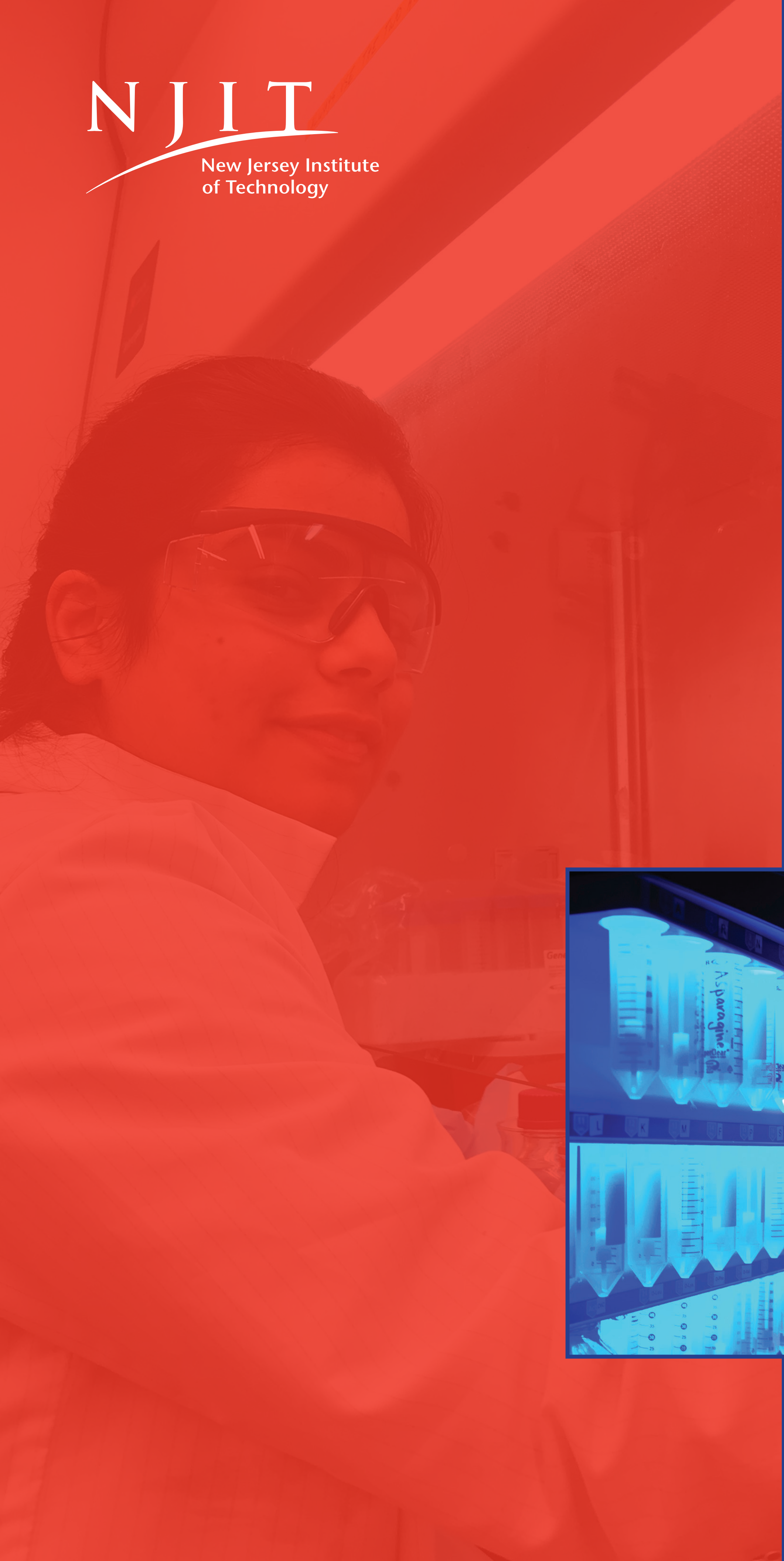
NJIT
New Jersey Institute of Technology



2019 RESEARCH LABORATORIES, CENTERS AND INSTITUTES SHOWCASE

THURSDAY
NOVEMBER 14, 2019


Microfabrication Innovation Center

As one of five critical priorities spelled out in NJIT's Strategic Plan, *2020 Vision*, scholarly research is at the very center of university life. It is integrated into everything we do, from the recruitment of new faculty, to the proliferation of research opportunities for our graduate and undergraduate students, to events like today's Laboratories, Centers and Institutes Showcase, which is designed to foster collaborations that lead to groundbreaking new ideas and innovations.

As NJIT moves into the ranks of premier research institutions, we do so strategically. Our mission is to play a leading role in four emerging areas of multidisciplinary research: data science and information technology, the nexus of life sciences and engineering, sustainable systems and a transdisciplinary category that allows us to address the large systemic challenges of "smart cities," for example.

The university's research centers and institutes are the primary vehicles for tackling multifaceted societal problems and seeing them through to completion. By drawing on the insights and expertise of original thinkers across sectors, they achieve capabilities that are greater than the sum of their parts. NJIT is committed to supporting our researchers in several ways. In 1979, the university's research expenditures totaled $375,000; today they near $170 million. More importantly, over the next five years, we aim to double the number of awards our faculty secure from external funding agencies and private sector partners. In 2014, we inaugurated a seed-grant program to support interdisciplinary projects between fields as diverse as architecture and biomedical engineering, and we are delighted to report that some of these initiatives have taken off and are now attracting outside funding.

With our ongoing $400 million capital-building program, we are transforming research and education on campus. The opening of our Wellness and Events Center, the gut-level renovation of the five-story Central King Building, and the construction of a new 24,500-square-foot life sciences and engineering building are bringing our students and faculty new teaching and research labs, rooms to conduct projects and common areas where they can socialize and share ideas. NJIT's new Microfabrication Innovation Center, to open in December, houses advanced equipment and a cleanroom environment that provides a state-of-the-art facility for the fabrication of micro- and nanoelectronic and microfluidic devices and sensors.

The Makerspace at NJIT, a 21,000-square-foot training-focused, rapid prototyping facility, provides the university's education and research community with equipment ranging from small 3D printers to large industrial machines such as an additive metal 3D printer that uses powdered stainless steel to print parts; an optical scanner that effectively digitizes real-life objects, enabling reverse engineering; and a continuous fiber 3D printer that is capable of depositing strands of carbon fiber, fiberglass or Kevlar inside 3D-printed parts.

Just as exciting, we are broadening the scope of our research and building capacity through our people. Over the past five years, we have hired nearly 150 new faculty members as we deepen our capabilities across STEM and other disciplines. Under our *2020 Vision*, we are beginning a multiyear hiring effort that will expand our faculty even further, from 268 in 2014 to 345 by 2020. For those who are new to the community, you are most welcome. We hope the research showcase opens up intriguing new vistas for you. Dive in!

Fadi P. Deek
Provost and Senior Executive Vice President


MTS
MTS Criterion™
Model 43

Welcome to the 2019 Research Laboratories, Centers and Institutes Showcase, an annual celebration of NJIT's most potent and promising engines of innovation. The approximately 110 institutes, centers and labs represented today reflect the steady, strategic growth in the university's research enterprise. Over the past five years, more than 70 of these hubs have been created, while total external R&D expenditures have nearly doubled.

We come together today, however, because these nodes of expertise do not exist in isolation. NJIT strongly believes that as researchers, we are most innovative and productive when we join together across disciplines to solve complex challenges that defy simple answers and niche know-how. Our current research clusters encompass life sciences and engineering, sustainable systems, data science and information technology, and a broader transdisciplinary category created to address problems such as intelligent transportation, systems resilience and point-of-care health devices. We invite collaboration with each other, as well as with partners in industry, government and peer institutions.

Our centers and institutes attract future-focused researchers, innovators and entrepreneurs across disciplines who work together to develop technologies capable of addressing a broad range of societal needs. This year, we are pleased to establish two new research institutes, the Institute of Data Science and the Institute of Materials Research, to comprehensively address complex, transdisciplinary problems of global importance.

The Institute of Data Science will exploit synergies in data science and related research areas, such as big data analytics, artificial intelligence and cybersecurity to address problems in health and medicine, space weather, transportation, finance, marketing, economics, genomics and social networks, among other sectors in which specific data are collected. The Institute of Materials Research will promote collaborative research in material science and engineering to develop smart materials, sensors and devices for real-world applications in the medical, environmental technology and energy sectors. The institute will transcend the traditional boundaries of a single-lab academic environment by leveraging state-of-the-art materials characterization and processing and fabrication facilities at the York Center of Environmental Research, the Life Sciences and Engineering Research Center and our new Microfabrication Innovation Center.

As NJIT develops its next five-year strategic plan, which will guide the university until 2025, the university will re-organize its research enterprise into five clusters; they include bioengineering and bioscience; data science and management; environment and sustainability; materials science and engineering; and robotics and machine intelligence. Our goal is to harness multidisciplinary collaborative resources and synergies to focus on select grand challenges identified by the National Science Foundation, as well as on other "big ideas" designed for meaningful societal impact.

So I urge you again, as I do each year, to step out of academic silos, to delve into conversations with scholars outside of your disciplines and to seek inspiration in each other's work. You are guaranteed to walk away with new ideas and, more than likely, future collaborators.

Atam P. Dhawan
Senior Vice Provost for Research

Research is an integral part of a strong academic experience and a critical priority in NJIT's strategic plan, *2020 Vision*. The university aims for national and international prominence in research through new discoveries in areas ranging from robotics, to nanotechnology, to cybersecurity, to next-generation materials, among other topics of vital importance in basic, applied and translational research.

The 150 new faculty members we have hired over the past five years strengthen our efforts considerably. They include experts on topics such as machine learning, data analytics, biomaterials and biomechanics. They arrive with impressive track records in securing grants from key funding agencies such as the National Institutes of Health, the National Science Foundation and the U.S. Department of Defense. We are confident that their participation in our multidisciplinary centers will help NJIT reach its ambitious funding benchmarks.

To achieve our research and educational goals, the university's strategic plan calls for seamless collaborations among faculty, staff and students, who all have a central part to play in advancing science, engineering and technology to fuel societal progress. 2020 Vision organizes our core 13 research focus groups into four clusters. Comprised of an average of 20 active research members, they include:

LIFE SCIENCES AND ENGINEERING

This research cluster includes both basic and applied research in the areas of neuroscience, neural engineering, regenerative and rehabilitative medicine and point-of-care technologies. Researchers at NJIT are advancing our understanding of the functions of the brain and spinal cord under normal, injured and diseased states at molecular, cellular and functional levels through experimental, theoretical and computational methods. Imaging experts, computer scientists and biomedical engineers are working together, for example, to devise therapies and devices that will improve motor, cognitive and organ functions. To this end, our tissue engineers focus on replacing dysfunctional cells with regenerating cells and tissues. The Life Sciences and Engineering cluster also includes healthcare information systems and management involving primary care, hospitals and emergency care resources and protocols.

The scope of the proposed cluster includes areas that are aligned with the National Academy of Engineering (NAE) and National Academy of Sciences (NAS) Grand Challenges in "Reverse Engineering of the Brain," "Tools for Scientific Discovery," and "Engineering Better Medicine." NJIT's new life sciences and engineering building is designed to accelerate game-changing collaborations with new teaching and research labs, rooms to conduct projects and common areas where faculty and students can socialize and share ideas.

SUSTAINABLE SYSTEMS

This cluster represents research areas in urban ecology and sustainability, advanced materials and nanotechnologies, and smart manufacturing systems. The urban ecology and sustainability area emphasizes sustainable infrastructure, ecological communities, urban modeling and simulation. This area also focuses on the water-energy nexus and the impact of ocean levels on the environment, as well as the development of technologies to clean water and to provide green energy, such as biofuel cells and powerful, long-lasting batteries. The scope of nanotechnology research includes scientific and engineering phenomena at the minutest and most fundamental levels in order to develop technologies for environmental and pharmaceutical applications. The interdisciplinary group on engineered materials and particulates focuses on technology development for the preparation, processing and use of engineered-particulate materials and their composites for a spectrum of applications.

Research in the manufacturing systems group involves developing new methods and technologies for design innovation and process automation. A specific emphasis is to devise new processes and tools for pharmaceutical manufacturing. NAE and NAS Grand Challenges within the scope of this proposed cluster include solar energy, energy from fusion, clean water and urban infrastructure.

DATA SCIENCE AND INFORMATION TECHNOLOGY

This research cluster includes the study and practice of extracting information and knowledge from data that can be used for medical, financial, scientific and engineering applications. These groups conduct research on bioinformatics, medical informatics, image processing, data mining, solar-terrestrial physics, transportation, financial management, life sciences and healthcare.

The cybersecurity group designs secure cyber systems and improves cyber information and communications technology (ICT). ICT is shaping many aspects of society as the economy evolves rapidly, providing access to unprecedented amounts of information, anytime and anywhere, from any type of device. At the end of 2018, 5.1 billion people around the world subscribed to mobile services, accounting for 67% of the global population, according to GSM Association, a trade group that represents mobile network operators worldwide. Over the next seven years, 710 million people are expected to subscribe to mobile services for the first time. Between 2018 and 2025, the number of global IoT connections will triple to 25 billion. Global spending on security hardware, software and services will top $103 billion in 2019, up 9.4 percent from 2018, according to International Data Corporation (IDC), the market intelligence firm. The scope of this proposed cluster addresses NAE and NAS Grand Challenges, including secure cyberspace, virtual reality and tools for scientific discovery.

TRANSDISCIPLINARY AREAS

This cluster includes research centers focused on mathematical sciences, transportation systems, additive manufacturing and wireless communications technology, as well as on the societal impacts of science and technology. These three areas have a broader multidisciplinary and interdisciplinary scope with diverse applications in the life sciences and the design of smart cities, among other areas. The scope of this proposed cluster addresses NAE and NAS Grand Challenges in urban infrastructure, smart transportation, tools for scientific discovery and advanced personalized learning.

PROGRAM

Campus Center, Ballrooms A/B

10:00 a.m. – 10:05 a.m.:	Welcome Remarks and Announcement of the Institute of Data Science (IDS) Atam Dhawan, *Senior Vice Provost for Research*
10:05 a.m. – 10:10 a.m.:	Vision for the Institute of Data Science David Bader, *Distinguished Professor and IDS Director*
10:10 a.m. – 10:15 a.m.:	Introduction of the Keynote Speaker Atam Dhawan, *Senior Vice Provost for Research*
10:15 a.m. – 11:15 a.m.:	President's Forum: Keynote Speech Four Decades of HPC: Architectures, Programming Environments, Systems and Applications Dr. Vipin Chaudhary, *SUNY Empire Innovation Professor of Computer Science and Engineering, State University of New York (SUNY) – Buffalo; Program Director, National Science Foundation*
11:15 a.m. – 12:15 p.m.:	Networking and e-Poster Session-1
12:15 p.m. – 1:00 p.m.:	Lunch and Networking Session
1:00 p.m. – 2:00 p.m.:	Networking and e-Poster Session-2

This President's Forum is a featured event in the Albert Dorman Honors College Colloquium Series and is made possible in part by the generous support of the DeCaprio Family.

KEYNOTE SPEAKER

Dr. Vipin Chaudhary
SUNY Empire Innovation Professor of Computer Science and Engineering
State University of New York (SUNY) - Buffalo
Program Director, National Science Foundation

Dr. Vipin Chaudhary, SUNY Empire Innovation Professor of Computer Science and Engineering at the State University of New York (SUNY) Buffalo, specializes in the field of high performance computing (HPC). For more than three decades, Dr. Chaudhary has actively participated in the science, business, government and technology innovation frontiers of the field, heading research laboratories, holding executive management positions and starting new technology ventures. In addition to his role as the SUNY Empire Innovation Professor, he is the co-founder of the Center for Computational and Data-Enabled Science and Engineering. Dr. Chaudhary is currently on an Intergovernmental Personnel Act appointment at the National Science Foundation (NSF), where he is serving as a program director in the Office of Advanced Cyberinfrastructure. He co-leads the National Strategic Computing Initiative from NSF for the United States, and is in the working group of the agency's Quantum Leap Initiative and its I-Corps Program. He is also in the working group of the Interagency Modeling and Analysis Group, which represents more than 100 program staff from multiple government agencies in the United States and Canada.

Dr. Chaudhary co-founded Scalable Informatics, a leading provider of pragmatic, high performance software-defined storage and computing solutions for a wide range of markets, from financial and scientific computing to research and big data analytics. From 2010 to 2013, he was the chief executive officer of Computational Research Laboratories, where he grew the company globally to be an HPC cloud and solutions leader before selling it to Tata Consulting Services. Prior to this, as the senior director of advanced development at Cradle Technologies, Inc., he was responsible for advanced programming tools for multi-processor chips. He was also the chief architect at Corio Inc., which had a successful IPO in July 2000 and was later sold to IBM.

