received a prestigious **ONR Young Investigator** award. Englot will research leveraging a new variant of a classic artificial intelligence while Parziale will advance research in hypersonic flight. Assistant Professor Damiano Zanotto received the **NSF CAREER** award to focus on biomechatronics and wearable technologies for motion analysis. Assistant Professors Mehmet Kurt and Johannes Weickenmeier received the **NSF LEAPHI** grant that will be used to combine novel medical imaging methods, image analysis, computational modeling, and mechanical testing to determine the fundamental mechanical properties of living brain tissues and the differences in properties between healthy and diseased tissues. Professor Chang-Hwan Choi received an **ONR DURIP** award to pursue scientific research and education in additive manufacturing by acquiring the Optomec LENS 500 system.



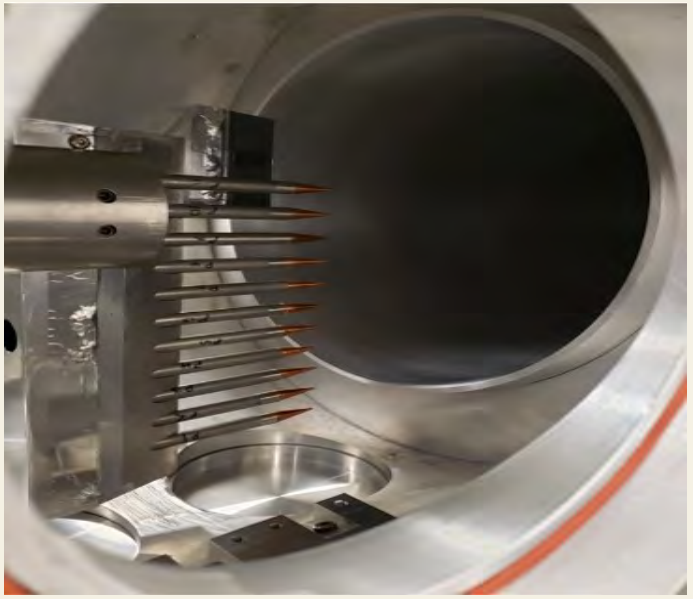
$977,693 ONR - YIP Award

Faculty Research Stories

The following briefly highlights the groundbreaking research of our faculty in a variety of mechanical engineering areas.

Remote-sensing Techniques in Supersonic/Hypersonic Flows
Nick Parziale, Associate Professor

Professor Nick Parziale's research with remote-sensing techniques in supersonic/hypersonic flows has given the first insights to flow physics that have been sought after by DoD and the fluid-mechanics community for decades. Parziale has performed pioneering work with optics, lasers, and atomic physics that has resulted in: Focused Laser Differential Interferometry (FLDI), which measures density; and Krypton Tagging Velocimetry (KTV), which measures velocity. These measurement techniques are so-called 'non-intrusive, optical diagnostics,' which means they do not disturb the gas flow, thus enabling Parziale to study new fluid mechanical phenomena in the thin (1 millimeter) gas layer near a high-speed vehicle called the boundary layer. The transition of a boundary layer from a laminar (well-ordered) state to a turbulent (chaotic) state dictates a vehicle's capability because a vehicle with a turbulent boundary layer has higher drag and heat transfer, requiring more thrust and thermal protection. Parziale's long-term vision for his high-speed fluid-mechanics research is to make time-resolved measurements in a broad class of previously inaccessible flow problems that are of interest to DoD/NASA now and in the future.



Pitot rake at the mach 6 nozzle exit to test flow uniformity

Biomechatronics and Wearable Robotics
Damiano Zanotto, Assistant Professor

Professor Damiano Zanotto in his Wearable Robotic Systems Laboratory has been focusing on biomechatronics and wearable technologies for human motion analysis and physical human-robot interaction (pHRI), with application to robot-assisted rehabilitation. In the area of wearable robotics, his group has been developing model-free learning-based controllers that can automatically adjust the behavior of a powered orthosis to the user's performance, to encourage motor learning of target walking patterns during robot-assisted exercises. This research, which is supported by an NSF CAREER award, will pave the way for more intuitive and personalized pHRI strategies for powered orthoses and exoskeletons. In the area of wearable sensing technologies, Zanotto and his group have extended the state of the art on wearable human motion analysis by establishing new abstraction models to enable high accuracy without the need for subject-specific sensor calibration procedures.

