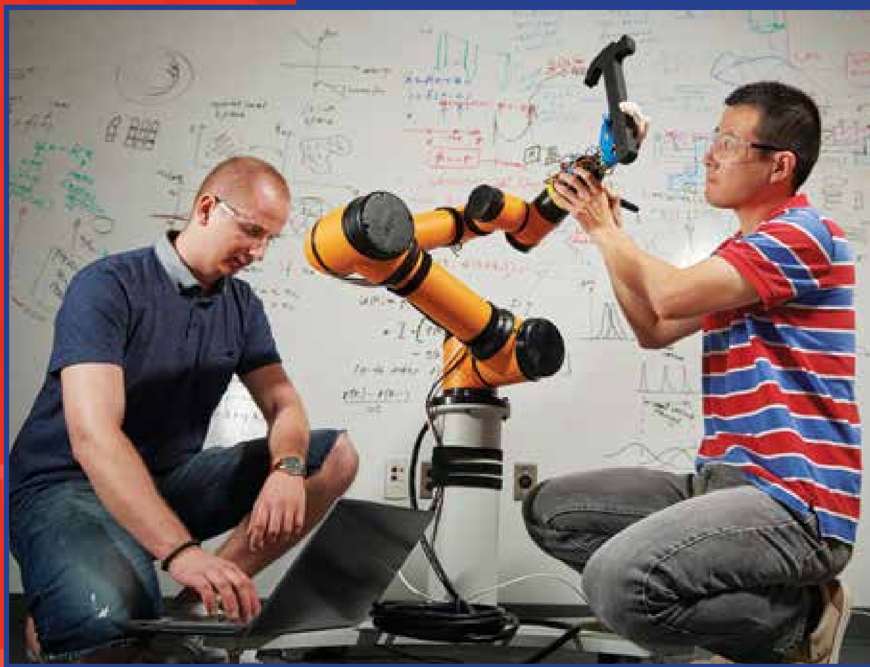
NJIT
New Jersey Institute of Technology

2017 NJIT RESEARCH CENTERS AND LABORATORIES SHOWCASE

THURSDAY
NOVEMBER 16, 2017



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 Research Centers and Laboratories Showcase, which is designed to foster collaborations that lead to groundbreaking new ideas and innovations.

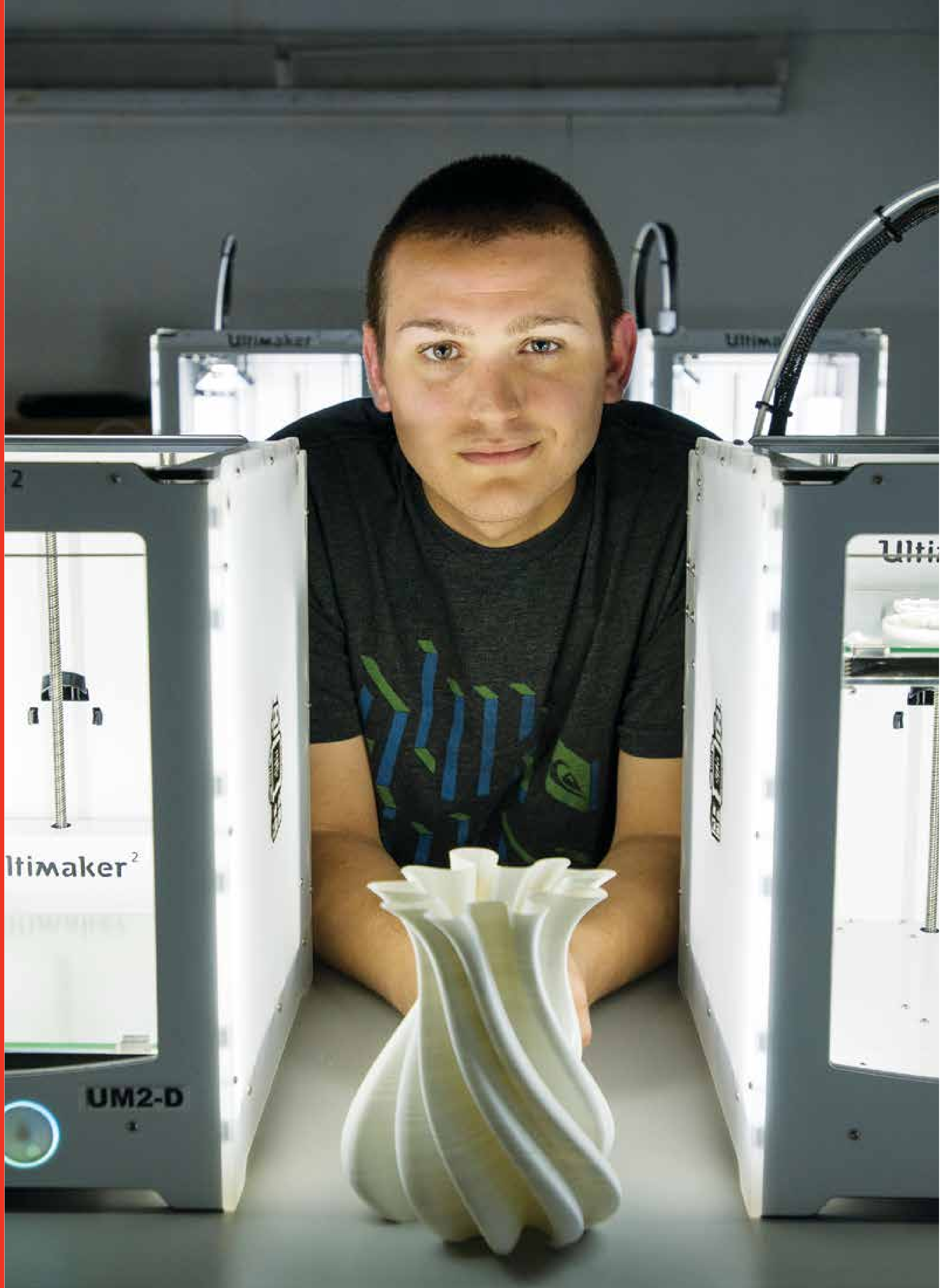
As NJIT moves into the ranks of premier research institutions, we do so strategically. Our mission is to play a leading role in four emerging areas of multidisciplinary research: data science and information technology, the nexus of life sciences and engineering, sustainable systems, and a transdisciplinary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