Abstract: Four Decades of HPC: Architectures, Programming Environments, Systems and Applications

High performance computing impacts every aspect of scientific endeavor. In this talk, I will cover various HPC problems and applications over four decades from my journey in academia and industry. These include new multicore processors and interconnection networks; parallelizing compilers for non-uniform dependences; OpenMP for heterogeneous processors; virtual machines for HPC; multi-threaded embedded operating systems; accelerating bioinformatics algorithms using field-programmable gate arrays and graphics processing units; hyper-converged computer systems and variable redundancy for flash storage arrays; and machine learning. I will describe applications of HPC in surgery and medical diagnosis and the future challenges in HPC. Additionally, I will discuss some of the new funding opportunities within the NSF Office of Advanced Cyberinfrastructure.

INTRODUCING THE INSTITUTE FOR DATA SCIENCE

The Institute for Data Science focuses on interdisciplinary research and development in all areas pertinent to solving real-world problems using data. The growing abundance and variety of data we amass gives us unprecedented opportunities to improve lives in multifold arenas: health care, financial management, cybersecurity, food safety, manufacturing and smart cities, to name a few.

Within the institute, collaboration among our existing research centers in big data, medical informatics and cybersecurity and our new centers in data analytics and artificial intelligence will generate data-driven technologies to achieve our goals. These centers, which conduct both basic and applied research, cut across all NJIT colleges and schools. Beyond academic research, the institute will interact closely with the outside world to identify and solve important problems in the modern data-driven economy.

The institute also emphasizes multidisciplinary research and workforce skills training to develop technology leaders who will solve global challenges involving data and high performance computing. Our new Master's in Data Science, for example, will train our students to think about what questions to ask of data, how to formulate analytics to answer them, to develop high performance machine learning and to design new techniques to turn data into real-world intelligence. By engaging confidently with complex data science tasks, our graduates will make a difference in organizations large and small.

The institute will be directed by Distinguished Professor David Bader. Bader recently joined NJIT's Ying Wu College of Computing from Georgia Tech, where he was chair of the School of Computational Science and Engineering within the College of Computing. His interests lie at the intersection of data science and high performance computing, with applications in cybersecurity, massive-scale analytics and computational genomics. He works closely with researchers in academia, industry and government to develop the next generation of computing capabilities and has advised the White House on the National Strategic Computing Initiative.

Atam P. Dhawan, senior vice provost for research at NJIT, said: "The new institute and its distinguished director will be a giant leap forward for NJIT's research enterprise. Beyond the increase in basic research that the new institute will generate, we will also collaborate closely in applied research with the thriving tech ecosystem in New Jersey and the New York metro area. These companies are hungry for data science expertise and solutions, and we will be in an excellent position to provide this to them."

LIFE SCIENCES AND ENGINEERING

Institute for Brain and Neuroscience Research
Farzan Nadim and Namas Chandra, Co-Directors

The Institute for Brain and Neuroscience Research (IBNR) takes a multipronged approach toward understanding neural circuits and their disruption. IBNR neurobiologists examine the simple nervous systems of animals such as crustaceans and worms, while mathematicians develop models of neuronal patterns. IBNR biochemists conduct laboratory analyses of the biochemical building blocks of internal mechanisms such as the circadian clock. The Institute is equally committed to mitigating the effects of disabling neurological disorders and injuries by designing devices and therapies that help people function to their full potential. In these efforts, neurorehabilitation and biomechanics engineers work closely with imaging experts who have devised ways to map the brains of people affected by diseases such as Alzheimer's and developmental conditions such as ADHD and dyslexia, as well as changes in brain patterns in response to visual and hearing disorder treatments that our researchers develop. IBNR researchers work closely with clinicians in the region and throughout the country on a variety of therapies. Our biomedical engineers partner with the Kessler Institute and hospital-based rehabilitation centers to develop exoskeletons and other devices that will help people with neurological disorders participate in classrooms and in workplaces; our traumatic brain injury specialists collaborate with New Jersey-based physicians and medical researchers on their work for the U.S. Department of Defense and with clinicians and researchers at pediatric hospitals from Pennsylvania, to Alabama, to California.

Center for Brain Imaging
Bharat Biswal, Director

The long-term goal of the Center for Brain Imaging is to better understand human brain functioning using integrative neuroimaging and statistical and computational modeling methods. We believe it is essential to understand the complexity of brain function and its development in order to develop effective treatments. We have four research themes: human brain functional patterns and their development; reliable neuroimaging measures; functional patterns in animal models; the links between specific psychological processes and brain function and the means by which mental and neurodegenerative diseases disrupt brain function. We use modern neuroimaging techniques (MRI, fMRI, PET, fNRIS) to map the three levels of intrinsic functional brain architecture – regions; subnetworks; and the entire brain. We then direct our investigations to brain development within different stages of life, to computational simulation of the brain's neural connections and to clinical psychology and psychiatry guided by our neuroimaging results. We are working on several disease models, including Alzheimer's, schizophrenia and autism, as well as on the effects of aging and spinal cord injury. Our research is currently funded by the National Institute on Aging and the National Institute of Biomedical Imaging and Bioengineering, the National Science Foundation, the New Jersey Commission on Spinal Cord Research and the N.J. Governor's Council for Medical Research and Treatment of Autism.

Center for Injury Biomechanics, Materials and Medicine
Namas Chandra, Director

The Center for Injury Biomechanics, Materials and Medicine (CIBM^3) is a multi- and interdisciplinary research center focused on understanding, diagnosing and treating brain injuries and concussions using experimental and computational methods. The CIBM^3 is involved in both traumatic brain injury (TBI), a major concern among U.S. soldiers and veterans, and mild TBI and concussion in sports injuries, which also raise serious health concerns. Specifically, through novel blast-tube and drop-tower facilities, we examine what type of helmets, pads and configurations offer the right protection for soldiers and players. We study when and how concussions are caused and if there are simple diagnostic methods to identify concussions. We use animal models and mechanical surrogates to examine the role of blast pressures and the height of falls to relate injury to medical outcomes. Some of our recently funded efforts include examining the effect of blast overpressures on the dose-response curve of animal models and research into the mechanisms of blast-induced brain injury. In yet another project, we use experimental methods to study the effect of eyewear and hearing protection on the TBI susceptibility of warfighters. Namas Chandra, Bryan Pfister and James Haorah, along with other colleagues from NJIT, medical schools and Veterans Administration facilities take a holistic approach to offer new measurement techniques, diagnostics and prognostic tools to address sports injuries and military medicine.

Center for Membrane Technologies

Kamalesh K. Sirkar, Director

The Center for Membrane Technologies investigates problems across multiple sectors that use membrane technologies to separate and purify water, air, industrial-fluid streams, solvents, pharmaceuticals, proteins, biopharmaceuticals, cells, particles and nanoparticles. Membrane synthesis, membrane modification and the development of novel membrane-based separation techniques are of particular interest. Three problems we are researching include solvent-resistant nanofiltration with pharmaceutical applications, the separation of organic solvent mixtures by a membrane, and the development of ultrathin membranes for use in gas separation. The organic synthesis of drugs involves many steps requiring frequent exchanges of solvents, the recovery of catalysts and the concentration of active pharmaceutical ingredients. Nanofiltration membranes capable of resisting solvents are of great value for such operations, as they allow solvents to pass through while retaining solutes with greater molecular weights. We are studying the behavior of novel, inert polymeric membranes for nanofiltration that permit solvent flow, but reject the solutes. We are also investigating the possibility of separating organic solvent mixtures by a membrane. We are exploring novel techniques for making ultrathin films with considerable separation potential for various gas separations, such as carbon capture from power plant emissions.

Center for Rehabilitation Robotics

Sergei Adamovich, Director

The Center for Rehabilitation Robotics is comprised of multiple projects applying robotics, virtual reality, brain imaging and non-invasive brain stimulation to improve the lives of individuals with disabilities. The largest of these, funded by the National Institutes of Health, employs a unique combination of robotics and virtual reality for neurorehabilitation of people with limited arm capability resulting from a recent stroke. Five smaller projects on wearable robots, supported by a multi-year grant from the National Institute on Disability, Independent Living, and Rehabilitation Research, address lower-extremity exoskeletons to restore walking in individuals with stroke; use epidural electrical stimulation to increase spinal cord transmission and improve the use of exoskeletons by people with spinal cord injury; and research new robotic technology for stroke therapy to be used in the home. In two development projects, Center researchers are designing new human-robot interfaces allowing people to control exoskeletons in a biologically natural way. The Kessler Foundation and the Department of Rehabilitation and Movement Science at Rutgers University are major collaborators.

BioDynamics Laboratory

Xianlian Alex Zhou, Director

The BioDynamics Laboratory focuses on computational biomechanics and bioengineering, robotics and human-robot interaction, injury prevention and personalized medicine. The lab aims to develop advanced computational methods and software to simulate and understand the dynamics and neuromuscular control of human locomotion; to analyze biomechanical loadings in different biosystems (such as musculoskeletal, vascular, and respiratory systems) under normal, extreme or injurious conditions. We also design and evaluate wearable assistive devices such as exoskeletons for human performance augmentation or rehabilitation and to develop protective or preventive measures and treatment options against injuries or diseases.

Biomaterial Drug Development, Discovery and Delivery Laboratory

Vivek Kumar, Director

The Biomaterial Drug Development, Discovery and Delivery Laboratory develops novel peptide-based hydrogels that are injected and then self-reassemble in situ in tissue spaces. These constructs can be designed to deliver drugs and other small cargo over day, week or month-long periods. Facile modification of the base peptide allows for the development of novel drugs that can specifically target angiogenesis, neurogenesis, osteogenesis and even the delivery of antigenic sequences for vaccine development. Motivated by translational goals, the lab engages in academic science, biopharmaceutical development, medical device prototyping, drug design and delivery and entrepreneurship. Our current work has led to the establishment of platforms for the treatment of maladaptive angiogenesis, ischemic tissue disease, diabetic ulcer wound healing and dental pulp regeneration, among other therapies.

Biophotonics and Bioimaging Laboratory

Kevin D. Belfield and Yuanwei Zhang, Co-Directors

The Biophotonics and Bioimaging Laboratory combines diverse chemical and biological approaches to develop novel biomaterials and techniques to explore pathological processes. The lab investigates fundamental principles and develops new methods for the interaction of light with biological organisms, tissues, cells and molecules, an area that is regarded as key science for the next generation of clinical tools and biomedical research instruments. We develop novel organic linear and nonlinear optical probes and bioconjugates that can be used to detect subcellular events and for deep tissue in vivo imaging via fluorescence microscopy and light-activated drug delivery and photodynamic therapy. We collaborate with other scientists and clinicians to optimize and apply these technologies to solve problems in biological and biomedical research. Early disease detection and subsequent treatment, viewed as central to disease management, require technologies that combine sensing, targeting and treating. To achieve this goal, the lab develops fluorescent probes for two-photon based deep tissue tumor and angiogenesis imaging for cancer diagnosis and imaging-guided surgery as one example. Functional organic, polymer, inorganic and hybrid nanoparticles are at the core of our efforts. Another aim of our research is to fully understand the basic tenets for the design of materials that will undergo multiphoton absorption, including self-assembled supramolecular photonic materials such as polymer, carbon nanotube and liquid crystal templating, through advanced ultrafast photophysical characterization.

Cardiovascular Tissue Engineering and Stem Cell Laboratory

Eun Jung Lee, Director

The Cardiovascular Tissue Engineering and Stem Cell Laboratory focuses on understanding and developing therapeutic strategies to repair cardiovascular diseases. The lab develops various in vitro cardiovascular tissue models that involve integrated use of stem cells, biomaterials and biomimetic bioreactors. These tissue models are used to investigate the biophysical cues needed for heart and microvascular development. Moreover, diseased tissue models allow us to understand the mechanisms and the interaction between cells and their extracellular environment during pathological conditions, providing a novel means for evaluating new treatments for diseased or damaged cardiac tissue.

Circadian Clock Laboratory

Yong-Ick Kim, Director

The Circadian Clock Laboratory researches the detailed biomolecular mechanisms of the circadian clock, the bodily and behavioral changes tied to the 24-hour daily cycle that synchronize to daylight and darkness. Increasingly, these patterns are disrupted by modern urban culture, including the omnipresence of artificial light and frequent travel across time zones. To explore the biochemical mechanisms that underlie these daily rhythms, we study the reconstituted in vitro circadian clock from a cyanobacteria, Synecochoccus elongates. The bacteria's central oscillator is encoded by three genes, KaiA, KaiB, and KaiC, whose protein products function together to generate a 24-hour rhythm of KaiC phosphorylation. The 24-hour KaiC phosphorylation rhythm is generated by the timely association and dissociation of these three Kai proteins. The laboratory works with biophysicists and mathematical biologists to examine hypotheses about the circadian clock's molecular mechanisms. By exploring them at this level, we expect to obtain critical clues for the treatment of medical problems related to the clock's disruption, including sleep deprivation and jet lag.

Computational Biophysics Laboratory

Cristiano Dias, Director

Research in the Computational Biophysics Laboratory concentrates on the development of computational tools to answer complex questions at the interface of physics, biology and chemistry for medical and industrial purposes. We focus on four areas: designing new biomaterials with superior mechanical strength through the aggregation of proteins into extended fibril-like structures that are biodegradable and biocompatible; investigating the cell toxicity of amyloid proteins responsible for degenerative diseases like Alzheimer's and Parkinson's; developing computational tools to predict how organic molecules in the cell modulate the stability of protein conformations; and understanding how water structures account for the stability of biomolecules and different phases of natural gases. We use multiscale approaches to provide atomic resolution of macroscopic structures in order to understand and control systems, by self-organization or by design, from nanometer to mesoscopic scales. Experimental methods used to validate our simulations include, but are not limited to, cell and single-molecule imaging techniques.

Computational Neuroanatomy and Neuroinformatics Laboratory

Xiaobo Li, Director

The Computational Neuroanatomy and Neuroinformatics Laboratory aims to fill the gaps in the fields of neurobiology and neuroimaging, especially the need for systematically constructed models of quantitative neurobiological criteria that can aid in clinical diagnoses of cognitive deficits associated with severe brain disorders. The Lab focuses on the development and implementation of analytical and statistical models for providing quantitative biological criteria that help identify cognitive deficits by integrating high-dimensional, multi-modal magnetic resonance neuroimaging, clinical and behavioral data and refined imaging analysis and machine learning techniques.

Computational Orthopaedics and Rehabilitation Engineering Laboratory

Saikat Pal, Director

The Computational Orthopaedics and Rehabilitation Engineering (CORE) Laboratory works on decoding the complexities of human movement through experiments and computational methods. In our experiments, we study three-dimensional kinematics, kinetics and electromyography from muscles during movement. Experimental methods alone cannot decode all of the musculoskeletal system's complexities, however, so we also develop and validate computational models of human movement during daily activities. Our insights are used to understand the onset, progression and treatment of musculoskeletal disorders. Current projects include: understanding joint loads during rehabilitation for bone health after spinal cord injury; changes in neuromuscular control strategies with aging; movement patterns in children with cerebral palsy; and building assistive devices for children with cerebral palsy.

Computer-Assisted Tissue Engineering and Blood System Biology Laboratory

Roman Voronov, Director

The Computer-Assisted Tissue Engineering and Blood System Biology Laboratory focuses on high-performance, image-based modeling of complex flows with applications ranging from bone tissue engineering, to blood systems biology, to drug delivery. The lab is currently involved in two major projects. First, we are developing computer-assisted tissue engineering technologies through predictive modeling of stem cell behavior and the control of single-cell migration. Second, we are looking closely at the mechanisms of blood clot formation, which is relevant to thrombotic disorders such as strokes, heart attacks and hemophilia. The tools used for this work involve soft lithography, hardware automation, superresolution microscopy, computer vision and machine learning.

Coppélia Research Laboratory

Carlotta Mummolo, Director

In the Coppélia Research Laboratory, a diverse team of students and researchers studies the behavior and performance of motor skills in biological and robotic systems. Our research is at the intersection of biomechanics, robotics and dynamical systems, leading to translational projects in the field of human motor rehabilitation. We focus on the development of theories, algorithms and robotic prototypes to understand fundamental principles of motor skills such as balance, locomotion and manipulation. This will provide novel models of motor behavior, as well as means for evaluating motor performance, in populations affected by conditions that impair mobility, such as aging, Parkinson's disease and spinal cord injury, among others. Ultimately, the mission of the Coppélia Research Laboratory is to translate our multidisciplinary research effort into improved bio-engineering solutions to human motor assistance and rehabilitation.