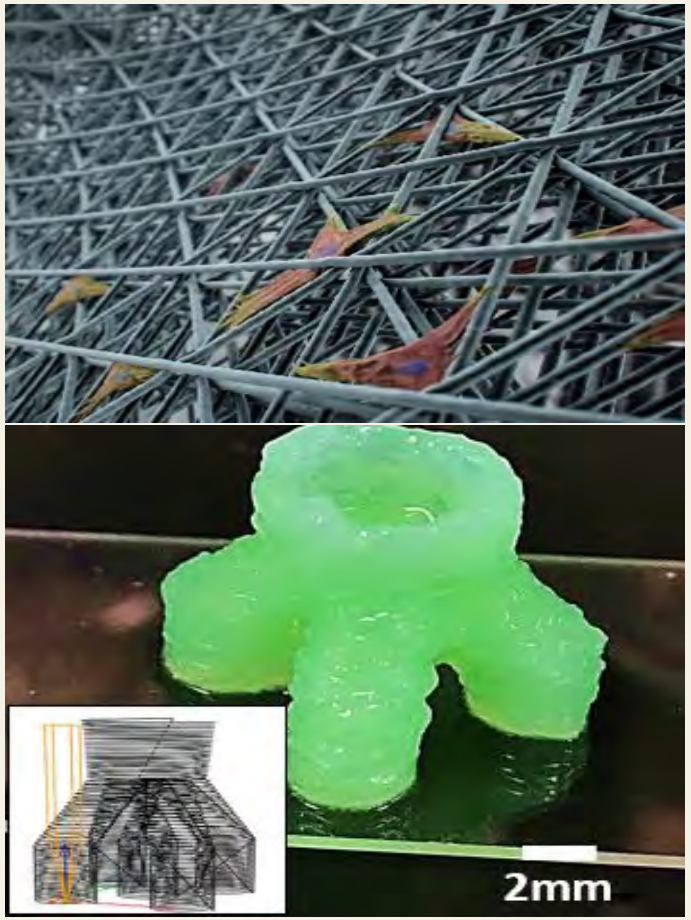
The ultimate goal of this research, which is currently supported by grants from the NSF and from the Muscular Dystrophy Association, is to increase range of applicability of wearable sensors for gait analysis in real-life environments, to enable extended-time measurements by non-expert users and reduce the accuracy gap between traditional laboratory equipment and emerging wearable sensors for motion analysis. Out-of-the-lab measurements make it possible to measure real-life performance in patients with movement disorders. High accuracy, in turn, allows the detection of subtle but meaningful changes in motor outputs that may unveil an underlying condition, or reflect a patient's responsiveness to treatments.

Biomechatronics and wearable technologies for human motion analysis and rehabilitation

Sponsored Research *(Cont'd)*

Additive Manufacturing Process Innovation for Modeling Biological Tissue Models
Robert Chang, Associate Professor

Recent innovations in additive manufacturing process and materials have enabled a broadening scope of biomedical manufacturing applications, including advancements in the safety, quality, cost, efficiency, and speed of healthcare services and research. It is within this space that Professor Chang's Biomodeling and Biomeasurement (BMBM) lab is working to enable transformative gains in understanding the fundamental science and engineering basis towards new additive process development, modeling, and optimization in various engineered tissue and cell therapy applications. To carry out this work, the BMBM lab is externally funded by the NSF to investigate onboard process charge measurements for neuronal cell-cell communication and the DOD to study the scalable in situ manufacturing of skin grafts. The BMBM lab has continued to build on its core competency in developing and optimizing additive biomanufacturing technology platforms with precise control of operational variables. In establishing a suite of computer-automated technologies to fabricate 3D structural and functional parts, BMBM's process innovation efforts have primarily encompassed the manufacturing principles of material jetting and extrusion. A key distinction in the BMBM group's unique perspective to manufacturing technology innovation work is a firm grounding in closing the manufacturing loop by way of in-process and post-process quantitative metrology or measurement science for robust experimental validation and prediction. The workflow adopted by the BMBM lab enables the rigorous deconstruction of the material-process-structure-biological performance relationships governing the fabrication of 3D structured biomaterials. This synergistic approach has yielded significant expansion of both the additive manufacturing and measurement capabilities at Stevens. Furthermore, the BMBM group has demonstrated multiple specific and compelling implementations of these capabilities for fundamental cell biology and targeted therapeutic health applications, foremost among them biologically reprogramming stem cells towards phenotype enrichment and industrial scale-up of quality-assured cell populations in skin pressure ulcer applications for the military/veterans population.