The university's research centers 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 surpass $140 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 $375 million capital-building program, we are transforming research and education on campus. The gut-level renovation of the five-story Central King Building and the construction of a new, 24,500 sq. ft. 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.

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 110 new faculty members as we deepen our capabilities across STEM and other disciplines. Under *2020 Vision*, we are beginning a multiyear hiring effort that will expand our faculty even further, from 280 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



Welcome to the 2017 Research Centers and Laboratories Showcase, an annual celebration of NJIT's most potent and promising engines of innovation. The approximately 70 institutes, centers and labs represented today reflect the steady, strategic growth in the university's research enterprise. Over the past three years alone, more than 25 new labs have been created; by 2020, the annual research showcase will feature no fewer than 100.

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. By forming four research clusters around the 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 attract future-focused researchers, innovators and entrepreneurs across disciplines who work together to develop technologies capable of addressing a broad range of societal needs. To advance these goals, NJIT last year launched a more comprehensive cluster still, the Institute for Brain and Neuroscience Research, to translate our growing understanding of neural circuits into personalized care.

We begin by harnessing recent breakthroughs in imaging technology and biomolecular research, made in our labs and others, that shed light on the brain's fundamental operations and the mechanisms by which genetic mutations unravel executive functioning. By connecting researchers across disciplines, we strive for significant breakthroughs that will help maximize human potential: to enable children born with neurological disorders to thrive in classrooms, to ensure that the young paralyzed in accidents walk again before they reach their prime and to return blast-injured veterans to productive life.

As with the field itself, the university's expanding cluster in this area includes an array of biochemists, physicists, mathematicians, biomedical engineers, biologists and computer scientists with diverse perspectives but complementary goals. Experts in imaging technologies work hand in hand, for example, with neurorehabilitation engineers to determine how visual and aural therapies impact neural pathways.

So I urge you again, as I did at last year's inaugural showcase, 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
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 110 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 energy resources, such as biofuel cells. 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.