Laboratory of Environmental Microbiology and Biotechnology
Mengyan Li, Director

The Laboratory of Environmental Microbiology and Biotechnology seeks to make advances in the fields of applied microbiology and molecular biotechnology, and to develop innovative techniques to mitigate and address environmental issues related to water and energy. We develop water remediation techniques that deploy microorganisms to biodegrade organic pollutants of emerging global concern. We further research interdisciplinary methods to improve urban water treatment technologies, including the application of nanotechnology to disinfect supplies contaminated with pathogens, and we use biomass-derived charcoal to remove metal toxins. We employ surrogate and indicator microorganisms to investigate the potential impacts of engineered nanomaterials and disinfection byproducts once they are released into the environment. To examine the microbial processes in natural and engineered systems, we integrate conventional culture-dependent approaches with state-of-the-art high-throughput molecular technologies, such as cloning, microarray, metagenomics and next-generation sequencing. We design innovative and inexpensive genetic forensic tools for the rapid quantification of microbial populations and functions in the environment. Other projects include mitigation of biofouling in membrane-treatment facilities, the control of microbe-induced corrosion, and the identification of microbial enzymes for biofuel production.

Laboratory of Evolutionary Pattern and Process
Phillip Barden, Director

Work in the Laboratory of Evolutionary Pattern and Process is comparative in nature. We analyze phenotypic and genomic variation across multiple species and lineages to understand the evolutionary history of life and the mechanisms responsible for maintaining biodiversity. Part of this work is historical. We estimate the phylogenetic relationships of living and extinct organisms in a temporal context, quantify ecological change over time, and reconstruct patterns of biogeography and trait evolution. We also work to uncover broad trends in evolution by analyzing behavioral or morphological traits at the lineage or ecosystem level. Because they are ecologically impactful and phenotypically diverse, we primary use eusocial insects, especially ants, as model systems for asking core questions. Our approach is multidisciplinary and combines paleontology, imaging methodology such as micro CT-scanning and confocal microscopy, comparative genomics, and systematics. The lab is currently focused on identifying convergent trends in genome evolution related to advanced social behavior; quantifying links among phenotype, ecology, and extinction; and maximizing data collection from fossil amber.

Fluid Locomotion Laboratory
Brooke Flammang, Director

In the Fluid Locomotion Laboratory, we take a multidisciplinary approach, integrating comparative anatomy and physiology, biomechanics, fluid dynamics, and biologically-inspired robotic devices to investigate the ways in which organisms interact with their environment and drive the evolutionary selection of morphology and function. By combining these different areas, we are able to approach broad-impact ecological and evolutionary questions from an experimental perspective and directly test the effective relationship between an organism and its environment. We use both live animal and robotic models to investigate several ongoing research projects in our lab. One major initiative focuses on the functional morphology of the remora's adhesive apparatus with applications in defense, healthcare, and technologies and devices requiring long-term reversible attachment in wet conditions. Other projects include studying the swimming behaviors of sharks, reptiles, and robotic models to interpret the functional morphology of extinct ichthyosaurs, modeling the passive high-throughput flow dynamics of chondrichthyan egg cases, and investigating the adaptive morphology and comparative biomechanics of fishes that can walk on land.

Instructive Biomaterials and Additive Manufacturing Laboratory

Murat Guvendiren, Director

The Instructive Biomaterials and Additive Manufacturing Laboratory (IBAM-Lab) develops novel biodegradable polymers and hydrogels and fabricates biomaterials, medical devices and tissue-engineered organs using additive manufacturing. Despite significant efforts, the lack of organs and tissue for transplantation poses a major hurdle in medicine. We take a multidisciplinary approach toward developing innovative treatment alternatives using novel biomaterials with 3D-bioprinting. The IBAM-Lab develops biodegradable polymers and hydrogels with user-defined and tunable processibility, mechanics, degradation and functionalizability; engineers medical devices, tissues and organs using 3D-bioprinting; develops material-based technologies to control stem cell differentiation; and fabricates patient-specific in vitro disease models for fundamental studies and drug screening. Additionally, the IBAM-Lab devises novel strategies for biomimetic material design, stimuli-responsive materials, surface patterning and photopolymerization. Our facilities include a wet lab designed for polymer discovery, synthesis and processing, and a biolab for elucidating cell-material interactions in vitro. Additive manufacturing capabilities offer extrusion-based and vat photopolymerization printing, including a multi-functional state-of-the-art EnvisionTec bioplotter.

Keck Laboratory for Topological Materials

Camelia Prodan, Director

The Keck Laboratory for Topological Materials uses interdisciplinary research to investigate the existence of what are known as topological phonons in microtubules (MTs), a naturally occurring biological material. Our theoretical evidence suggests that topological phonons are integral to the function of MTs – a cytoskeletal component in all eukaryotic cells that is essential for many fundamental cellular processes, including cell division and movement. Inspired by the mechanical properties of the microtubules, we work on laying the theoretical and experimental foundation for a new class of engineered materials that exhibit the unique vibrational and thermal properties of topological phonon edge-modes. Such materials may find application in sound deadening and amplification, and the management of heat flow.

Mass Spectrometry Center

Hao Chen, Director

Mass spectrometry (MS) is a fascinating technology with a growing impact on chemical measurement and imaging for a variety of areas, such as analytical chemistry, environmental chemistry, forensic chemistry and life science research. The Mass Spectrometry Center focuses on its use to study proteomics (the analysis of sets of expressed proteins), electrochemistry, organic chemistry and forensic chemistry. In one of our projects, we combine electrochemistry and mass spectrometry to elucidate disulfide bond-containing protein sequences and protein conformational structures. Electroreduction of disulfide bonds is fast and reagent-less, which can be coupled with online mass spectrometry analysis of protein structures in both bottom-up and top-down approaches. Furthermore, our group has successfully combined electrochemistry with cross-linking mass spectrometry to probe protein 3D-structures and conformational changes. Combining these techniques also permits the absolute quantitation of peptides and other organic compounds without the use of standards or calibration curves.

Material Analysis in Biological Systems Laboratory

Kathleen McEnnis, Director

The Material Analysis in Biological Systems Laboratory investigates the interaction of polymer drug delivery vehicles with the biological environment, including cells, blood, proteins and physiological temperature, using physical chemistry techniques in novel ways to design successful particles for drug delivery. Drug delivery vehicles are an ideal treatment for many diseases. In practice, however, their design is challenging, and few are currently used clinically. The interaction of the biological environment with drug delivery vehicles is not well understood, and by addressing this gap, better and more successful models can be designed. The Materials Analysis in Biological Systems Laboratory investigates novel techniques to analyze nanoparticles in blood, nanoparticle aggregation and protein corona formation in blood, particle glass transition temperature in biological conditions and the cellular uptake of particles.

Laboratory of Nanomedicine and Healthcare Biomaterials

Xiaoyang Xu, Director

The Laboratory of Nanomedicine and Healthcare Biomaterials aims to develop new biomaterials and nanotechnologies for a variety of medical applications, including diagnosis, bioimaging, controlled drug delivery and regenerative medicine. We look at both fundamental and applied questions in the cross-disciplinary fields of biomaterials, nanomaterials and medicine in order to develop novel therapeutic methods for the treatment of cancer, obesity, cardiovascular disease and many other conditions and diseases. One specific goal is to develop multifunctional polymeric nanoparticles for medical applications, including drug-delivery mechanisms and regenerative medicine, such as the development of targeted nanoparticles to deliver therapies to the brain. Another major thrust of our work involves developing synthetic biomaterials and processing techniques to fabricate hydrogels and scaffolds with degradable and biocompatible properties for use in drug delivery and tissue engineering. In particular, we focus on biomaterial engineering to understand structure-function relationships and to investigate the effects of biomaterial characteristics on the deployment of therapies and on cell and tissue interactions.

Neural Dynamics Laboratory

Farzan Nadim, Director

Neurons and the circuits they form produce electrical activity in a complex way that cannot be understood simply on the basis of a synaptic wiring diagram. Neuronal signaling is shaped by a multitude of nonlinear dynamic properties that operate on multiple time scales. The gating properties of ion channels, short-term synaptic plasticity, neuromodulation, as well as long-term regulatory mechanisms, all contribute to activity- and time-dependent changes in excitability. The Neural Dynamics Laboratory uses various electrophysiological techniques, such as extra- and intracellular recording and voltage clamps, molecular biology, confocal microscopy, computational modeling and dynamical systems mathematical approaches to characterize these phenomena. We also perform cell ablations and have pioneered the use of realistic voltage waveforms in the measurement of ion channel and synaptic currents. We use both experimental and theoretical approaches to study the neurophysiology of the stomatogastric ganglion, a small central-pattern-generating (CPG) circuit in lobsters and crabs. CPGs are neuronal networks in the central nervous system that generate the basic patterned electrical activity underlying most rhythmic behaviors like walking and breathing in all animals. We take advantage of the experimental accessibility of the crustacean nervous system to uncover fundamental principles that govern neural processing across all animal and human nervous systems.

Neural Engineering for Speech and Hearing Laboratory

Antje Ihlefeld, Director

The Neural Engineering for Speech and Hearing Laboratory examines how the brain processes sound through psychophysical, physiological and computational modeling experiments. We focus in particular on the experience of people with hearing loss who use cochlear implants, electronic devices that function as the inner ear by sending sound signals to the brain. While these implants work well in quiet settings, they are much less effective in situations with background noise. Normal-hearing listeners overcome this hurdle by tracking quality differences between target voice and background interference, easily distinguishing, for example, between men's and women's voices. By contrast, cochlear implant users have poor pitch sensitivity and typically can't make these distinctions. Why is this gap critical? The inability to hear in daily social settings — restaurants, meetings and parties — can lead to isolation and depression. A recent landmark study showed it also causes cognitive decline. We aim to identify the behavioral and neuronal mechanisms for hearing disruption caused by background noise to advance our understanding of how hearing loss affects the capacity to ignore competing sounds — and to develop remediation strategies that will improve cochlear implants.

Laboratory of Neuroethology of Locomotion

Gal Haspel, Director

The Laboratory of Neuroethology of Locomotion studies the neurobiology of locomotion: How do nervous systems generate coherent muscle activity to propel animals in their environment? In particular, we focus on the levels of neuronalcircuits coordination in the locomotion of the nematode, C. elegans. This 1-millimeter-long roundworm moves through its environment by counteracting muscle contractions activated by a nervous system, as do all other animals, while also using the same molecular and cellular mechanisms, such as neurotransmitters and neuromodulators. Moreover, it offers several advantages as a research model: its nervous system is compact and includes only 302 neurons; it is small and transparent and fits under a microscope; and it is the only animal whose genome and nervous system have been completely mapped. This allows us to use a combination of optical methods to record and control neuronal activity together with transgenic methods to direct these tools to their targets. We use focused laser light to precisely dissect neuronal processes to study the circuit response to injury and regeneration and high-resolution techniques to map neuronal connectivity. More broadly, our research goal is to determine rules that govern the connectivity, activity and robustness of neuronal networks that generate behavior.

Laboratory of Neurovascular Inflammation and Neurodegenerative Diseases

James Haorah, Director

The Laboratory of Neurovascular Inflammation and Neurodegenerative Diseases examines the underlying molecular, biochemical and cellular mechanisms of oxidative damage of the neurovascular units in substance abuse, NeuroAIDS and traumatic brain injury. The layer-structure of the neurovascular components consists of the endothelium bloodbrain barrier (BBB) – the interface between the cerebral blood flow and the brain, the pericytes, astrocytes, microglia, and neurons. We hypothesize that protecting the BBB is key to the prevention of neurological diseases, because oxidative damage of the BBB facilitates immune cell infiltration, neuroinflammation and interruption of endothelial-astrocyteneuronal energetic interactions. The impairment of nutrient transport into the brain interrupts vital cellular processes. Among several research areas, we examine the co-morbid effects of alcohol and drug abuse in promoting the transmission and progression of HIV-1/AIDS; we also study the idea that chronic methamphetamine use causes cerebral vascular hemorrhage, which promotes degradation of the BBB components and delayed cerebral wound healing. Such a persistent, undiagnosed subarachnoid hemorrhage and surrounding neuropathy promotes neurological disorders and fast aging in Meth abuse.

Laboratory for Neurobiology and Behavior

Eric Fortune, Director

Research in the Laboratory for Neurobiology and Behavior examines the interactions between sensory and motor systems that are used to generate and control animal behavior. Experiments in the lab focus on two main questions: how sensory representations of movement are encoded by sensory systems and translated into motor commands, and how pairs of animals integrate social cues in the control of cooperative behaviors. We use methodologies that encompass varying levels of biological organization, from the computational consequences of transmembrane molecules to the behavior of multispecies flocks. Our work includes field studies of natural behavior in Amazon basin habitats, highly controlled behavioral studies in the laboratory, and a variety of neurophysiological approaches to central nervous system neurons in animals, pharmacological studies and mathematical modeling.

Neural Prosthetics Laboratory
Mesut Sahin, Director

The primary research focus of the Neural Prosthetics Laboratory (NPL) is to develop novel and translational neural prosthetic approaches and implantable devices in order to restore function in people with neurological disabilities resulting from injuries to the central nervous system, as in spinal cord injury, traumatic brain injury and stroke. At the same time, we aim to increase our knowledge about the role of the spinal cord and the cerebellum in motor coordination and sensorymotor integration. One of our current projects involves the extraction of volitional signals from the descending fiber tracts of the spinal cord. The goal is to utilize these signals in spinal-cord-injury patients to allow them to control a robot arm to perform daily activities. The Lab has also developed micro-devices that are activated by a near-infrared light beam for wireless neural stimulation in parts of the central nervous system where tethered electrodes cannot be implanted. We have demonstrated in an animal model that evoked potentials collected from the cerebellar cortex can provide a reliable metric to monitor the progression of brain injury following head trauma. We are now investigating the effects of DC electric currents as a treatment option for cognitive disorders in animal models.

Neuroecology of Unusual Animals Laboratory
Daphne Soares, Director

How do nervous systems evolve and adapt to extreme environments? Evolution through natural selection has shaped nervous systems to generate behaviors. However, there are very few opportunities to study neural-circuit evolution where the ancestral and derived forms, as well as the adaptive environment, are all known and accessible. The Neuroecology of Unusual Animals Laboratory studies the synthesis of neuroethological and ecological principles to understand the evolution of neural adaptation. In our research, we have a three-pronged approach that examines the evolution of circuitries, molecular mechanisms of behavior, and sensory novelty. This integrative approach links a detailed characterization of the environment with the anatomy and function of neural systems within a phylogenetic context.

Opto and Microfluidics Laboratory
Sagnik Basuray, Director

The Opto and Microfluidics Laboratory establishes synergies among novel nanostructures, optics, biology and electrokinetics in order to develop disruptive new technologies in sensors, diagnostics, drug delivery systems and biofilms, using cost-effective tools. Among other aims, the Lab advances knowledge of interfaces and surface physics. Current research includes the development of a shear-enhanced electrochemical biosensor platform that meets the "ASSURED" criteria set by the World Health Organization for point-of-care (POC) devices. The biosensor is being used to develop a POC test for cancer panels, such as breast cancer. In collaboration with the Pacific Northwest National Lab, the sensor is being optimized for detection of PFAS (per- and polyfluoroalkyl substances), man-made chemicals in sourcewater. The same platform is being used to purify antibodies without post-modifications in order to preserve antibody functions. In collaboration with researchers at Rensselaer Polytechnic Institute, the Lab is developing a water purification membrane technology in which membranes are coated with the latest semiconductors, including graphene, metal oxide semiconductors and ReS2, a rhenium sulfide mineral. In another project, the Lab has designed a microfluidic organ-on-a-chip platform to study interactions between nanoparticles and the blood-brain barrier.

Organic Reactions and Mechanisms Laboratory
Pier Champagne, Director

The Organic Reactions and Mechanisms Laboratory focuses on the development of novel approaches toward organic molecules and the study of how chemical reactions happen at the molecular level. To this end, we combine experimental and computational tools to invent, understand and improve transformations in organic synthesis. Our current research focuses on organoboron compounds, molecules that have a carbon-boron bond, which are amongst the best reagents to synthesize complex molecules in pharmaceutical research. Ongoing projects include the synthesis of complex alkenes and alkanes, compounds which have been used for the treatment of breast cancer, but are still difficult to synthesize, the investigation of organic mechanisms using physical organic chemistry tools, and the study of important reactions catalyzed by organic molecules, using theoretical calculations based on density functional theory."