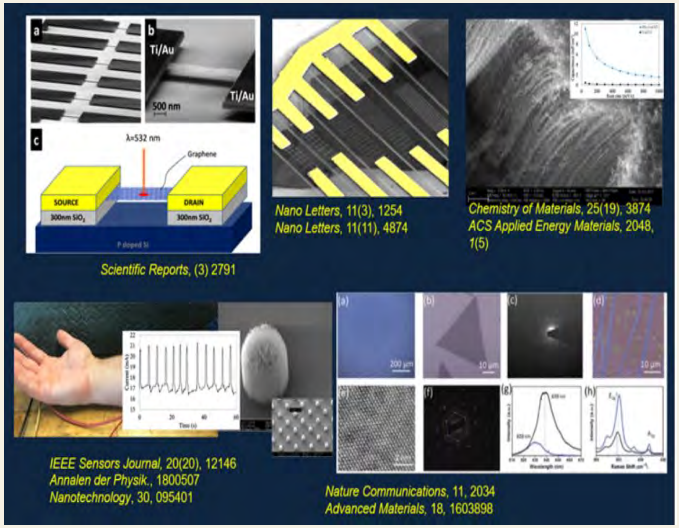


Modeling, optimizing, and qualifying structural and biological process outcomes for material jetting and extrusion-based AM technologies towards engineered tissue and cell therapy applications.

Sponsored Research *(Cont'd)*

Air Stability, Doping, and Magnetism in Transition Metal Dichalcogenides
EH Yang, Professor

Professor EH Yang has studied air stability, doping, and magnetism in Transition Metal Dichalcogenides (TMD). While the lack of bandgap is a serious limitation for graphene use in electronic devices, reports have shown highly promising prospects of using TMDs in electronics and optoelectronics because of their unique properties, which complement graphene. However, the in-air oxidation of TMDs presents an obstacle in any practical device applications. WS2/graphene heterostructures on a SiO2 substrate show a very slow oxidation rate since the graphene layer reduces the effect of surface electric-fields, resulting in significantly suppressed oxidation of WS2/graphene on a SiO2 substrate. Suspended WS2/graphene heterostructures are not oxidized in air, attributed to the absence of electric fields. On the other hand, 2D atomic crystals exhibiting magnetic properties provide an ideal platform for exploring new physical phenomena in the 2D limit, representing a substantial shift in the ability to control and investigate nanoscale phases. Experimental studies have shown doping of dissimilar atoms into TMDs to create 2D dilute magnetic semiconductors, which are promising candidates for spintronics applications. However, the success of these previous attempts was limited, resulting in either a Curie temperature well below room temperature or lacking scalability for practical integration into devices. Professor Yang's work demonstrated a 2D dilute magnetic semiconductor at room temperature via an in situ synthesis and characterization of Fe-doped TMD monolayers. This study simultaneously achieved the substitutional doping of Fe and the growth of MoS2 and WS2 monolayers and showed that Fe incorporates substitutionally into Mo and W lattice sites and probes ferromagnetism in Fe:MoS2 at room temperature. This new class of van der Waals ferromagnets highlighted critical applications, including on-chip magnetic manipulation of quantum states or spintronics.

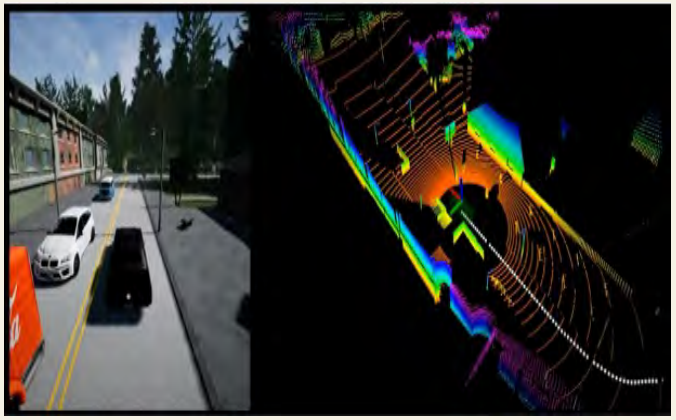


TMDs, Graphene/CNT Photodetector, Supercapacitors and Stretchable Sensors

Sponsored Research *(Cont'd)*

Distributional Reinforcement Learning for Safe Autonomous Navigation
Brendan Englot, Associate Professor

Professor Brendan Englot has been investigating the potential of Distributional Reinforcement Learning to allow mobile robots and autonomous vehicles to effectively manage risk and navigate with increased safety. This study has been funded by the Office of Naval Research Young Investigator Program (ONR YIP). In Professor Englot's research, rather than choosing actions based solely on the likely outcome, the robots will predict full probability distributions governing the outcomes of their activity, which will more accurately capture movement that can sometimes succeed, and sometimes fail. This has implications for self-driving cars, whose actions may sometimes yield a safe outcome, and other times result in collision. Englot and his students have been exploring this using a self-driving vehicle simulator, pictured at right, in which an autonomous car will make decisions based on the observations of the environment that it collects with a Lidar.