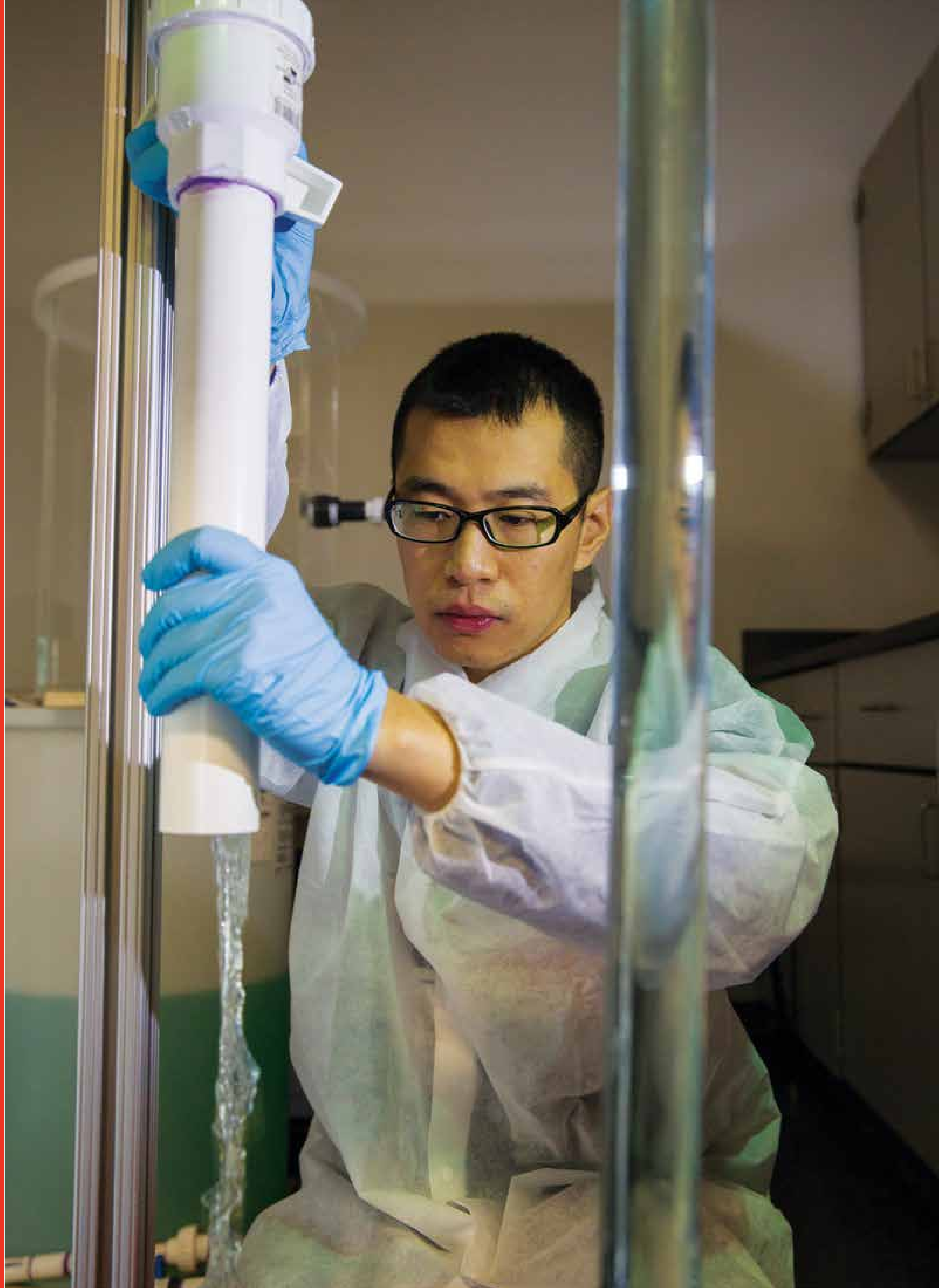
DATA SCIENCE AND INFORMATION TECHNOLOGY

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. A recent federal report indicates more than $13 billion in university R&D expenditures on cyber systems and information in 2011 alone. Currently, there are 7.4 billion mobile devices connected globally with mobile-data traffic reaching 2.5 exabytes per month. It is expected that by the year 2050 more than 100 billion devices will be connected across the globe. 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 and transportation systems, 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.