Swarm Lab

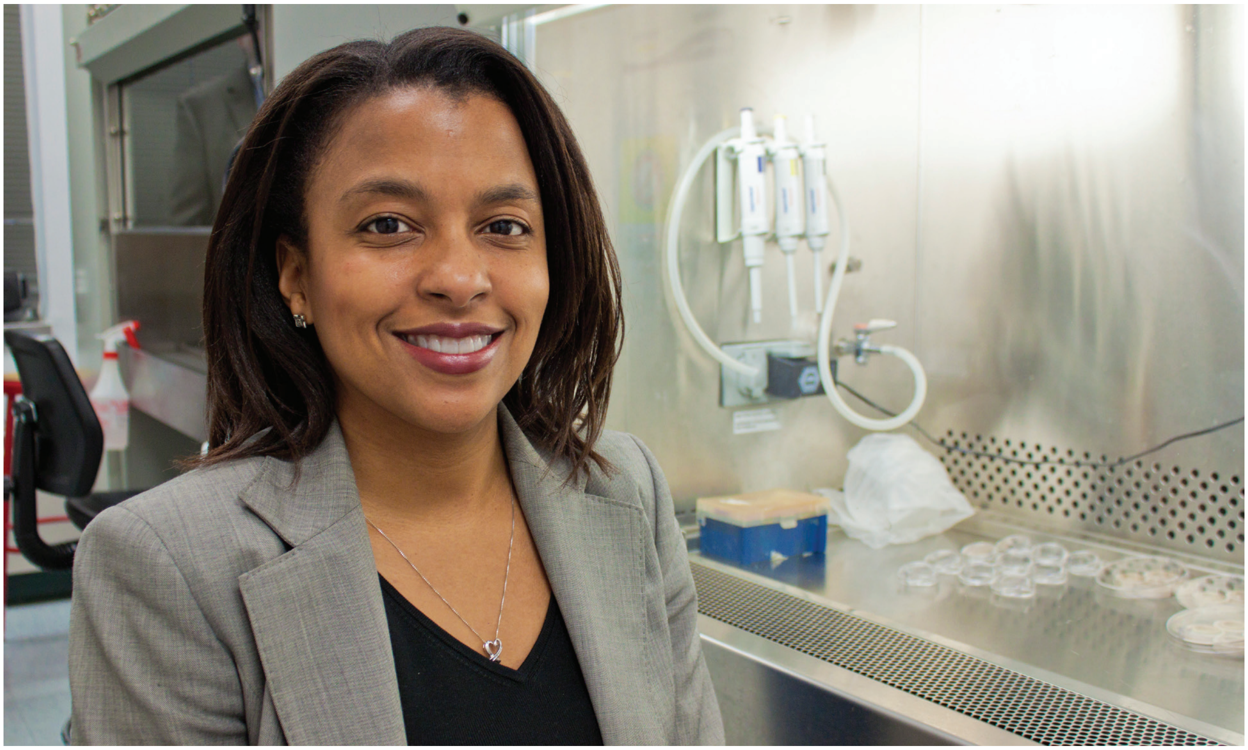
Simon Garnier, Director

The Swarm Lab is an interdisciplinary research unit that explores the mechanisms of swarm intelligence. We study how information is exchanged and transformed during interactions between members of a group and how this leads to "intelligent" group behaviors. We focus on the coordination of large animal groups, such as ant colonies, ungulate herds, baboon troops and human crowds. We use this knowledge to develop applications to problems such as the organization of pedestrian traffic and the control of miniature robotic swarms. We collaborate with biologists, social scientists, physicists, mathematicians and computer scientists around the world to elucidate the principles that underlie collective behavior across levels of biological and social organization. Current projects include research into the decision-making abilities of neuron-less organisms such as the slime mold; the organization of traffic and supply chains in leaf-cutting ants; the dynamic construction behavior of nomadic army ants; the role of vocal communication in the coordination of activities in mammal groups; the impact of poaching on movement decisions and social structure in African elephant herds; and the application of swarm intelligence principles to predictive policing software.

Tissue Engineering and Applied Biomaterials Laboratory

Treena Livingston Arinzeh, Director

The Tissue Engineering and Applied Biomaterials Laboratory develops functional biomaterials for regenerative medicine applications. Recent discoveries in the tissue-engineering field have shown that the microenvironment can influence stem cell self-renewal and differentiation, which has had a tremendous impact on identifying potential strategies for using these cells effectively in the body. This laboratory develops functional biomaterials that impart cues to stem cells, either already present within the body or implanted, to affect their behavior. These biological cues stimulate growth in bone and spinal cord tissue, for example. Our laboratory has pioneered the use of bioactive ceramics and composites for use in bone-tissue engineering. Novel bioinspired materials such as glycosaminoglycan (GAG) mimetics and piezoelectric materials also are being developed for bone, cartilage and neural applications. GAG mimetics combine with growth factors to stimulate tissue growth and piezoelectric materials provide electrical stimulation to cells. Current funding is from federal, state and private agencies.



Vision and Neural Engineering Laboratory

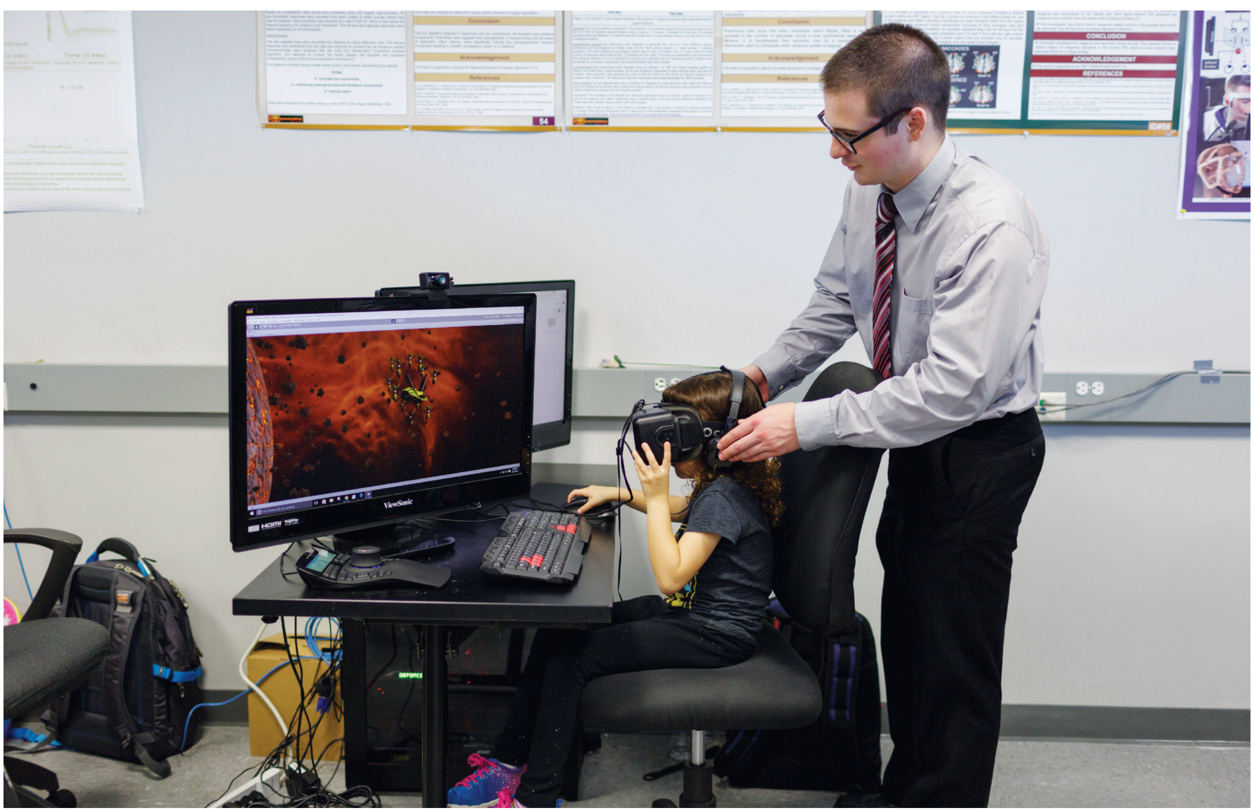
Tara Alvarez, Director

Convergence Insufficiency (CI) is a prevalent binocular vision disorder that disrupts coordination of the eyes as they turn inward to focus on a near object. Symptoms, which include double and blurred vision, eyestrain and headaches during reading or other close work, negatively impact activities of daily living and can significantly impair a child's ability to focus and learn, for example. CI is present in about 5 percent of the population; just over a quarter of these patients do not improve even with validated therapy. While office-based therapy is effective in about 75 percent of patients with CI, home-based therapies are no more effective than a placebo. Our National Institutes of Health-funded project studies two potential mechanisms that may cause CI that we believe could be improved through therapy. This knowledge could lead to targeted therapeutic interventions, improved treatment success rates, reduction in the time to remediation and reduced healthcare costs. The Laboratory is also funded by a life-science focused venture capital fund and through an IEEE EPICS grant to develop a virtual reality-game therapy device with NJIT's Computer Gaming Program, Salus University and The Children's Hospital of Philadelphia.

Zebrafish Neural Circuits and Behavior Laboratory

Kristen Severi, Director

The Zebrafish Neural Circuits and Behavior Laboratory researches the neural circuits underlying locomotor behavior in the larval zebrafish. These tiny fish with transparent bodies are ideal for studying in real time how the brain and spinal cord work together to produce everyday movements the fish needs to swim around its environment. The techniques we employ are multidisciplinary, including high-speed behavioral recordings and analysis, dynamic imaging of calcium activity within populations of neurons and electrophysiology. Using these techniques, we try to understand what specific circuits are essential for performing different motor actions and how those circuits are wired together.



SUSTAINABLE SYSTEMS

Institute for Space Weather Science

Haimin Wang, Director

The Institute for Space Weather Science (ISWS) promotes multi-disciplinary research and education on space, with a focus on the powerful bursts of electromagnetic radiation, energetic charged particles and magnetized plasma known as space weather. To understand and predict the physics of solar activities and their effects on space weather, the Institute combines the strengths of three NJIT research centers – the Center for Solar-Terrestrial Research, the Center for Computational Heliophysics and the Center for Big Data. At the Institute's core is the Center for Solar-Terrestrial Research (CSTR). With its array of unique instruments on land and in space – the world's largest operating solar telescope, a newly expanded radio array with 15 antennas, instruments aboard NASA's Van Allen Probes spacecraft and devices deployed across Antarctica, to name a few – the Center is uniquely poised to advance understanding of the genesis, acceleration and impact of solar storms, as well as provide a comprehensive view of solar activity over months and years. Joining the CSTR are modeling and big data analytics experts at the Center for Computational Heliophysics who partner with NASA's Advanced Supercomputing division at the NASA Ames Research Center, and researchers at the Center for Big Data. The latter's mission is to synergize expertise in various disciplines across the NJIT campus and to build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance. Within a year of its establishment, the Institute obtained a $840,000 National Science Foundation (NSF) EarthCube award, aimed at the transformation of geosciences research and education and sponsored through a partnership between the NSF Directorate of Geosciences and the Office of Advanced Cyberinfrastructure in the Directorate for Computer and Information Science and Engineering. Faculty members from all of the participating centers will participate in this research.

NJIT Center for Building Knowledge

Deane Evans, Director

The Center for Building Knowledge (CBK) is a 31-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. The Center is dedicated to generating new knowledge to improve the built environment and enhance the planning, design, construction and operation of facilities. CBK's mission is to help individuals and communities make better-informed decisions about the performance, sustainability and resilience of buildings and communities. The Center created and currently manages the New Jersey Clean Energy Learning Center, a unique online energy-efficiency training and resource platform for the New Jersey Clean Energy Program. CBK also manages and is currently updating a national online training platform funded by the U.S. Department of Energy (DOE) and focused on training building owners and operators on how to use the DOE's Asset Score energy optimization tool. The tool evaluates the energy efficiency of key physical assets within a facility – its building envelope, lighting and HVAC systems – and tabulates an "asset score." In addition, CBK recently received a three-year grant from the DOE's Building America program. The Re-Side Right project will test and validate a new, two-component insulation/air/water barrier system that can be used to significantly improve the energy efficiency of typical re-siding jobs in the U.S.

Center for Energy Efficiency, Resilience and Innovation

Haim Grebel and Roberto Rojas-Cessa, Co-Directors

The Center for Energy Efficiency, Resilience and Innovation (CEERI) conducts research and development, provides technical and educational assistance for the deployment of sustainable technologies and applications to manage energy and water resources and promotes public awareness of energy resources. The activities of CEERI are interdisciplinary. With support from state, federal and business partners, CEERI's main focus is identifying and implementing cost-effective measures that reduce operating costs and environmental impacts with the deployment of sustainable technologies and applications related to energy and water. The Center is a collaboration between the industry and NJIT.

Electronic Imaging Center

Haim Grebel, Director

The Electronic Imaging Center is an interdisciplinary center focused on nanotechnology, spectral analysis with subwavelength structures and energy. Nanotechnology is a field dealing with underlined phenomena at the nanoscale. It covers diverse phenomena that encompass molecular and biological interactions, interfacial science, as well as bulk and surface properties. The field is fast expanding into agriculture, energy and pharmaceutical sectors. Spectroscopy with subwavelength structures is a field important to pollution detection, remote sensing and imaging at resolutions surpassing the diffraction limits. It is related to nanoscale phenomena, but can also find applications in the infrared and the THz frequency range. Energy is fast becoming a crucial commodity: its transmission, delivery and storage are key to the development of the U.S. economy and to the safeguarding of national security. Ongoing projects that focus on one or several aspects of the above include graphene-coated nano-optical antennas for molecular detection, tunable supercapacitors for energy storage, digital energy for efficient energy management and white-light sources.

Elisha Yegal Bar-Ness Center for Wireless Information Processing

Alexander Haimovich, Director

The Elisha Yegal Bar-Ness Center for Wireless Information Processing (CWiP) researches diverse areas of communications, signal processing and radar. Principal areas of research include cloud radio-access networks (C-RAN), cooperative networks, distributed radar, fuze radar, SIGINT and acoustics communications. Our research on C-RAN, the virtualization of basestation functionalities in a cellular system via cloud computing, explores novel cellular architectures and C-RAN inspired by network information-theoretic principles. In decentralized networked systems, a fundamental challenge is coordinating the activities of different nodes so they reach a state of consensus. We focus on applications to distributed surveillance applications, automatic vehicle-control applications, and load balancing with divisible tasks in large computer networks or power grids. In radar, distributed architectures offer wide coverage and improved performance against low radar cross-section targets. We detect and track ground-moving targets embedded in ground clutter with sensors that are time-synchronized, but not phase synchronized; the sensors communicate with a central processing center. We also design new waveforms that improve the performance of current fuzing radars. In the realm of military applications, we work on methods for separating unknown mixtures of wireless signals. In other applied research, we research wireless communication by way of acoustic propagation to achieve high transmission rates. In the oil drilling industry, for example, real-time transmission of data such as temperature, pressure, torque and drilling direction from downhole to the surface is vital. Since boreholes are typically very deep, wired communication is expensive and prone to failure.

Membrane Science, Engineering and Technology Center

Kamalesh K. Sirkar, Director

The Membrane Science, Engineering and Technology Center, a National Science Foundation Industry/University Cooperative Research Center, conducts basic research and related development on innovative materials and processes that facilitate the use of membrane technology. The Center also provides timely and effective technology transfers between the Center's researchers and its sponsors, including both industry sponsors and U.S. government laboratories. With the research preformed primarily by graduate students, the Center promotes education in membrane science and technology. The research topics are decided by corporate members of the Industrial Advisory Board. This Center is located at three university research sites: NJIT, the University of Colorado at Boulder and the University of Arkansas at Fayetteville. NJIT faculty members from the following departments are active in this Center: chemical, biological and pharmaceutical engineering; chemistry and environmental science; civil and environmental engineering; biomedical engineering; and electrical and computer engineering.

Center for Natural Resources

Michel Boufadel, Director

The Center for Natural Resources investigates practical and efficient approaches to environmental and energy resource utilization. Research projects include assessment and remediation studies of pollution in natural settings and the evaluation of natural resources for the potential production of energy, especially renewable energy. Current projects include determining the trajectory of the underwater oil plume in the Gulf of Mexico and evaluating remediation techniques for oil spills, including using microorganisms to break down the oil. Projects have also been initiated to study the impact of oil releases in high salinity (brine) pools, commonly encountered at depths exceeding a mile in the ocean and the Gulf of Mexico. Little is known to date about the effect of high-salinity water on the behavior of either oil or spill countermeasures, such as applied dispersants.