Self-driving vehicle simulator

Optomec LENS 500 Metal 3D Printer
Chang-Hwan Choi, Professor

The Optomec LENS 500 system has been the latest addition to the Additive Manufacturing & Materials Lab (AMML) located in the Carnegie building. This state-of-the-art direct energy deposition (DED) system was funded by the ONR DURIP Program for scientific research and education in additive manufacturing. It has been especially useful in the development of novel metal alloys against corrosion and biofouling in naval applications. The DED system allows rapid manufacturing and repair of metal components in state-of-the-art materials such as stainless steel, aluminum, titanium, and Inconel. The system uses energy from a high-power fiber laser to build up structures one layer at a time directly from metal powders, alloys, or composites. Two powder feeders allow gradient materials to be made. This enables new materials to be made and analyzed with extraordinary speed. Such technical advantages of the DED system is the key to understand and develop novel methods for additive manufacturing of metals that can be applied to the wide range of naval systems with optimized anti-corrosion and anti-biofouling properties. The DED system is an ideal solution for additive manufacturing of various metals and will significantly impact the ongoing research projects at Stevens, including the corrosion behaviors of the additively manufactured metallic materials.

Optomec LENS 500 metal 3D printer

Sponsored Research *(Cont'd)*

AIMED - AI Managed Explorations of Designs Symbiotic Design Process - AI + Human Work Together to Enhance Design Innovation
Kishore Pochiraju, Professor
Brendan Englot, Associate Professor

Professors Pochiraju and Englot have teamed with Perspecta Labs (ex. Bell Core) and Princeton University, under a DARPA sponsored research grant, to study AI managed explorations of designs symbiotic design process to accelerate the development of complex multi-domain systems from years to months and to enable new flexible platforms that can be easily adopted for multiple missions. Traditionally designs are developed in siloed (mechanical, electrical, chemical) disciplines. New and novel designs emerge under the direction and inspiration from human design experts. Current state of the art is that humans provide inspiration/imagination for innovative designs and design tools provide the automation/perspiration. Humans can rarely explore all possible designs and find it challenging to find novel cross-disciplinary designs. When multiple disciplines are involved, human designers are challenged by the cognitive load required to navigate complex design spaces. AI tools developed in this project work symbiotically with the human designers to identify novel design possibilities by efficiently exploring across domains for complex systems, thereby reducing the cognitive load on the human designers.

Novel designs will be inspired by a corpus of similar, but incomplete designs, database of components, goals and constraints, rules and policies and learning from how seed designs were developed. The research team at Stevens will focus on the designs emerging from the symbiotic process and guide the team towards novel solutions to the challenge problems. They will lead the development and integration of high-fidelity simulations tools for various domains including robotics, controls, structures, materials and optimization. They will also lead the creation of digital-twins for the challenge problems. The developed optimization methods will be tested through two challenge problems. Air Taxi for urban mobility of passengers and a long endurance unmanned underwater vehicle (UUV) will be designed, prototyped and tested under this research work.

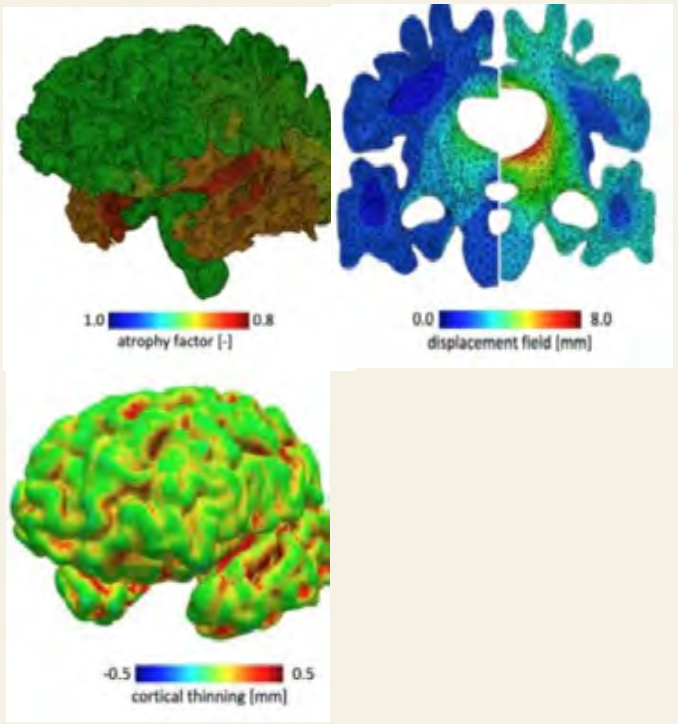
Example simulated AirTaxi mission used to optimize mission management and control