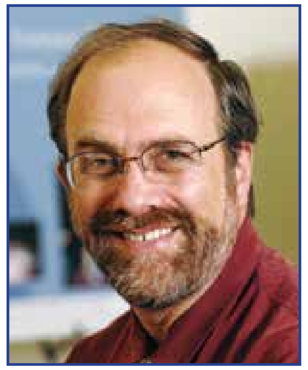


PROGRAM

10:30 a.m. - 10:30 a.m.	Introductions and Welcome
10:45 a.m. - 11:30 a.m.	President's Forum: Keynote Talk and Lecture: Dr. Steven Schachter, *Chief Academic Officer and Program Leader of Neurotechnology* Consortia for Improving Medicine with Innovation & Technology Professor of Neurology, Harvard Medical School
Ballroom B	
11:30 a.m. - Noon	Lunch and Networking
Ballroom A & B	
Noon - 2 p.m.	Poster Presentations and Networking Session

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. Steven Schachter

Chief Academic Officer and Program Leader of Neurotechnology
Consortia for Improving Medicine with Innovation & Technology
Professor of Neurology at Harvard Medical School

Dr. Steven Schachter is an internationally recognized expert in the treatment of epilepsy, a nervous system disorder caused by electrical disturbances in the brain that affects 50 million people worldwide, including three million in the United States. A professor of neurology at Harvard Medical School, he has directed more than 70 research projects involving antiepileptic therapies, and published more than 200 articles and chapters. He compiled the six-volume "Brainstorms" series, which has been distributed to over 150,000 patients and families worldwide in several languages, and edited or written 26 other books on epilepsy and behavioral neurology.

He is also the chief academic officer and program leader of neurotechnology at the Consortia for Improving Medicine with Innovation & Technology, a Boston-based consortium launched nearly two decades ago to accelerate innovation in healthcare by facilitating collaboration among clinicians, healthcare managers, technologists, engineers, and entrepreneurs to develop and implement leading-edge products, services, and procedures that improve patient care. The organization's medical domain now supports a wide spectrum of medical innovations, including healthcare-related information technology, patient-care workflows, drugs and biologics.

Dr. Schachter is the founding editor and editor-in-chief of the medical journals *Epilepsy & Behavior* and *Epilepsy & Behavior Case Reports*, the clinical editor for the *Journal of Translational Engineering in Health and Medicine,* the past president of the American Epilepsy Society and the past chair of the professional advisory board of the Epilepsy Foundation. He currently serves on the foundation's board of directors.

He attended medical school at Case Western Reserve University in Cleveland, Ohio. He completed an internship in Chapel Hill, North Carolina, a neurological residency at the Harvard-Longwood Neurological Training Program, and an epilepsy fellowship at Beth Israel Hospital in Boston, Massachusetts.

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. Institute 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.

Biophotonics & Bioimaging Lab
Kevin D. Belfield and Yuanwei Zhang, Co-directors

The Biophotonics and Bioimaging Lab 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.

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 (CIBM3) is a multi- and interdisciplinary research center focused on understanding, diagnosing and treating brain injuries and concussions using experimental and computational methods. The Center 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.

Rehabilitation Engineering Research Center

Richard Foulds and Sergei Adamovich, Co-directors

The Rehabilitation Engineering Research Center develops robotic devices and therapies to improve the lives of people with disabilities. The largest of the center's eight current projects is the development of a device that combines a robotic exoskeleton and a virtual reality program for neurorehabilitation of people with limited arm movement resulting from a stroke. Smaller projects on wearable robots focus on lower-extremity exoskeletons to restore walking to individuals following a stroke; epidural electrical stimulation to increase spinal cord transmission; the improved use of exoskeletons by people with spinal cord injury; and the study of new robotic technology for stroke therapy to be used in the home. Researchers at the center are also designing new human-robot interfaces that allow people to control exoskeletons in a biologically natural way. Lastly, the organization Parent Project Muscular Dystrophy is backing a center project to equip 30 young men with Duchenne Muscular Dystrophy with NJIT-developed exoskeletons that will extend the use of their arms for up to five years. The Kessler Foundation and Rutgers Department of Rehabilitation and Movement Science are major collaborators. The center's work is supported by the National Science Foundation, the National Institutes of Health and the National Institute on Disability, Independent Living, and Rehabilitation Research, among other agencies and organizations.

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.

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, super-resolution microscopy, computer vision and machine learning.

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.

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 (IBAM-Lab)

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 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, 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.

The 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.

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 Basis of Locomotion Laboratory

Gal Haspel, Director

The Neural Basis of Locomotion laboratory researches 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 neuronal-circuits 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. However, 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.