New Jersey Center for Engineered Particulates

Rajesh Davé, Director

The creation of advanced particulate materials and products through particle engineering is a major research focus of the New Jersey Center for Engineered Particulates (NJCEP). The Center's research combines experimental, computational and theoretical studies to achieve an understanding of particle properties at the individual particle scale to predict particle and product behavior at the macro-scale. NJCEP research has applications in the pharmaceutical, food, cosmetics, ceramics, defense, electronics and specialty chemicals industries. Center researchers have more than a dozen granted patents. An example of a noteworthy licensed technology is a solvent-free particle coating process with applications in taste-masking and the controlled release of drugs. NJCEP is funded by federal and industry sources, including through its participation in the National Science Foundation (NSF) – Engineering Research Center, which is focused on improving pharmaceutical manufacturing processes. NJCEP has developed several pharmaceutical technology platforms, including a thin stripfilm real-time release methodology, funded by NSF and the U.S. Food and Drug Administration, for delivering nano and micron-sized poorly water-soluble active ingredients for enhanced therapeutic effects. Currently, NJCEP is developing patient-compliant drug-delivery vehicles for pediatric and geriatric care, with commercial applications.

NJIT Center for Resilient Design

Deane Evans, Director

The Center for Resilient Design (CRD) is a seven-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. Established in the immediate aftermath of Super Storm Sandy, CRD's founding mission was to serve as a resource to help New Jersey communities recover from the effects of Sandy – first as a special program within the College of Architecture and Design (COAD) and then as a full-fledged center within the university. These activities soon evolved into broader explorations of how these same communities could become more resilient in the face of future events. Building on lessons learned in New Jersey, the Center has become a research, technical assistance and training institution focused on improving the resilience of buildings and communities in the face of natural disasters and other stresses to inform and support disaster-resilience initiatives in other jurisdictions across the U.S. and beyond. CRD recently completed and launched a new, online educational platform – the Community Microgrids Planning Academy – to help jurisdictions across New Jersey create microgrid development plans to improve the energy performance and resilience of their communities. The project – funded by the U.S. Department of Housing and Urban Development and managed by the N.J. Department of Community Affairs – was designed to constitute the first component of a comprehensive educational program that addresses first the planning and then the technical feasibility and financing/procurement phases of a microgrid development project. Funding for these activities has recently been secured from the New Jersey Clean Energy Program for the technical feasibility module and from the U.S. Department of Energy (through the New Jersey Board of Public Utilities) for the financing/procurement module. The Planning Academy also received a prestigious Award of Merit for "Innovations for High-Performance Buildings and Communities" from the National Institute of Building Sciences' 2018 Beyond Green Awards program.

Polar Engineering Development Center

Andrew Gerrard, Director

The Polar Engineering Development Center (PEDC), housed within NJIT's Center for Solar-Terrestrial Research, consists of a highly skilled group of professors, research scientists, electrical and mechanical engineers and technicians who bring decades of experience in instrument and hardware design for deployment at high latitudes and Polar regions. The group was formed in the 1980s as part of the National Science Foundation-supported Automatic Geophysical Observatory (AGO) program, which operates to this day on projects active across the Antarctic ice shelf. Today, the PEDC is reaching out to serve the broader astrophysical and geospace scientific communities conducting research in Polar environments by providing support in the areas of sustainable "green" power generation in the 10-W to 100-W range; power conditioning and control; robust engineering for Polar climates; data acquisition techniques, units, and transmission services; and general Polar field support. As an NSF-sponsored facility, the PEDC manages instruments at South Pole Station, McMurdo Station, Palmer Station and across the Antarctic ice shelf.

Center for Solar-Terrestrial Research

Andrew Gerrard, Director

The Center for Solar-Terrestrial Research (CSTR) is an international leader in ground- and space-based solar and terrestrial physics, with a particular interest in understanding the effects of the Sun on the geospace environment. CSTR operates the Big Bear Solar Observatory and Owens Valley Solar Array in California, the Jeffer Observatory at Jenny Jump State Forrest in New Jersey and the Automated Geophysical Observatories distributed across the Antarctic ice shelf. The CSTR also manages a large number of instruments at South Pole Station, McMurdo Station and across South America and the United States. CSTR is one of the principal investigators in NASA's Van Allen Probes mission, which explores the radiation and plasma environment around Earth, and houses the Space Weather Research Laboratory, which conducts scientific research in the area of space weather with the mission to understand and forecast the magnetic activity of the Sun and its impact on Earth. Such instrumentation and data resources enable scientific studies ranging from the Sun's surface to its extended atmosphere, and into Earth's atmosphere.

Center for Solar-Terrestrial Research–Big Bear Solar Observatory

Wenda Cao, Director

The Center for Solar-Terrestrial Research operates Big Bear Solar Observatory (BBSO) in California, which houses the highest-resolution solar optical telescope in the world at 1.6 meters. With its state-of-the-art adaptive optics and scientific instrumentation, the telescope obtains high-resolution views of the Sun's surface features, such as sunspots, filaments, faculae, granulation, spicules and jets. Its instruments measure the magnetic fields and motions of these features to understand the basic physics of solar activity that affect the Earth and near-Earth technological systems. Through the BBSO telescope, NJIT scientists have explored how twisted magnetic fields interact to produce the sudden release of energy that powers solar flares, and the response of the solar plasma to such energy releases. Using data from multiple NASA solar spacecraft and advanced computer modeling, we are developing an understanding of fundamental processes that improve our ability to predict the occurrence and outcomes of such solar activity on the Earth.

Center for Solar-Terrestrial Research–Expanded Owens Valley Solar Array

Dale Gary, Director

The Center for Solar-Terrestrial Research (CSTR) operates the Expanded Owens Valley Solar Array in California, a recently completed major expansion operating as one of the most capable solar-dedicated radio arrays in the world. The array consists of 15 antennas and is used to image solar flares at hundreds of frequencies over the frequency range 2.5-18 GHz within one second. Its ability to follow evolving radio emissions with such high frequency and time resolution allows us to capture and quantify the energy release, acceleration and transport of energy in flares. In addition, the array will image the slower timescale emissions of sunspot regions on 30-minute timescales, and the full disk of the Sun on 6-12 hour timescales. Among other advantages, such data will provide the first daily coronal magnetograms, maps of magnetic field strength 1,500 miles above the Sun's surface, which will open a new window on the processes of solar activity. Our research has included the discovery that radio emissions from the Sun can directly affect cellular communications and navigation systems, such as GPS at the CSTR.

Advanced Energy Systems and Microdevices Laboratory

Eon Soo Lee, Director

The Advanced Energy Systems and Microdevices Laboratory is dedicated to research on new nanomaterials for advanced energy systems and new microdevices for disease detection and diagnosis for biomedical applications. The Lab's energy research focuses on the non-platinum group of metal (non-PGM) catalysts to replace PGM catalysts for electrochemical-energy systems, such as fuel cells and batteries, and industrial applications such as filtering systems and petroleum-processing systems. Principal research includes synthesizing and characterizing new, high-performance non-PGM catalysts from carbon materials such as graphene, and understanding the fundamental mechanisms of the reaction. The Lab's microdevices research concentrates on applying micro- and nanotechnology to diagnose complex diseases, such as cancers, at their early stages using a nano-biochip. The biochip incorporates microchannels with a self-driven flow mechanism of biofluid and nanocircuits to sense the existence and the level of severity of a disease with high sensitivity and selectivity. Our research has been supported by the National Science Foundation, the New Jersey Health Foundation, NJIT and a private company, Abonics, Inc.; we work in collaboration with and support from the John Theurer Cancer Center at Hackensack University Medical Center, Brookhaven National Laboratory-Center for Functional Nanomaterials, CUNY's Advanced Science Research Center, Rutgers University and Montclair State University. We have obtained several patents for our technology innovations.

Applied Electrohydrodynamics Laboratory

Boris Khusid, Director

The Applied Electrohydrodynamics Laboratory explores electric and magnetic field-driven phenomena in suspensions, which are mixtures of solid particles and a liquid. Suspensions are a ubiquitous feature of our daily environment — paints, blood, milk, inks — while they are also utilized in a wide variety of industries. Ongoing projects in the lab focus on understanding how the electric and magnetic interactions between particles affect their arrangement, and thereby, their suspension properties. Practical applications are related to the development of electro-magnetic methods utilizing a difference in polarizability between suspended particles and a suspending liquid for the precise manipulation, separation and sorting of particles in suspensions. These methods do not require moving parts and employ an electrical or magnetic force acting on a particle that is insensitive to the particle charge, which is difficult to control.

Laboratory of Applied Biogeochemistry for Environmental Sustainability

Lucia Rodriguez-Freire, Director

The goal of the Laboratory of Applied Biogeochemistry for Environmental Sustainability is to understand and control the complex mechanisms of contaminant transformations in natural and engineered environments in order to engineer remediation and resource recovery technologies that mimic natural sustainable processes. Biogeochemical interactions play a key role in controlling the speciation and mobility of metals in the environment through direct metabolic processes such as metal uptake, biotransformation and biomineralization, or indirectly by changing ambient redox/pH conditions, producing ligands or new biominerals and altering mineral surfaces. Current research projects include the biological-mediated recovery of valuable elements from wastes, such as rare earth elements from mine waste and biopolymers from wastewater; the design of biomimetic membranes for selective separation of heavy metals from wastewater; the description of the mechanisms affecting corrosion control in water distribution systems; and the investigation of transformations controlling the fate of metal and organic contaminants in rhizosphere horizons.

Analytical Chemistry and Nanotechnology Laboratory

Somenath Mitra, Director

The Analytical Chemistry and Nanotechnology Laboratory is located in the Department of Chemistry and Environmental Science. Our research focuses on the fields of analytical chemistry, nanotechnology and water treatment. In analytical chemistry, we develop instrumentation for online and real-time monitoring analysis, environmental monitoring, field-portable instruments and microfluidic devices. In nanotechnology, we work on nanoparticles, particularly nanocarbons such as carbon nanotubes and graphene, with applications in the energy and environmental technologies sectors. In the area of energy, we focus mainly on batteries and supercapacitors, with prior work on solar cells. To improve water quality, we develop novel sorbents and membranes, for which our main thrust is desalination and water treatment. Our work on nanocarbon-based membranes focuses on various associated applications, such as membrane distillation. And lastly, to improve drug-delivery systems, we use nanotechnology to make hydrophobic drugs dissolve more effectively.

Assistive and Intelligent Robotics Laboratory

Lu Lu, Director

The Assistive and Intelligent Robotics Laboratory conducts research on robotic theory and applications that help people in need and benefit society in various ways. There are two primary research areas for this lab: assistive robotics and intelligent unmanned aerial vehicle (UAV) systems. The assistive robotics research aims to help individuals in need with daily activities at home using advanced human-robot interaction techniques. The UAV research develops new types of drones capable of dexterous locomotion and manipulation in the air, which can be applied to a variety of practical applications such as automated infrastructure maintenance, tree pruning and subterranean mapping and investigation.

Atmospheric Chemistry Laboratory

Alexei Khalizov, Director

The Atmospheric Chemistry Laboratory investigates the origins of atmospheric pollution and evaluates its environmental impacts. Since many pollutants, such as ground-level ozone, are formed directly in the atmosphere through a sequence of complex chemical and physical processes, an understanding of these processes is required to develop appropriate control measures for pollution prevention. The two ongoing research projects in our lab focus on atmospheric aerosols and atmospheric mercury. Atmospheric aerosols originate from direct particle emissions and also from gas-to-particle conversion. We study how atmospheric aerosols form and evolve, and also assess the impacts of aerosols on the climate and human health. We conduct experiments to investigate the atmospheric processing of combustion-generated soot particles and the relationship between particle morphology and optics. Additionally, we develop hyphenated mass-spectrometry instrumentation for chemical analysis of aerosol particles and their gas-phase precursors. The goal of our mercury project is to understand the chemistry and speciation of this persistent, bioaccumulative pollutant emitted to the atmosphere in large quantities by coal-fired power plants. We study gas-phase oxidation of mercury and its interactions with atmospheric surfaces, and we also develop new detection techniques for atmospheric oxidized mercury based on chemical ionization mass spectrometry.

Biophotonics Sensing and Imaging Laboratory

Xuan Liu, Director

The Biophotonics Sensing and Imaging Laboratory investigates advanced biophotonics technologies with a focus on optical coherence tomography (OCT). We have in-house capabilities to develop novel optical imaging systems for a variety of applications, including the design of optical imaging systems, optical component alignment, algorithm development and real-time signal processing. In one of our funded research projects, we investigate dual-modality OCT imaging that performs structural and mechanical characterization of breast tissue to achieve higher accuracy in breast cancer diagnoses. We also collaborate with industrial partners to develop OCT sensor-guided surgical instruments and an ultrafast 3D imaging technology.

Computational Laboratory for Porous Materials

Gennady Gor, Director

The main focus of the Computational Laboratory for Porous Materials is nanoporous materials, solids with pores of 100 nanometers and below. Such materials play a significant role in both nature and technology. Synthetic nanoporous materials are widely used in the chemical industry as adsorbents, catalysts and separation membranes, among other uses. Naturally occurring nanoporous materials include coal and shale, key fuels in the production of energy. Another research focus is soot agglomerates, which are not porous, but rather nanostructured materials with features on the same scale as nanoporous solids. We work on the wide spectrum of phenomena related to the interfaces between these nanoporous or nanostructured solids and fluids: fluids adsorption, fluids transport and the propagation of ultrasound in fluid-saturated porous media, to name a few. Our approaches are purely theoretical; we use various modeling techniques to represent phenomena at the nanoscale: Monte Carlo simulations, molecular dynamics, density functional theory and finite element analysis.

Computational Nanomechanics and Materials Science Laboratory

Dibakar Datta, Director

The Computational Nanomechanics and Materials Science Laboratory (CNMSL) promulgates a fundamental understanding at the atomic and molecular level of the chemical-electrical-mechanical phenomena of nanomaterials used for real-life applications such as energy storage devices (rechargeable batteries, fuel cells), electronic devices (smartphones, laptops) and healthcare (targeted drug delivery, medical nanodevices), among other areas. The Lab investigates various nanomaterials, including crystalline solids such as silicon and germanium; atomically thin two-dimensional materials such as graphene and transition metal dichalcogenides; and their heterostructures, which include the combination of different nanomaterials. Novel theories and methodologies are developed for modeling the interplay between mechanical, electronic, thermodynamic and kinetic aspects of nanostructures. The computational results provide the guidelines for the experimentalists for the most efficient experimental design of nanomaterials-based structures that are used in everyday life.

Controls, Automation and Robotics Laboratory

Cong Wang, Director

The Controls, Automation and Robotics Laboratory (CAR) focuses on the development of control theories and their applications to automation and robotics. With a strong tie to the community of dynamic systems and controls, we continue to push frontiers in the field, especially in the direction of machine learning-based methods and data-oriented and statistical methods. We emphasize the use of computational intelligence and data science. Our work enables us to develop advanced automation and robotics technologies. In particular, we are challenging the limits of high-performance control for advanced manufacturing and automation, as well as developing intelligent and ultra-high-maneuverability motion systems for human-robot interactive and collaborative operations and extreme robotic manipulations. This technology is targeted at sectors ranging from advanced manufacturing, to household automation, to healthcare.

Environmental Systems Lab

Lisa Axe, Director

The Environmental Systems Lab focuses on chemical and physical processes in environmental systems. Researchers in the group use a suite of analyses to study the effects of surface chemistry on contaminant transport and attenuation. Recent projects include work with the water company SUEZ North America on converting filters and adsorbents used in water treatment plants into biologically active filters for the additional purpose of treating emerging contaminants that involve pharmaceuticals, personal healthcare products and pesticides. The Lab studies biologically active filters with equipment that includes a TOC analyzer, nutrient analyses and ATP analysis. Additionally, Chemours Company is supporting the Lab's research into reactive mineral phases using core samples preserved for redox integrity. A primary goal is to advance understanding of interfacial processes, the interaction between minerals and chlorinated solvents, and their impact on water quality and contaminant mobility and bioavailability. The Lab has been funded by the National Science Foundation, the U.S. Army, SUEZ North America, Chemours Company and the state transportation agencies of both New Jersey and New York.

Geo-Resources and Geotechnical Laboratory

Bruno M. Goncalves da Silva, Director

The Geo-Resources and Geotechnical Laboratory investigates the multi-scale physical mechanisms responsible for the fracturing of rocks subject to various confinement stresses and hydraulic pressures. The Lab focuses in particular on fracture connectivity and micro-seismicity caused by hydraulic fracturing. Based on laboratory tests, our group develops theoretical and numerical models to simulate and interpret the fracturing mechanisms at the macro- and microscopic scales, ultimately elucidating the impact of these processes at the field scale. Broadly speaking, this research aims to reduce the environmental impact and maximize the financial potential of geothermal, oil and gas production, as well as to better predict and mitigate geotechnical-related hazards triggered by natural or man-made causes, particularly related to the stability of rock slopes and underground openings.