Sponsored Research *(Cont'd)*

Computational and Experimental Methods to Test, Model, and Predict the Biophysical Response of the Brain
Johannes Weickenmeier, Assistant Professor

Mechanics, and its intricate coupling with biology, chemistry, and electrophysiology, is increasingly recognized as an important ingredient in understanding the form and function of the most complex organ: the human brain. To uncover some of these mechanisms, the Weickenmeier Lab specializes in computational and experimental methods to test, model, and predict the biophysical response of the brain during early brain development, healthy aging, and dementia. They measure the mechanical stiffness of brain tissues and relate it to its underlying cellular microstructure; develop mathematical models of tissue growth, neurodegeneration, and other mechanisms associated with aging and neurological disorders in order to predict changes of so-called biomarkers, i.e., hallmark features that linked to particular changes of brain microstructure, function, shape, or state of health; and create anatomically accurate computer models of the brain to provide personalized prediction of brain shape changes during healthy aging and in Alzheimer's disease.

Professor Weickenmeier received support from the National Institute of Health (NIH) and the National Science Foundation (NSF) to develop a multiphysics framework to simulate the spreading of toxic proteins through the brain that are associated with Alzheimer's disease and related dementias. They combine longitudinal medical imaging, disease modeling, and realistic brain models to predict how the brain will lose neurons, shrink, and change shape with age. On the one hand, the work provides new knowledge of basic biophysical mechanisms in the brain and on the other hand, it is critical in providing earlier diagnosis of dementia - disease which starts affecting the brain up to two decades before the first symptoms appear and that is linked to tremendous health care costs.

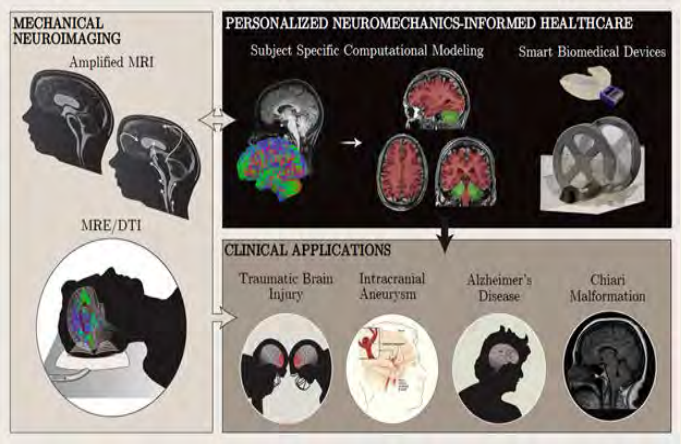


Anatomicallly accurate computer models of the brain

Sponsored Research *(Cont'd)*

Distributional Reinforcement Learning for Safe Autonomous Navigation Mechanical Neuroimaging and Neuromechanics-Informed Brain Research
Mehmet Kurt, Assistant Professor

The brain is our most studied and least understood organ. Due to its incredible complexity, the origin and development of numerous neuropathological conditions are still far from completely elucidated, while at the same time having an enormous impact on the life quality and expectancy of the ones affected. There is a dire need to find novel strategies for addressing the clinical and diagnostic questions that remain. Despite clear evidence that mechanical factors play an important role in brain development, pathophysiology, and disease mechanisms, current research efforts focus on the biochemical or electrophysiological aspects, mostly due to the difficulty of probing the brain mechanically. Professor Kurt brings forward a novel platform for investigating the mechanobiology of the brain in health and disease by merging advanced neuroimaging tools and multi-scale computational modeling of the human brain. The overarching goal of the research program is to merge advanced neuroimaging tools and multi-physics brain modeling for the in vivo subject-specific investigation of brain mechanics. During a time when the U.S. spends more than double on healthcare per capita as its peers in developed nations, the proposed research program will strengthen preventative medicine and early diagnostics of neurological disorders, which could simultaneously reduce the financial burden on our society and increase the quality of millions of lives. Professor Kurt's research vision will focus on the fast clinical translation of research in brain mechanics.