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 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 thrust 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 sensory-motor 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 establish synergies among novel nanostructures, optics, biology and electrokinetics to develop disruptive new technologies in sensors, diagnostics, drug delivery and biofilms, using cost-effective tools. Our research advances understanding of interfaces and surface physics. Current research includes a shear-enhanced biosensor 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. This same device is being used for monoclonal antibody purification without post-modifications in order to preserve antibody functions. We are also developing a microfluidic organ-on-a-chip platform to study interactions between nanoparticles and the blood-brain barrier. In collaboration with researchers at Rensselaer Polytechnic Institute (RPI), we are developing water purification membrane technology in which membranes are coated with the latest semiconductors, including graphene, MOS (metal oxide semiconductors) and ReS2, a rhenium sulfide mineral. Our collaborators include researchers at NJIT, RPI and Hackensack Medical Center.

SwarmLab

Simon Garnier, Director

The SwarmLab 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 simulate 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 five 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 NIH-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.

SUSTAINABLE SYSTEMS

Center for Building Knowledge
Deane Evans, Director

The Center for Building Knowledge (CBK) is a 30-year-old research, training and technical assistance institute affiliated with the College of Architecture and Design. CBK 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. Recently, CBK developed the Clean Energy Learning Center, a new online energy-efficiency training and resource platform for the New Jersey Clean Energy Program. CBK was recently awarded a grant from the U.S. Department of Energy (DOE) in collaboration with TRC Solutions to pilot test energy efficiency packages at three higher education institutions in New Jersey. Other recent online training programs include methods for saving energy in leased space, affordable housing design and a professional certification in asset scoring. The certification program provides training on the use of a new tool from the DOE that evaluates the energy efficiency of key physical assets within a facility – its building envelope, lighting and HVAC systems – and tabulates an asset score. Developed with the Consortium for Building Energy Innovation, the program launched in April 2016.

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 super-capacitors for energy storage, digital energy for efficient energy management and white-light sources.

The 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 base-station 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 Development and Protection
Michel Boufadel, Director

The Center for Natural Resources Development and Protection 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.

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 Center 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.

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—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 1500 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 energy systems and nanomaterials and microdevices for disease detection and diagnosis for biomedical applications. The lab's energy research is focused 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 innovative high-performance new 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 like cancers at their early stages using a nano-biochip. The biochip incorporates microchannels with a self-driven flow of biofluid and nanocircuits to sense the existence and severity of a disease with high sensitivity and selectivity. Our research has been supported by the National Science Foundation, New Jersey Health Foundation and NJIT, with many patents issued, and in collaboration with or 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.

RESEARCH CENTERS AND LABORATORIES 2017

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.

Analytical Chemistry and Nanotechnology Laboratory
Som 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.

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.

Catalysis and Photoelectrochemistry Laboratory
Yong Yan, Director

The Catalysis and Photoelectrochemistry Laboratory investigates catalytic materials and methods to convert water, air, solar energy and small organic molecules into fuels and value-added chemical feedstocks. The future of clean energy and green products depends heavily on innovative breakthroughs in the design of efficient systems for the conversion and storage of solar energy. Photoelectrocatalytic water splitting, CO_2 conversion and N_2 reductions are promising solutions in which solar energy storage and useful products such as hydrogen fuels, ethanol and ammonia-based fertilizer, among others, are combined into a single green energy system. The lab focuses on designing and developing catalytic and photocatalytic materials and systems to facilitate energy storage and chemical conversion. Additionally, we develop renewable and sustainable methodologies and approaches to activate small organic molecules for the photocatalytic synthesis of valuable organic molecules. This economical solar-induced synthesis project is proposed to benefit the drug development and pesticide industries for large-scale and cost-effective manufacture.

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.

Controls, Automation, and Robotics Laboratory

Cong Wang, Director; Lu Lu, Co-director

The Controls, Automation, and Robotics (CAR) Laboratory 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 health care.

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.

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 fiber-reinforced 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-ft.-long columns with automated closed-loop hydraulic testing machines; our reaction walls enable us to simulate lateral loads from both wind and earthquakes. The recent addition of two new civil engineers, Matthew Adams and Matthew Bandelt, who are expert in advanced concrete materials, further expands our programs into research on the fatigue and durability of high-performance, fiber-reinforced concrete and microstructures of high-performance concrete using scanning electron microscopes and transmission electron microscopes. 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.

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 microscale 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 Labs

Xianqin Wang, Director

The goals of the Nanomaterials for Energy and Environment Labs (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; bio-alcohols 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 6.4eV, 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 ideal materials system and device structure for applications in biological sensors, solid-state lighting, digital displays, electronic textiles, water purification systems, solar cells, and hydrogen generation and carbon-dioxide reduction for future clean, storable and renewable source of energy.