Heat and Fluid Transport Engineering Research Laboratory

Angelantonio Tafuni, Director

The mission of the Heat and Fluid Transport Engineering Research (HaFTER) Laboratory is to investigate state-of-the-art problems in the field of fluid mechanics and heat transfer within complex engineering systems. Problems of interest include multiphase flow and fluid-structure interactions in aerospace and ocean engineering applications, free-surface flow in river and coastal environments, and the optimization of industrial processes involving fluid dynamics. Computational fluid dynamics techniques are developed and validated to address challenging problems in engineering. These include three-dimensional highly nonlinear flow with one or more phases, such as the bubbly flow and spray generated by ships. The laboratory is also home to a mechanical platform for the experimental investigation of various liquid sloshing phenomena.

High Performance Concrete and Structures Laboratory

Methi Wecharatana, Director

Critical innovations in the area of high-performance concrete in recent years include the development of highly durable concrete, impact-resistant concrete, microdefect-free concrete, fiber-reinforced concrete, fly-ash concrete, high-performance carbon fiberreinforced concrete and high-strength fiber-reinforced plastics, among others. With funding from the National Science Foundation (NSF), we have installed six closed-loop hydraulic MTS and Instron testing machines with capacity ranging from 25,000 to 1 million pounds in our state-of-the-art laboratory and testing facility. In our high-bay structural concrete lab, we test full-scale, 12-footlong columns with automated closed-loop hydraulic testing machines; our reaction walls enable us to simulate lateral loads from both wind and earthquakes. Past and ongoing funding for our research comes from government agencies such as the NSF, the U.S. Department of Energy and the National Oceanic and Atmospheric Administration, as well as from private partners such as Public Service Electric and Gas and SCG of Thailand.

Idea Factory

Martina Decker, Director

The Idea Factory was founded in 2008 to create a research space for faculty, students and industry members from the fields of architecture and biomedical engineering. Since 2012, the interdisciplinary research hub has expanded upon the collaborative mission and now additionally fosters relationships between team members from numerous areas: the Department of Physics, the Department of Mechanical and Industrial Engineering, the Department of Chemistry and Environmental Science, the Department of Biology, the Department of Civil and Environmental Engineering, the Department of Electrical and Computer Engineering and the Department of Computer Science. The Idea Factory serves as a vital junction for interdisciplinary innovation and undergraduate research through the application of the design thinking methodology. Projects that emerge from the Idea Factory are as diverse as its collaborators, and include: the reconstruction of prehistoric "hell ants"; the fabrication of a collaborative robotic fleet of sensor bots; smart material-driven building "skins" for environmental control; and a multispectral camera that takes laboratory-bound tabletop inventions to a hand-held design stage that can be tested in the field.

Intelligent Transportation Systems Laboratory

Jo Young Lee, Director

The Intelligent Transportation Systems Laboratory (ITSL) is a multidisciplinary research hub for the development and deployment of cutting-edge ITS and connected and automated vehicles (CAV) technologies to improve the mobility, safety and environmental performance of the transportation system. Among other devices, the Lab houses traffic signal controllers, traffic sensors that employ radar, Bluetooth/WiFi and lidar, dedicated short range communications (DSRC) devices, microscopic traffic simulation tools and a high-fidelity driving simulator. The Lab also operates two connected and automated transport (CAT) vehicles. Equipped with a DSRC on-board unit (OBU), a real-time kinematic global positioning system, an on-board diagnostics-II (OBD-II) platform, an infrared pavement temperature sensor, and an automated pothole detector, the CAT test vehicles are used for field pilot tests of ITS and CAV technologies developed in the lab. ITSL is also utilized as a testbed for local communities. The sensor fabrication room, for example, develops, tests and deploys cost-effective traffic sensors for low-income communities.

Materials and Structures Laboratory

Matthew P. Adams and Matthew J. Bandelt, Co-Directors

The Materials and Structures Laboratory (MatSLab) is a research center focused on improving the knowledge base of materials and structures in the built environment and reengineering them for the future. The laboratory consists of experimental and computational facilities capable of evaluating the performance of existing and emerging construction materials and structures from the nanometer to the meter scale. Recent research has focused on the behavior of sustainable materials, such as recycled concrete aggregates (RCA), and resilient and damage-tolerant materials, such as high-performance fiber-reinforced concrete (HPFRC). Recent laboratory upgrades allow for testing, characterization and modeling of other sustainable and resilient materials and structures. RCA materials are being used in pavement design, such as for the Illinois Tollway, to increase sustainability and reduce cost; HPFRCs are being deployed in bridge structures, such as the Pulaski Skyway Project, to decrease construction time, and in earthquake-resistant buildings, such as the Lincoln Square Expansion in Bellevue, Washington, to increase ductility and damage tolerance. Recent research at the MatSLab has been funded by the Federal Highway Administration, the U.S. Department of Transportation's University Transportation Center, the New Jersey Department of Transportation and the American Concrete Institute.

Laboratory for the Mechanics of Advanced Materials

Shawn A. Chester, Director

The primary research goal of the Laboratory for the Mechanics of Advanced Materials is to understand interesting and exciting phenomena in solid mechanics, particularly multiphysics material behavior. Multiphysics behavior occurs when multiple physical phenomena are present in a material's response, beyond deformation. For example, temperature can have a profound impact on the stiffness of materials and some oils degrade the strength of a material over time. Research includes experimental, theoretical and computational solid mechanics. The Laboratory works on continuum-level descriptions of polymeric behavior of materials, including polymer gels, dielectric elastomers and shape-memory polymers, among others. The Lab's general procedure is to conduct experiments to obtain a material's behavior over a wide range of environmental conditions; to develop constitutive models to capture that behavior; to design and implement numerical procedures for use in finite element simulations; and lastly, to validate the constitutive model and its numerical implementation in exciting representative applications.

Micro and Nano Mechanics Laboratory

Siva Nadimpalli, Director

The Micro and Nano Mechanics Laboratory in the Department of Mechanical and Industrial Engineering aims to provide a fundamental understanding of the mechanics of deformation, fracture, degradation, and the failure of solid materials such as metals, ceramics, polymers and other emerging materials, using a combined experimental and modeling approach. The current focus of this lab is to understand the role of mechanics phenomena in the degradation of lithium-ion batteries to help develop durable and light-weight battery designs for automotive and other future energy-storage needs. The unique facilities of this lab include the experimental apparatus to carry out real-time stress and mechanical property measurements while the battery electrodes are being electrochemically cycled. We also have the ability to make mechanical property measurements in both hot and cold environments. We develop new nano- and micro-scale testing methods to understand the mechanics at nano- and micro-scale pertaining to the interface fracture, degradation and failure of solids.

Mixing Laboratory

Piero M. Armenante, Director

The Mixing Laboratory is dedicated to the study of single- and multi-phase mixing phenomena, such as those occurring in industrial stirred tanks and reactors, involving single fluids – primarily liquids with different rheological properties – in the presence or absence of one or more additional phases, such as fine solid particles, a dispersed gas or an immiscible liquid. Mixing phenomena are extremely common in industry, taking place in very small systems, such as tablet dissolution in testing units used in the pharmaceutical industry, and in large production units, such as drug solid suspensions in a carrier liquid for pharmaceutical product manufacturing. The outcome in each case is significantly affected by the hydrodynamics established by a moving component, typically an impeller. Understanding the fluid dynamic characteristics of these systems is critical. For this purpose, the Lab is equipped with state-of-the-art equipment, such as particle image velocimetry, to non-intrusively measure the fluid velocities anywhere in the system. Additionally, numerical tools, including computational fluid dynamics and theoretical process modeling, such as mass transfer models, are used to determine how mixing affects processes of real industrial interest – often in collaboration with industrial partners – and how it can be modified to improve outcomes.

Nanoelectronics and Energy Conversion Laboratory

Dong-Kyun Ko, Director

Research in the Nanoelectronics and Energy Conversion Laboratory focuses on the discovery of new nanomaterials, the design of novel high-performance device structures and the experimental demonstration of device prototypes. Our particular interest is in colloidal quantum dot-based devices, in which semiconductor nanocrystals with tailored electronic properties are used as fundamental building blocks to construct various electronic and optoelectronic devices from the bottom up. This approach provides an opportunity to exploit unique properties arising from nanoscale components and to explore unconventional device concepts and designs for energy harvesting and optical sensing. One of our recent efforts includes the development of paper-based thermoelectric devices that offer a compelling combination of low-cost, high-throughput fabrication and flexible form. These devices can produce electrical power efficiently from body heat with applications ranging from wearable electronics to sensor-based healthcare monitoring and improvement. Other projects include quantum dot-based sensors and imagers that concentrate on developing new infrared-sensing nanomaterials and device structures for highly sensitive photo-detection.

Nanomaterials for Energy and Environment Laboratory

Xianqin Wang, Director

The goals of the Nanomaterials for Energy and Environment Laboratory (NEEL) are to develop advanced functional nanomaterials for sustainable energy production and environmental protection, and to investigate the structure and reactivity of catalytic systems under operational conditions such as high pressure and temperature. Research topics include, but are not limited to: hydrogen production from bio-alcohols on a series of transition metal oxide nanoparticles; bioalcohols or biofuel production from biomass over novel catalytic materials; completely green catalytic materials for solar water splitting and oxygen reduction reactions; fuels production and purification for solid-oxide fuel cells and proton-exchange fuel cells, among others; water treatment with catalytic nanoparticles encapsulated in a hierarchical framework; nitrogen and sulfur removal from crude oil and other organics; structural and electronic properties of various materials using synchrotron-based in situ time-resolved techniques, such as catalytic, pharmaceutical and energetic materials. Our aim is to contribute to a cleaner, healthier environment for current and future generations.

Nano-Optoelectronic Materials and Devices Laboratory

Hieu P. Nguyen, Director

The Nano-Optoelectronic Materials and Devices Laboratory develops high-performance nanophotonic and nanoelectronic devices for lighting and energy storage applications. Such devices are fabricated from gallium nitride (III-nitride)-based semiconductors in the form of nanostructures devised through a state-of-the-art epitaxial growth technique called molecular beam epitaxy. The direct energy bandgap of the III-nitride material system covers a wide energy range from ~ 0.65eV to 6.2eV, which encompasses nearly the entire solar spectrum. It has emerged as a powerful platform to effectively scale down the dimensions of future devices and systems. The group seeks to develop high-power laser diodes, emitting light in the green and ultraviolet spectrum regimes, using these III-nitride nanostructures. In other projects, the group aims to develop superior quality III--nitride nanostructures wherein we will investigate the epitaxial growth, characterization and applications of III-nitride nanostructures. We believe this will provide an enhanced materials system and device structure for applications in biological sensors, solid-state lighting, digital displays, electronic textiles, water purification systems and solar cells, as well as hydrogen generation and carbon-dioxide reduction for future clean, storable and renewable sources of energy.

Laboratory for Numerical Turbulence

Simone Marras, Director

The Laboratory for Numerical Turbulence aims to understand the ties between the numerical approximation of the equations of fluid dynamics and the physical parameterization of the sub-grid scale mechanisms at the core of turbulence. Specifically, the lab concentrates on the development of efficient algorithms for the direct and large-eddy simulation of turbulence with the goal of minimizing the numerical error introduced by the discretization of governing equations onto the modeling of the sub-grid scale mechanisms. Our research is used in the fields of atmospheric turbulence, aeroacoustics and aerodynamics, among other areas of engineering and science; applications range from managing turbulence in free surface flows to the aeroacoustics of wind turbines and large wind farms in the atmospheric boundary layer.

Operations Management Laboratory

Wenbo Selina Cai, Director

The Operations Management Laboratory seeks to advance the understanding of the impact of key players' decision making processes on the design, pricing, and management of products and services in supply-chain management. Theories and methodologies in both operations research and microeconomics, such as stochastic processes, optimization, and game theory, are used. Research topics include accelerating the implementation of carbon-capture and storage (CCS) technology through the design of economic incentives and optimal service contracts among participants of CCS networks; improving the performance of primary healthcare services through stochastic scheduling and optimal capacity allocation among reserved and urgent patients; and examining the economic and environmental implications of adopting additive manufacturing technology in the retail and supply chain.

Optimized Networking Laboratory

Abdallah Khreishah, Director

The Optimized Networking Laboratory engages in research to improve the performance of wireless and wireline networks and to utilize these networks in emerging applications. The goals of the Lab are to identify, model, simulate and demonstrate proof-of-concept setups for next-generation networking technologies and to add to the knowledge base for next-generation networks, to train tomorrow's network-engineering innovators and to foster industrial collaboration and international partnerships. One future networking technology the Lab investigates is Visible-light Communications (VLC), in which indoor light fixtures are used to jointly perform communications and illumination. We spend 90 percent of our time indoors, where 80 percent of Internet traffic is generated. The Lab was the first to demonstrate a proof-of-concept setup that designs a cognitive Internet access system to leverage hybrid Radio Frequency (RF) access points or WiFi and VLC, an emerging concept. VLC has been extended to use very low-power Internet access for small Internet of Things (IoT) devices. With respect to the vehicular networks used by intelligent transportation systems, the Lab is exploring the emerging concept of edge computing to enhance wireless networks in order to solve several problems related to traffic monitoring systems and congestion control on the highways of New Jersey. The Lab is also investigating several wireless technologies for unmanned aerial vehicles and drones to help in situations such as emergency-response and recovery from natural disasters.

Particle Engineering and Pharmaceutical Nanotechnology Laboratory

Ecevit Bilgili, Director

The Particle Engineering and Pharmaceutical Nanotechnology Laboratory (PEPNAL) designs advanced particulate formulations and processes for various high-value-added product industries such as the pharmaceutical, flavors and fragrances, nutraceuticals and agrochemical industries. With an array of characterization and processing equipment, the Laboratory has made significant advances on the bioavailability enhancement of poorly water-soluble drugs via three platform approaches: nanosuspensions, nanocomposites and amorphous solid dispersions. Highlights from recent research include the preparation of sterile-filterable drug nanosuspensions for long-acting injectables, fast-dissolving surfactant-free drug nanocomposites with colloidal superdisintegrants for bioavailability enhancement, and hybrid nanocrystal–amorphous solid dispersions (HyNASDs) for enhanced drug solubilization. The Laboratory also examines mechanisms such as particle breakage, aggregation, agglomeration and growth during the formation of nanoparticles and microparticles in various approaches. We couple experimentation with population balance modeling, discrete element modeling, computational fluid dynamics and microhydrodynamic modeling to elucidate complex non-linear rate processes that occur in pharmaceutical manufacturing operations. The laboratory has secured funding from the National Science Foundation, the Food and Drug Administration, as well as from private sources such as Boehringer-Ingelheim, Catalent Pharma Solutions, International Flavors & Fragrances, Nisso America and SIAM Research & Innovation Co., Ltd.

Reactive and Energetic Materials Laboratory

Edward L. Dreizin, Director

Metals, alloys and metal-based composite powders are used as fuel additives in advanced propellants, explosives and pyrotechnics. These materials have higher temperatures of combustion than conventional hydrocarbon fuels and monomolecular energetic compounds. However, they typically have longer ignition delays and lower burn rates than organic energetic materials. The focus of the Reactive and Energetic Materials Laboratory is to design and characterize new metal-based reactive materials with accelerated reaction rates. We also work on mechanistic models describing ignition and combustion of metals and metal-based reactive materials, which can be used to describe the performance of complex energetic systems, in which such materials are used. Most new materials designed in our Lab are nanocomposite powders prepared using mechanical milling of readily available powders of metals, metalloids and metal oxides. Thermal analysis is used extensively to characterize reactions occurring in the prepared materials upon their heating. Common materials characterization techniques, such as X-ray diffraction and electron microscopy, are used as well. A set of customized ignition and combustion experiments are aimed to characterize ignition delays, burn rates and flame temperatures for the prepared materials in different oxidizing environments.

Soft Matter Research Laboratory

David C. Venerus, Director

The focus of the Soft Matter Research Laboratory is the characterization of soft matter, such as synthetic polymers, biomaterials, gels, foams and emulsions, with the goal of establishing relationships between microstructure and material properties. The experiments carried out in the lab advance development of new processes and materials for applications ranging from plastics packaging to biomedical devices. The laboratory includes both commercial and custom-made instruments to perform novel rheological experiments in both shear and elongational flows. Also included in the laboratory is a custom-made optics setup that allows for novel light scattering to investigate non-classical thermal and mass transport in soft matter.

Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory

Wen Zhang, Director

In the Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory, we integrate concepts and principles of nanotechnology and sustainability into environmental engineering research and education. Our research is mainly focused on: material characterization at nanoscale using hybrid atomic force microscopy; environmental behavior and interfacial processes for nanomaterials and nanobubbles; novel catalytic processes for harnessing renewable energy and pollutant degradation; and reactive membrane filtration systems. In the investigations of nanomaterial interfaces, the laboratory specializes in performing in situ measurements of multiple materials' properties using a combination of atomic force microscopy (AFM), Raman spectroscopy, infrared spectroscopy and scanning electrochemical microscopy. Material properties that could be acquired at a local or nanoscale include morphology, surface potential, electronic structures, hydrophobicity, chemical compositions, distribution and electrochemical activities. Holistic and accurate measurements of these properties are critical for devising functional nanomaterials and devices in catalysis, fuel cells, nanomedicine, drug delivery, pollution treatment and remediation.


Track how Trump's election ripples through the markets.
Financial Analysis
SSMUTIX Index
98 Actions
97 Output
98 Settings
S&P 500 Multi-Utilities Industry Index GICS Level 3
12 Months Ending
Valuation Metrics
Price/Earnings
Price/Book Value
EV/Sales
EV/EBIT
EV/EBITDA
Dividend Yield
Fundamentals
Gross Margin
Operating Margin
Profit Margin
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Company Phone
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Company Email
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Focus

DATA SCIENCE AND INFORMATION TECHNOLOGY

Institute for Data Science

David Bader, Director

The Institute for Data Science (IDS) focuses on interdisciplinary research and development in all areas pertinent to solving real-world problems using data, including health care, financial management, cybersecurity, food safety, manufacturing and smart cities, to name a few. The institute is composed of existing research centers in big data, medical informatics and cybersecurity, as well as new centers in data analytics and artificial intelligence; the centers conduct both basic and applied research and cut across all NJIT colleges and schools. Beyond academic research, the institute interacts closely with the outside world to identify and solve important problems in the modern data-driven economy. In collaboration with NVIDIA, a leading technology company that makes GPU accelerators such as the DGX Deep Learning server, for example, IDS is contributing to RAPIDS.ai, an open GPU data science framework for accelerating end-to-end data science and analytics pipelines entirely on GPUs. These new analytics pipelines are more energy-efficient and run significantly faster, which is critical for making swift, data-driven decisions. The institute also emphasizes multidisciplinary research and workforce skills training to develop technology leaders who will solve global challenges involving data and high performance computing.

Center for Big Data

Chase Wu and Dantong Wu, Co-Directors

The mission of the Center for Big Data is to synergize expertise in various disciplines across the NJIT campus and build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance to facilitate research collaboration and scientific discovery. Current research projects at the center focus on the development of high-performance networking and computing technologies to support big data applications. We are building fast, reliable data-transfer systems to help users in a wide spectrum of scientific domains move big data over long distances for collaborative data analytics. We are also developing high-performance workflow processes to manage the execution and optimize the performance of large-scale scientific workflows in various big data computing environments, including Hadoop/MapReduce and Spark. Furthermore, we are developing new machine-learning, data-mining and data-management techniques to address volume, variety, velocity, variability, and veracity challenges to enable big data analytics and predictive modeling in real-life applications. For example, we are developing a platform for analyzing user-contributed social media data to discover adverse drug effects, a leading cause of death. We are also developing data-driven methods to analyze web-page browsing behaviors to better understand user needs as well as the economics that sustain the free Web. These projects have been supported by the Leir Charitable Foundations, the National Science Foundation and Google.

Center for Computational Heliophysics

Alexander Kosovichev, Director

The primary goal of the Center for Computational Heliophysics is to develop data analysis and modeling tools in the area of heliophysics – the study and prediction of the Sun's magnetic activity – by combining expertise from computer scientists in the Ying Wu College of Computing with that of physicists and mathematicians in the College of Science and Liberal Arts. We work in partnership with NASA's Advanced Supercomputing Division at the NASA Ames Research Center. The Center is involved in the NSF EarthCube initiative to transform geoscience research by developing cyberinfrastructure to improve access, sharing, visualization and analysis of all forms of geosciences data and related resources. The Center's work is focused on novel, innovative approaches, including the development of intelligent databases, automatic feature identification and classification, machine-learning, realistic numeric simulations based on first-physics principles and observational data modeling. The Center develops synergies among these approaches to make substantial advances in heliophysics and computer science. Our new methods and tools can be used in broader scientific and engineering applications for developing new approaches to intelligent big data databases, as well as for image recognition and characterization methodologies.

Cybersecurity Research Center

Kurt Rohloff and Reza Curtmola, Co-Directors

Cyber technologies are critical in modern society and include communication networks, hand-held computers, cloud computing environments and embedded computing technologies that are integrated into all modern automobiles, airplanes and military systems. The Cybersecurity Research Center seeks to address ongoing and long-term future cybersecurity needs for protection and further economic development across the State of New Jersey, nationally and internationally. The Center develops new methods for understanding how modern cyber systems can be compromised and fail, how to design cyber systems so they are secure, and how to improve or fix the cyber infrastructure that has already been deployed. Current areas of investigation to address these challenges include developing and applying new approaches to practical encryption, secure cloud-computing services, privacy technologies, improved software engineering techniques, better data-encoding and communication protocols, and research on human factors. The Center is primarily affiliated with the Ying Wu College of Computing, but is intended to be highly collaborative and inclusive, with the goal of including and supporting collaboration with researchers outside of the college and with researchers and practitioners outside of the university. The Center is supported exclusively through external research funds, including from the U.S. Department of Defense and the National Science Foundation. Current collaborators include MIT, École Polytechnique Fédérale de Lausanne, Raytheon and the U.S. Navy's Space and Naval Warfare Systems Command, among others.

Leir Center for Financial Bubble Research

William Rapp, Director

The Leir Center for Financial Bubble Research seeks to understand through quantitative and qualitative research how financial bubbles can be identified, including their stages of development and what policies can best manage impacts. The Center examines recent financial crises with the goal of developing a more precise understanding of what constitutes a bubble and what does not. Behavioral characteristics such as over-optimism or pessimism regarding policy, investments and contracts are areas of inquiry. Importantly, the Center's objective is to take an approach to bubble research that focuses on analyzing bubbles in ways that are meant to be useful to practitioners. The proximate "customers" for the research findings are other academics interested in finance and financial institutions generally, and in economic instability more particularly. The Center's research on the links between disruptive technologies and bubbles will have relevance for the study of entrepreneurship, which is another focus for the Martin Tuchman School of Management. Outside of academia, we expect significant interest within the financial community and by relevant government regulators.

Structural Analysis of Biomedical Ontologies Center

Yehoshua Perl and James Geller, Co-directors

The Structural Analysis of Biomedical Ontologies Center (SABOC) is an interdisciplinary research center linking computer science and medicine. It deals with medical terminologies and ontologies, a subject of study that is a sub-field of medical informatics. Many biomedical terminologies are measured in the tens of thousands to hundreds of thousands of terms, including drug names and their chemical ingredients, symptoms, diagnoses, body parts, medical procedures, medical devices, infectious agents and accidents, among others. Understanding these terms and finding inconsistencies with textual representations is difficult, and we therefore use graphical representations: biomedical terminologies appear as networks in which the terms are symbolized as boxes and the relationships between pairs of terms are symbolized as arrows. Without a sophisticated approach, visualizing these networks on a computer screen can lead to failure. The core research efforts of SABOC are to develop small abstraction networks that summarize large biomedical terminologies; to visualize abstraction networks on a computer screen in a manner that is easier to comprehend than the original terminologies; and to perform quality assurance on the original terminologies by using the abstraction networks to find and remove inconsistencies. As biomedical terminologies are increasingly used in applications such as electronic health records, ensuring that terminologies are free of inconsistencies helps ensure the correctness of these applications. SABOC is currently funded by a three-year, \$1.75 million grant from the National Institutes of Health.

Advanced Networking Laboratory

Nirwan Ansari, Director

The Advanced Networking Laboratory (ANL) engages in research to improve the performance and dependability of telecommunications networks. The goals of the ANL are to identify, model, simulate and demonstrate next-generation networking technologies; to add to the knowledge base for next-generation networks; to train tomorrow's network-engineering innovators; and to foster industrial collaboration and international partnerships. ANL worked with NEC America and Huawei, for example, to improve passive optical networks. The National Science Foundation (NSF) has supported the lab's investigations into new ways to provide services to a growing set of traffic classes in next-generation networks. Other recent projects that have been funded by NSF include: SoarNet, which leverages free space optics – the use of light in free space to wirelessly transmit data – as backhaul and energizer for drone-assisted networking; FreeNet, Cognitive Wireless Networking Powered by Green Energy, which liberates wireless access networks from spectral and energy constraints; Greening at the Edges, which creates mechanisms for making the access portion of communications infrastructure more energy-efficient; REPWiNet (Renewable Energy Powered Wireless Networks), which aims to efficiently power future wireless networks with renewable energy; and Fast Autonomic Traffic Congestion Monitoring and Incident Detection, which seeks to provision real-time traffic monitoring through advanced networking, edge computing and video analytics.

Big Data Analytics Lab

Senjuti Basu Roy, Director

The Big Data Analytics Lab (BDaL) is an interdisciplinary research laboratory with a focus on large-scale data analytics problems that arise in different application domains and disciplines. One of the primary goals of our lab is to investigate an alternative computational paradigm that involves "humans-in-the-loop" for large-scale analytics problems. These problems come up at different stages in a traditional data science pipeline, including data cleaning, query answering, ad-hoc data exploration and predictive modeling, while also presenting in emerging applications. We study optimization opportunities that can be exploited in these unique man-machine collaborations, and address data management and computational challenges to enable large scale-analytics with humans-in-the-loop. Our focus domains are social networks, healthcare, climate science, retail and business and spatial data. The research projects at BDaL are funded by the National Science Foundation, the Office of Naval Research, the National Institutes of Health and Microsoft Research.

Face Recognition and Video Processing Laboratory

Chengjun Liu, Director

The Face Recognition and Video Processing Laboratory investigates advanced pattern recognition and video analytics methods and develops novel technologies to solve challenging problems, such as automated traffic incident detection and monitoring, facial recognition, image search, video retrieval, big-data analytics and visualization. Our video analytics system, which achieves next to a one order of magnitude improvement over RADAR for vehicle counting, has outperformed commercial systems for automated traffic incident detection and monitoring in challenging environments. Our facial recognition technology is able to reliably verify face images at a very low false-accept rate. Our patented face detection technology, iris detection and recognition technologies, and image-search technologies are additional focuses of the lab's research and development work.

Gidget Lab – (G)ender-(I)nclusive (D)esign, (G)ame and (E)ducational (T)echnology Lab

Michael Lee, Director

The Gidget Lab examines various ways in which technology can better inform, engage and teach diverse learners a range of STEM topics. We build tools and study new technologies to attract more people and increase diversity in STEM. Our free computing education game, Gidget (helpgidget.org) has helped thousands of people across the globe to learn introductory programming concepts; nearly half the users are girls and women. The lab runs Newark Kids Code, a weekly program that assists middle school students in Newark, N.J. in learning programming and website design. We also work with local high schools to teach chemistry using virtual reality headsets. Our lab is funded by the National Science Foundation and Oculus Research.

GIScience & Remote Sensing Laboratory

Huiran Jin, Director

The GIScience & Remote Sensing Laboratory focuses on the advancement of geospatial analysis and quantitative modeling of environmental changes at regional to global scales. Remotely sensed data acquired by various airborne and spaceborne sensing systems, such as multi, hyperspectral and thermal sensors, synthetic aperture radar (SAR), light detection and ranging (LiDAR) and unmanned aerial vehicles are used in conjunction with geographic information system (GIS) techniques and quantitative analytics to address a range of social and environmental issues. Research topics include land cover and land-use mapping, wetland inundation monitoring, urban growth detection, crop characterization and the simulation of cropland carbon storage and carbon fluxes. The tools we use include big data processing, spatio-temporal analysis, land-surface modeling and decision-support algorithm development for an improved understanding of the Earth.

High-Performance Computing Lab

Qing Gary Liu, Director

The overarching goal of the High Performance Computing Lab (HPCL) is to research and develop methodologies and software tools to accelerate discovery on large scientific instruments, such as supercomputers, and at experimental and observational facilities. Our mission is to not only develop new ideas and advance knowledge, but to also work with computing facilities to develop hardened solutions that can benefit various science and engineering disciplines. HPCL researchers have successfully deployed software into various production environments, such as the U.S. Department of Energy's computing systems, National Science Foundation computing centers and U.S. Department of Defense computing centers. An estimated usage of software developed by HPCL researchers is 1 billion computing hours each year. The HPCL lab provides research and educational opportunities involving computer science and engineering, applied math, and computational engineering. Research activities are focused in the broad areas of parallel and distributed computing, data analytics and high-speed networking.

Intelligent Computing Laboratory

Bipin Rajendran, Director

The Intelligent Computing Laboratory is building novel computing systems that are inspired by the architecture of the brain. We pursue a holistic approach toward building such computing systems by developing novel algorithms, system architectures and nanoscale devices that mimic some of the key computational mechanisms of the brain. We are also developing proof-of-concept prototypes that could be used to implement state-of-the-art machine-learning algorithms for applications that have limited energy and computing resources, such as mobile devices and sensor networks. We are collaborating with some of the world's leading research groups in this field, including industrial research labs such as Intel and IBM and universities such as King's College London and École Polytechnique Fédérale de Lausanne.

Intelligent Internet and Information Systems Laboratory

Songhua Xu, Director

Research activities in the Intelligent Internet and Information Systems Laboratory focus on web intelligence, online content search, understanding, mining, and recommendation, with particular emphasis on information retrieval and knowledge discovery regarding biomedical contents. We have conducted extensive studies on automatic document-content understanding, text mining, and text-information fusion from multiple sources. The Lab's research portfolio further includes projects on artificial intelligence, computer graphics and visualization techniques, human-computer interaction, digital art and design and calligraphy. The Lab holds 25 approved invention patents and 55 registered software copyright licenses. Recent externally funded projects include big data computing for cancer informatics. The Internet and online social media have revolutionized the way medical knowledge is disseminated and health information is exchanged and shared among patients, supporters and health care providers. Online patient communities have grown substantially with millions of active participants from all age groups. Recent studies on researching and analyzing social media content for health-related applications show that these cyber trends provide access to valuable health information, traditionally acquired with scientific methods such as observational epidemiological studies. Our research leverages the power of online content, including user-generated content on social networking sites, to tackle complex migration patterns and their effect on environmental cancer risk.

Intelligible Information Visualization Lab

Aritra Dasgupta, Director

The mission of the Intelligible Information Visualization Lab (IIVL) is to enhance our ability to access and understand real-world data by using visualization as a transparent and trustworthy analytical medium. We develop exploratory and communicative visualization techniques to help experts, such as data and domain scientists, to gain insights into the reliability of complex computational models, and to help non-expert data consumers, such as policymakers and the public, reason transparently about algorithmic outcomes. IIVL's mission contributes to the interdisciplinary and highly impactful research area of human-centered data science and aims to establish NJIT's reputation as a premier institution for visualization research and education.

Interactive Cross-Reality Lab

Margarita Vinnikov, Director

The Interactive Cross-Reality Lab (iXR) addresses the general areas of interactive mix reality (XR) applications and serious game development. The lab investigates specific topics in virtual and augmented reality and cross-model (visual, audio and haptic) user experiences in the context of driving simulations and military mission planning. Another critical focus in the lab is the design of gaze-contingent displays for gaming and social interaction applications. The lab work is split between simulating and visualizing complex phenomena, such as different weather conditions and complex data formations, and user studies looking at the impact of spatial displacement in the context of navigation and learning.