Mechanical neuroimaging and neuromechanics-informed brain research

$2 million NSF LEAP-HI Award

The Center for Neuromechanics (CFN)
Faculty Participants: Professors Robert Chang, Mehmet Kurt, George McConnell, Raviraj Nataraj, Johannes Weickenmeier, Antonia Zaferiou, and Damiano Zanotto

The newly formed CFN, part of the Mechanical Engineering Department at Stevens Institute of Technology, was launched in 2019 and is the first of its kind in the nation with a primary focus on the mechanical behavior of the neural system. Mechanics is an emerging and highly interdisciplinary field that is increasingly recognized as a fundamental contributor in understanding the function, structure, and health of the human brain. One of the critical roadblocks to this is finding a common language between different disciplines, which has resulted in a substantial lack of engineering solutions being translated into the clinical domain. The team of researchers consists of radiologists, neurosurgeons, neurologists, engineers, and applied mathematicians who are leading research and educational initiatives that serve as a bridge between mechanical and clinical brain health sciences with the goal of connecting more clinicians with a mechanical solution for neurological disorders and treatment. CFN has been sponsored by grants from NSF, NIH, DoD, and New Jersey Health Foundation.

The Center for Neuromechanics research team

Faculty

The Department's faculty constitutes a body of 25 tenure/tenure-track, world-class researchers, and educators who practice diverse activities across the engineering spectrum. They are dedicated to supporting hands-on learning, research and technology that provides each student with invaluable experiential knowledge and offers students a myriad of opportunities and resources to further their educational and professional goals, at the university level beyond. Their collective talents have been globally recognized for world-class faculty, leading-edge research facilities and a premiere location proximate to New York City. The Faculty pride themselves on the student-centric approach that enables them to guide students toward becoming the leaders of tomorrow!

Recent Tenure Track Faculty Hires

The Mechanical Engineering Department recently hired seven new tenure track faculty, including three in 2019-2020 academic year.

Gizem Acar, Assistant Professor, Mechanical Engineering, Ph.D.: Michigan State University, Specialization: Dynamics and Vibrations

Shima Hajimirza, Assistant Professor, Mechanical Engineering, Ph.D.: University of Texas at Austin, Specialization: Computational heat transfer, Machine-learning based optimization and design, Renewable energy, Energy conversion in nanomaterials

Hamidreza Jafarnejad Sani, Assistant Professor, Mechanical Engineering, Ph.D.: University of Illinois at Urbana-Champaign, Specialization: Secure and Resilient Control of Cyber–Physical Systems

Jason Rabinovitch, Assistant Professor, Mechanical Engineering, Ph.D.: California Institute of Technology, Specialization: Computational Fluid Mechanics for Entry, Descent and Landing (EDL) and space applications.

Long Wang, Assistant Professor, Mechanical Engineering, Ph.D.: Vanderbilt University, Specialization: Modeling, Sensing, and Control of Robots

Fan Yang, Assistant Professor, Mechanical Engineering, Ph.D.: University of California, Berkeley, Specialization: Micro/Nanoscale heat transfer and energy conversion

Annie Xian Zhang, Assistant Professor, Mechanical Engineering, Ph.D.: Columbia University, Specialization: Thermal transport and thermoelectrics, Nanotechnology.

210% increase in Faculty Research Awards and 265% in Research Expenditure since July 2018

$14.6 million Active Faculty Research Awards

30% increase in Tenure Track Faculty since 2018

Faculty *(cont'd)*

Souran Manoochehri
Professor and Chair

Hamid Hadim
Professor and Associate Chair for Undergraduate Education

Yong Shi
Associate Professor and Associate Chair for Graduate Education

Robert Chang
Associate Professor and Ph.D. Coordinator

Gizem Acar
Assistant Proessor

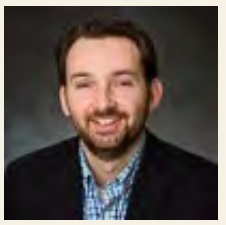
Elsayed Aziz Ramadan
Teaching Associate Professor

Constantin Chassapis
Professor and Senior Vice Provost for Graduate Education

Chang-Hwan Choi
Professor

Kevin Connington
Teaching Associate Professor

Alexander De Rosa
Teaching Associate Professor



Brendan Englot
Associate Professor

Sven Esche
Associate Professor

Frank Fisher
Professor

Maxine Fontaine
Teaching Assistant Professor

Shima Hajimirza
Assistant Professor

Hamid Jafarnejad Sani
Assistant Professor

Chang Beom Joo
Lecturer

Mehmet Kurt
Assistant Professor

Faculty *(cont'd)*

Yazan Manna
Teaching Assistant Professor

Nicholaus Parziale
Associate Professor

Christophe Pierre
Professor and Provost and Vice President for Academic Affairs

Kishore Pochiraju
Professor and Associate Dean for Undergraduate Studies

Jason Rabinovitch
Assistant Professor

Anthony Russo
Teaching Associate Professor

Mishah Salman
Teaching Associate Professor

Leonid Shnayder
Teaching Professor

Siva Thangam
Professor and Dean of Academic Administration

Long Wang
Assistant Professor

Johannes Weickenmeier
Assistant Professor

Eric Williams
Teaching Assistant Professor

Eui-Hyeok Yang
Professor

Fan Yang
Assistant Professor

Chan Yu
Lecturer

Damiano Zanotto
Assistant Professor

Xian Zhang
Assistant Professor

Jean Zu
Professor and Dean of the Schaefer School of Engineering and Science

Faculty Outreach

Professors Maxine Fontaine and Mishah Salman

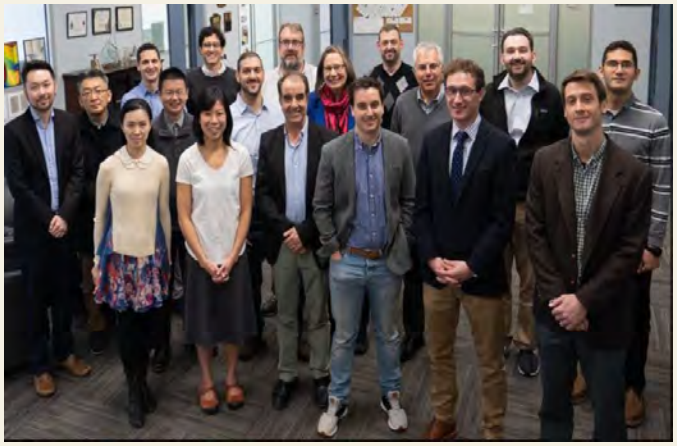
Continuing to build on the Mechanical Engineering Department's legacy of innovation in engineering education, Professors Alexander De Rosa and Frank Fisher co-chaired the **2020 Fall Mid-Atlantic Section Meeting of the American Society for Engineering Education (ASEE)** at Stevens on November 7th. The theme of the conference was "Student Centricity" and involved various other members of the Mechanical Engineering Department and campus community.

Faculty within the Mechanical Engineering Department have a long history of working closely with the ASEE and within the field of engineering education. **Professor Alexander De Rosa is the current Chair-Elect of the local Section of the ASEE and Professor Maxine Fontaine is the Secretary-Treasurer** of the local group. Many Mechanical Engineering faculty have published widely within the ASEE as well, including Professors De Rosa and Fontaine, whose work in spatial skills assessment and training has been nationally recognized, Professor Weickenmeier who works to engage undergraduate students with summer research, and Professor Fisher who is co-PI on the NSF Foundations project.

The **"Women in Mechanical Engineering"** group was established in September 2020, providing an opportunity for women faculty, graduate students, and undergraduate students to connect and discuss topics specific to women in our field. Past meetings have included a trivia game on women in engineering, a presentation on job search advice and tips, and a discussion with a panel of Stevens ME alumni on their workplace experiences.

In February 2020, Professors Maxine Fontaine and Mishah Salman presented to the students at the Heywood Avenue School in Orange, NJ during their annual **Engineering Week.** Once a year, the Mechanical Engineering Faculty visit where they have the opportunity to engage directly with grade school children fostering their curiosity regarding STEM fields and related professions.

Faculty Honors and Awards



The Department of Mechanical Engineering Faculty

Mechanical Engineering Employee Recognition Awards:

Associate Professor Brendan Englot received a 2019 -2020 Stevens Employee Recognition Award for “Strengthened Reputation, Increased Prestige.”

Associate Professor Nick Parziale received a 2019 -2020 Stevens Employee Recognition Award for “Excellence in All We Do.”

Assistant Professor Mehmet Kurt Won 2020 Provost’s Early Career Award for Research Excellence

Teaching Associate Professor Mishah Salman Won 2020 Alexander Crombie Humphreys Distinguished Teaching Associate Professor Award

Teaching Assistant Professor Maxine Fontaine Won 2020 Harvey N. Davis Teaching Assistant Professor Award

External Honors and Awards:

Professor E.H. Yang was invited to serve on the NAI Fellows Advisory Committee

Mechanical Engineering Teaching Assistant Professors Alexander De Rosa and Maxine Fontaine received the national award of “2018 Best Zone Paper” across the whole of ASEE for their paper titled “Implementation and First-Year Results of an Engineering Spatial Skills Enhancement Program.”