Media Interface and Network Design Lab
Hannah Kum-Biocca, Associate Director

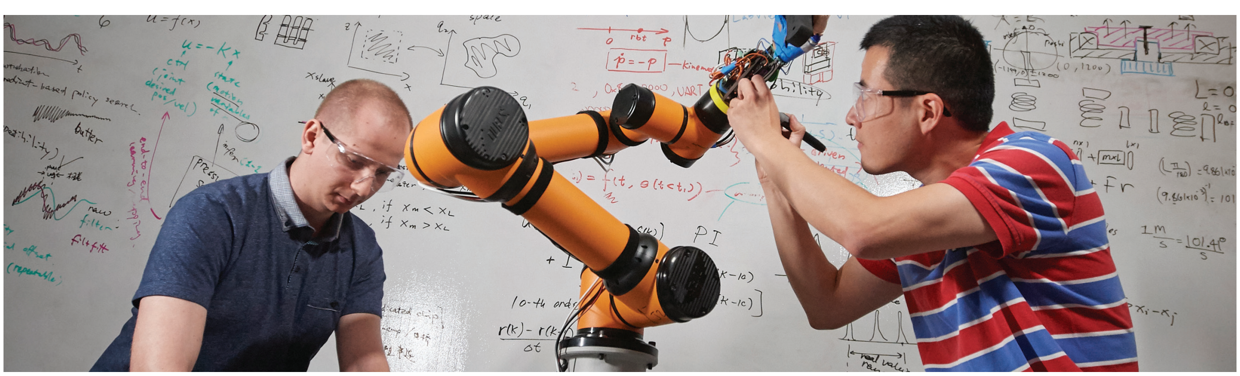
The Media Interface and Network Design (M.I.N.D.) Lab is a center for research and design of interactive computer interfaces, dynamic data visualizations and human-computer interaction. Teams of faculty and students design interactive software; projection mapping installations; and virtual and augmented reality experiences. The M.I.N.D. Lab also conducts human-computer interaction studies assessing the effectiveness of new interactive hardware and software on user performance, learning, cognition and aesthetic experience. A recent interface design project explores the use of augmented reality to directly experience physical forces around us. In collaboration with a physics research team affiliated with NJIT's Big Bear Solar Observatory in California, the lab is building an augmented reality prototype that uses real-time electromagnetic data for visualizing and experiencing the earth's magnetic fields. In the human scale, near-space visualization, instrumented users walk through an oscillating 3D grid that visualizes the forces of the magnetic fields. Users see how the field bends in waves around their moving body and is distorted by magnetic forces in the room. An accompanying "gods eye" visualization represents the magnetic fields and solar flares linking the earth. An augmented reality 3D model of terrestrial and solar magnetic field floats in the room. Users touch and manipulate the models of the sun and earth as well as the fields that connect both. The M.I.N.D. Lab is the local site of a network of collaborative human-computer interaction labs that over time have spanned the United States, Europe and Asia, including more than 50 computer scientists, neuroscientists, artists and human-computer interaction specialists. Recent M.I.N.D. Lab projects have been funded by the U.S. Air Force, the National Science Foundation and the European Union and clients such as HP, Korea Telecom, Amazon and Samsung.

Networked Controls and Intelligent Diagnostics Laboratory
Mohsen Azizi, Director

The Networked Controls and Intelligent Diagnostics (NCID) Laboratory focuses on the design and development of controllers and fault diagnosis algorithms that target the optimal and robust performance of industrial and dynamic systems. Decentralized control techniques are specifically designed for large-scale dynamic systems in which computation resources are distributed and communication bandwidth is limited. Moreover, hybrid diagnostics algorithms are designed based on a combination of classical and artificial intelligence-based fault diagnosis techniques that aim at the resilient and reconfigurable performance of dynamic systems in the presence of faults and failures. These control and fault diagnosis algorithms are developed for microgrids and renewable energy systems, and will be applied in the future to other applications, including autonomous vehicles, robotics and aerospace systems.

Robotics and Data Laboratory
Pramod V. Abichandani, Director

The Robotics and Data Laboratory works on problems centered on optimal, multi-dimensional, data-driven decisionmaking for systems involving multiple aerial, terrestrial, underwater and manipulator robots. Techniques from mathematical programming, linear and nonlinear systems theory, statistics and machine learning are leveraged to create theoretical frameworks and associated real-time embedded systems to solve these problems. Past and current research sponsors include the National Science Foundation, the National Institutes of Health, the Office of Naval Research, Lockheed Martin and Mathworks.



Social Interaction Laboratory

Donghee Yvette Wohn, Director

The Social Interaction Laboratory is an interdisciplinary research hub that combines psychology, communication, computing and design to understand how people interact with technology, a field known as human-computer interaction (HCI). We are particularly interested in studying technologies that are social, such as social media, mobile-health apps and multiplayer games. Many of our current projects revolve around technology and mental health, including the development of a mobile app to support women in STEM and the use of bots to facilitate social support in virtual environments.

Systems Optimization and Analytics Laboratory

Ismet Esra Buyuktahtakin-Toy, Director

The Systems Optimization and Analytics Laboratory is designed to conduct theoretical and applied research on largescale mathematical optimization, including model formulation and analysis, algorithm development and software implementation, in order to tackle complex systems and develop optimal decision strategies. Students apply data analytics and optimization techniques in production-planning and supply-chain systems as well as in energy, healthcare and agricultural systems, among others. The Lab has been funded by the National Science Foundation Early CAREER Development Program and other grants, the U.S. Department of Agriculture, the U.S. Forest Service and the Kansas Board of Regions.

Urban Informatics & Spatial Computing Lab

Xinyue Ye, Director

The Urban Informatics & Spatial Computing Lab focuses on the integration of urban science and computational science, using network science and deep learning, toward a better understanding of human dynamics. With it, we aim to leverage powerful technologies to tackle challenges in diverse areas: climate change, public health, traffic congestion, economic growth, the digital divide, social equity, political movements and cultural conflicts, among others. Our research has been applied to work on smart cities and regional sustainability in North America, South America, Africa and Asia. We are currently examining human dynamics across social media and social networks in order to model the diffusion of information over both time and space. We study the connection between online activities and real-world human behaviors. We are, for example, building a prototype to facilitate rapid dissemination of official alerts and warnings notifications during disaster events via multiple social media channels to targeted populations. The lab has been funded by the National Science Foundation, the National Institute of Justice, the U.S. Department of Commerce and the U.S. Department of Energy, as well as state-level agencies in transportation and economic development. Our work, funded by more than 20 internal and external grants, includes collaborations with faculty members from 18 different departments on campus and across institutions.

TRANSDISCIPLINARY AREAS

Henry J. and Edna D. Leir Research Institute for Business, Technology and Society

Junmin Shi, Director

The Henry J. and Edna D. Leir Research Institute for Business, Technology and Society (LRI) focuses on some of the most critical global challenges facing business and society today: the impacts of climate change and other disruptive societal and operational events on corporate sustainability and business continuity. LRI has an integrated, dual mission of innovative business research and targeted outreach necessary to realize the institute's overarching goal of helping business and industry to become more eco-efficient, resilient and sustainable. The LRI's research builds upon and leverages decades of NJIT experience and intellectual capital in the fields of sustainability and industrial ecology, environmental science, operations management and decision analytics, organizational behavior and business data science. In addition to conducting business and management research, the LRI works closely on problems with academic and business communities, regional economic leaders and government agencies. New cognitive business and machine learning methodologies, designed to help companies collect, visualize and analyze data from wide-ranging sources, are viewed as central to these efforts.

New Jersey Innovation Institute

Donald Sebastian, President

The New Jersey Innovation Institute (NJII) is an NJIT corporation focused on helping private enterprise meet the grand challenges shared across an entire sector while also helping individual companies innovate new product or market opportunities and develop new strategic business partnerships that embrace emerging technology. It is unique in its formation and role as a not-for-profit corporation in pursuit of economic development and in its agility in transforming intellectual capital into commercial success. More broadly, NJII is driving economic-cluster development, entrepreneurship and enterprise expansion. NJII has strategically organized Innovation Labs (iLabs) serving market verticals to follow industry-led agendas. The five initial iLabs serving as the catalyst for collaboration among the academic, private and public sectors are:

- Healthcare Delivery Systems: NJII helps create new models of evidence-based healthcare. Building on the secure exchange of digital information, these new delivery systems improve the quality of care and foster new medical-device technology to lower costs and improve outcomes.
- Biotechnology and Pharmaceutical Innovation: NJII helps pharmaceutical companies develop and apply innovative, cost-saving manufacturing technologies and works with biotechnology firms to scale innovation from lab to commercial production.
- Civil Infrastructure Policy and Planning and Smart City: Drawing on leading-edge engineering and materials science, NJII works with partners on innovative solutions to upgrade public infrastructures and develop resilient systems to withstand natural disasters. Solutions include advanced materials, new design and construction methods, and smart-building and sensor technologies.
- Defense and Homeland Security: NJII helps address the demands of national security and defense, including port security, biometric and sensor-based detection systems, unmanned systems, weapons, energetics and material logistics, as well as communications projects and security systems for infrastructure defense, command, control and first-responder support.
- Financial Services: NJII partners with financial and information-technology professionals on issues ranging from identifying and mitigating the impact of financial bubbles to developing and implementing new supply chain management systems, data analytics for applications ranging from computer-based trading to actuarial assessment, and application design to facilitate new customer services.

Center for Applied Mathematics and Statistics

Lou Kondic, Director

The Center for Applied Mathematics and Statistics (CAMS) is an interdisciplinary research center dedicated to supporting applied research in the mathematical sciences at NJIT. CAMS brings researchers from academia, industry and government to NJIT by organizing the annual "Frontiers in Applied and Computational Mathematics" meeting and other workshops. CAMS activities include support for the submission of interdisciplinary research proposals, a summer program for graduate students and support for undergraduate research. The main applications areas of the CAMS researchers include mathematical biology, wave propagation, fluid mechanics, soft matter and various other interdisciplinary research areas.

Intelligent Transportation Systems Resource Center

Lazar Spasovic, Director

The Intelligent Transportation Systems Resource Center (ITS) was established as a research and technology resource for the New Jersey Department of Transportation's Division of Traffic Operations and Division of Mobility and Systems Engineering. ITS utilizes roadside sensing, information and communication technologies and integrates them into traffic engineering and management practices with the goal of reducing congestion and improving the mobility, safety and efficiency of the transportation system in support of sustainable regional growth and economic development. The main purpose of the center is to conduct research studies of innovative ITS technologies and optimize strategies for their deployment in the regional transportation system. This is accomplished through technology assessment, the evaluation of strategies and deployment scenarios, concept-development studies and technology transfer and training. The center and its laboratory also serve as a test bed for innovative and promising new ITS technologies. They include vehicle sensing and traffic-flow monitoring, automated traffic-incident detection and emergency response, active traffic management using traffic sensors and wireless communication, traffic and transportation data analytics, ITS system integration, and the introduction of connected and autonomous (driverless) vehicle technologies on our roadways. From a teaching and learning standpoint, the center builds on and further strengthens NJIT's competencies and national stature in the research areas of information and communication technology and sustainable systems and infrastructure. The center also serves as the nexus among federal and state transportation agencies, the regional academic research community and the private sector engaged in the development and implementation of innovative transportation-intelligence technology and services.

New Jersey Innovation Acceleration Center

Michael Ehrlich and Judith Sheft, Co-Directors

The New Jersey Innovation Acceleration Center (NJIAC), established within the NJIT Martin Tuchman School of Management as a resource for innovators and entrepreneurs throughout the region, is dedicated to fostering the entrepreneurial ecosystem of NJIT, Newark and New Jersey. The NJIAC focuses on the commercialization of technology and is dedicated to speeding the time to market and time to revenue for valuable new technology innovations. The center sponsors several important activities at NJIT for students, faculty, innovators and other entrepreneurial participants.

- For NJIT students, the NJIT Innovation Acceleration Club's weekly meeting gathers undergraduate and graduate students from all of the colleges to work together to learn how to develop their business models and develop novel products, technologies and devices.
- For NJIT faculty and students, with support from the National Science Foundation (NSF), the center hosts the NSF I-Corps Site at NJIT which provides mini-grants and training to faculty/student teams that allow them to explore the commercialization of their novel technologies.
- For Newark area students and innovators, with support from Capital One Bank, the center sponsors the annual Newark Innovation Acceleration Challenge, in which student and community-based entrepreneurs submit early-stage business models. Finalists present before a panel of business and entrepreneurial experts and the winners receive $3,000 Innovation Acceleration Fellowships to support their participation in the NJIT Lean Startup Accelerator the following summer.
- For health IT startups, with support from J.P. Morgan, NJII has created the Health IT Connections Program, which supports early-stage health IT companies and helps them to scale up their businesses through face-to-face training and cluster activities. Participating companies have achieved revenue and employment growth of more than 40 percent following their participation.
- For the NJIT community, the center has sponsored TEDxNJIT since 2011, and annually showcases "Ideas Worth Sharing" throughout the community.
- For regional entrepreneurs, with support from Synchrony Bank and in partnership with the Enterprise Development Center and the Greater Newark Enterprises Corporation, we have been offering short classes in Business Model Development, Financial Modeling and Valuation, among other areas.

VentureLink

Simon Nynens, Director

Formerly known as the Enterprise Development Center, VentureLink is a community hub for technology companies at NJIT for Northern New Jersey. The organization provides space and services to startups that are pre-revenue, pre-legal formation and pre-product market fit, as well as to established tech companies that need a place to grow. VentureLink operates within the NJIT campus, providing in-residence companies with weekly programming, workspace and expert mentorship; its aim is for companies to hone entrepreneurial skills by learning experientially.

Otto H. York Center for Environmental Engineering and Science

Somenath Mitra, Director

The Otto H. York Center for Environmental Engineering and Science offers core research facilities as a resource for many interdisciplinary research programs and initiatives. The Center was the first building in the nation specifically constructed for cooperative public and private research in hazardous waste management. Today, it has diversified into many other areas, with research projects in nanotechnology, drug-delivery systems, particle engineering, microfluidics, membrane science, environmental science and engineering and biomedical engineering. Researchers from a range of disciplines — chemistry, environmental science, chemical engineering, biomedical engineering, mechanical engineering, material science and pharmaceutical engineering — have laboratories in the center with extensive facilities in microscopy, mass spectrometry and material characterization. York Center research projects are funded with faculty grants from agencies such as the National Science Foundation, the National Institutes of Health, the National Institute of Environmental Health Sciences and the U.S. Department of Defense, as well as from leading industries. The new Life Science and Engineering Center associated with the York Center provides additional shared laboratory space for interdisciplinary projects. The York Center supplies Faculty Instrument Usage Seed Grants (FIUSG) for the use of core laboratories in order to support faculty and to promote research across campus by providing free instrument time to pursue preliminary findings that will lead to the development of new ideas and grant proposals. The FIUSG initiative aims to support the launch of new initiatives in core and emerging interdisciplinary areas aligned with NJIT's strategic interests.

Additive Manufacturing Laboratory

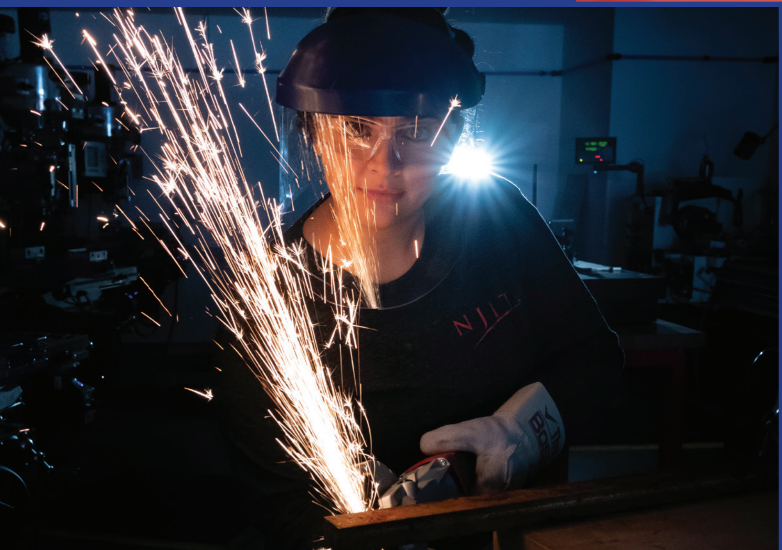
John Federici and Ian Gatley, Co-Directors

The Additive Manufacturing Laboratory (AddLab) specializes in innovations using modern additive manufacturing techniques, including 2D and 3D printing in conjunction with embedded electronics. Additive manufacturing has revolutionized manufacturing production, bringing down the cost of prototyping, while allowing for novel designs and devices never before possible. In-situ, non-destructive evaluation methodologies that monitor the fabrication process and efficiently qualify fabricated components are under development. The AddLab works with industrial partners to transition research and development from the laboratory into industrial scale production. Our extensive 2D and 3D fabrication tools, in combination with expertise with simulations and modeling, enables the lab to develop and optimize manufacturable components for U.S. Department of Defense customers as well. The AddLab faculty, staff and students take pride in developing the workforce of the future. Many opportunities are available for undergraduate internships during the academic year and over the summer, as well as graduate student research.

Terahertz Spectroscopy, Imaging and Wireless Communication Laboratory

John Federici and Ian Gatley, Co-Directors

The Terahertz Spectroscopy, Imaging, and Wireless Communication (THz SPICE) Laboratory specializes in the development and application of terahertz (THz) technology to spectroscopy, imaging and wireless communication. The THz frequency ranges from about 0.1-3 THz corresponds to the far-infrared spectral range. The laboratory's research in spectroscopy and imaging focuses on the non-destructive evaluation of materials, including THz Computed Tomography, additively manufactured components and plastic welding. The laboratory has expertise in terahertz wireless communication. Research efforts include evaluating the effects of atmospheric weather on THz communications as well as THz reflectors and antenna arrays for indoor THz communications.



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