Mechanical Engineering Professor and Associate Dean for Undergraduate Studies Kishore Pochiraju (ME) and Director Sandra Clavijo won first place Best Paper/Teaching for their paper, “An Analysis of Freshman Teamwork Experiences in Required Design and Entrepreneurial Thinking Project-Based Learning Courses,” at 2019 ASEE Annual Conference.

Alumni and Student Success

The Department of Mechanical Engineering defines student success as the means that lead to positive student outcomes and realized fulfillment. The following are just a few of the Mechanical Engineering Department's successful students.

Ke Du's, Ph.D. '15 Quest to Diagnose COVID-19 and Contain Future Pandemics
Before the world confronted COVID-19, Ke Du Ph.D. ’15 was working to combat other infectious diseases that have taken a tragic toll worldwide. Du, a assistant professor of mechanical engineering and microsystems engineering at Rochester Institute of Technology, RIT, is now developing diagnostic devices to detect COVID-19. Du finds an even greater urgency in his work to develop a device that can quickly and affordably detect infectious diseases, and help to diagnose and contain not only this pandemic but also future pandemics.

Professor Ke Du, Ph.D. '15

Mary Michelle Easter '15, Joins NASA’s Coronavirus Effort from Spacecraft to Ventilators
When COVID-19 cases flooded the New York metropolitan area’s healthcare facilities at the peak of the coronavirus outbreak, the dwindling supply of ventilators sparked a frantic national hunt for the life-saving devices. The urgent demand prompted the world’s preeminent space agency (NASA JPL) to deploy a team of engineers to find a solution to what has become a global shortage of ventilators. “Everybody operated with the understanding that every second was critical - that we had to do everything we could and as fast as possible to get these designs out the door,” says Mary Michelle Easter ’15, a JPL mechatronics engineer who was part of that team.

Mary Michelle Easter '15

Chenxin Xu, Brandon Wang, Emily Sneddon, Gianna M Marcovecchio, Greg Ota, and Karina Hunstein
Professor Annie Zhang and six undergraduate students conducted research related to fabrication and measurement of two-dimensional heterostructures, specifically on their thermal transport and thermoelectric properties. An example of their research uses Raman optothermal technique to measure thermal conductivity of novel two-dimensional structure hexagonal boron nitride encapsulated MoS2. This is the first work about hexagonal boron nitride material’s efficient thermal dissipation properties in the research community. The undergraduate students collaborated with the doctoral students and successfully accomplished the goals of this project. This work was presented at the 2020 ASME IMECE conference.

Using Raman optothermal techinque to measure thermal conductivity of novel materials

Alumni and Student Success *(Cont'd)*

Anthony M. Palumbo ’20
Anthony M. Palumbo ’20 has been working on flexible, real-time pressure mapping system for prosthetics. Every year, billions of dollars are spent on prosthetic complications. Current sensors used to detect these complications are too inconsistent. Anthony worked in the Nanomaterial Growth and Nanofabrication Laboratory, under Professor EH Yang, to develop a flexible nano-electromechanical pressure detection system that is more consistent than current sensors. He created a prototype that is made of several proprietary pressure sensors, which consist of carbon nanotubes and Polydimethylsiloxane (PDMS.) These sensors have shown very consistent results and robust durability, even under high strain conditions.

Nanomaterial Growth and Nanofabrication experiments supervised by Professor EH Yang

Paul Szenher '20 and Michael DiGregorio '21
Paul Szenher '20 and Michael DiGregorio '21 worked on a novel approach to autonomous navigation for unmanned ground vehicles traveling off-road in previously unmapped environments. Starting as a Pinnacle Scholars summer research project in Summer 2019, they worked together to develop a novel mapping algorithm that can infer the traversability of the surrounding terrain in unmapped areas, allowing a robot to drive rapidly and safely to its destination while avoiding collision.

Paul Szenher '20 posing with the robot used, in a Kentucky limestone mine demonstrating the robot's navigation capabilities in a GPS-denied environment

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INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

DEPARTMENT OF MECHANICAL ENGINEERING

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ASME: A Connection to Mechanical Engineering at Stevens That Began in 1880

Stevens' first professor of mechanical engineering, Robert Thurston, was inspired to lead the way in professionalizing and standardizing the mechanical engineering field — and the American Society of Mechanical Engineers (ASME) was one of the results. Dr. Henry Morton, the first president at Stevens, was an early and enthusiastic supporter of the effort. Asked if he could use space at Stevens for the first meeting of ASME, he did not hesitate. In a gas-lit assembly hall in the Edwin A. Stevens Building, that first formal ASME meeting was held, announcing Thurston as first president of the new organization.