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

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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 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 concentrated sub-100 nm drug suspensions for sterile filtration, fast-dissolving surfactant-free drug nanocomposites with colloidal superdisintegrants for bioavailability enhancement, and a nanoextrusion–spray drying platform for comparing nanocomposites with amorphous solid dispersions. The laboratory also examines mechanisms such as particle breakage, aggregation, agglomeration, and growth during the formation of nanoparticles and microparticles in various approaches, from the top-down (wet stirred media milling), to the bottom-up (melt emulsification, liquid anti-solvent precipitation). 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 manufacturing operations. The laboratory has secured funding from the National Science Foundation, the European Research Council and the Food and Drug Administration, as well as from private sources such as Boehringer-Ingelheim, Catalent Pharma Solutions, International Flavors & Fragrances and Nisso America.

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.

Resilient and Sustainable Infrastructure Materials and Structures Laboratory

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

The Resilient and Sustainable Infrastructure Materials and Structures Laboratory 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). Ongoing laboratory upgrades will 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.

Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory

Wen Zhang, Director

The Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory integrates nanotechnology and sustainability into the research and teaching of environmental engineering, using an interdisciplinary approach to address the societal challenge of achieving environmental sustainability. Research areas include material characterization at nanoscale using a hybrid atomic force microscope (AFM); environmental behavior and physicochemical processes of engineered nanomaterials; novel photocatalytic processes for harnessing renewable energy and degrading pollutants; microalgae-harvesting and removal technologies using magnetophoretic-separation and reactive-membrane filtration; and chemically-modified polymeric and ceramic-membrane systems for removing emerging contaminants. In the investigations of nanomaterial interfaces, this laboratory specializes in probing multiple materials' properties using a combination of AFM, Raman, and IR (Hybrid AFM). The material properties acquired at a local nanoscale include morphology, surface potential, electronic structures, hydrophobicity, chemical compositions, distribution and quantification. Holistic and accurate measurements of these properties are critical for devising functional nanomaterials used in catalysis, fuel cells, nanomedicine, drug delivery, pollution treatment and remediation.

DATA SCIENCE AND INFORMATION TECHNOLOGY

Center for Big Data

Chase Wu and Yi Chen, 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's work is focused on novel, innovative approaches, including the development of intelligent databases, automatic feature identification and classification, 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 in collaboration with the Computer Science Department. The computational models have been used for modeling the magnetic activity of other stars in support of NASA's Kepler mission and the search for extraterrestrial life.

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, Ecole Polytechnique Federale 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, dependability and trustworthiness of telecommunications networks. The goals of the ANL are to identify, model, simulate and demonstrate 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. For example, ANL works in partnership with NEC America and Huawei to improve passive optical networks. The National Science Foundation (NSF) has supported our investigations into finding a new way to provide services to a growing set of traffic classes in next-generation networks. ANL has led a collaboration between Japan and the U.S. to identify and to develop advanced security technologies for the next generation of ubiquitous networks under the Strategic International Cooperative Program between Japan's Science and Technology Agency and the NSF. Four other recent NSF projects include: FreeNet: Cognitive Wireless Networking Powered by Green Energy to liberate wireless access networks from spectral and energy constraints; GATE (Greening At The Edges) to transform the access portion of communications infrastructure into an energy-efficient version; REPWiNet (Renewable Energy Powered Wireless Networks) to efficiently power future wireless networks by renewable energy; and Fast Autonomic Traffic Congestion Monitoring and Incident Detection through Advanced Networking, Edge Computing, and Video Analytics to provision real-time traffic monitoring.

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.

Intelligent Internet and Information Systems Laboratory
Songhua Xu, Director

Research activities in the Intelligent Internet and Information Systems Lab 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.

Social Interaction Laboratory
Donghee Yvette Wohn, Director

The Social Interaction Lab 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.

TRANSDISCIPLINARY AREAS

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.

Enterprise Development Center
Jerry Creighton Sr., Director

The Enterprise Development Center (EDC) is a business-development and commercialization center with an ecosystem designed to advance high-tech and life-science entrepreneurial initiatives. The array of service programs available at the EDC combines student, faculty and NJIT resources with a "know-how" network of subject-matter experts, partnerships, interactions among resident companies, and university and business and government collaborations as needed, to assist resident companies with R&D tasks, and to provide advice on meeting business-development milestones, scaling their businesses and preparing to obtain access to capital.

Intelligent Transportation Systems Resource Center
Lazar Spasovic, Director

The Intelligent Transportation Systems (ITS) Resource Center 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 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.

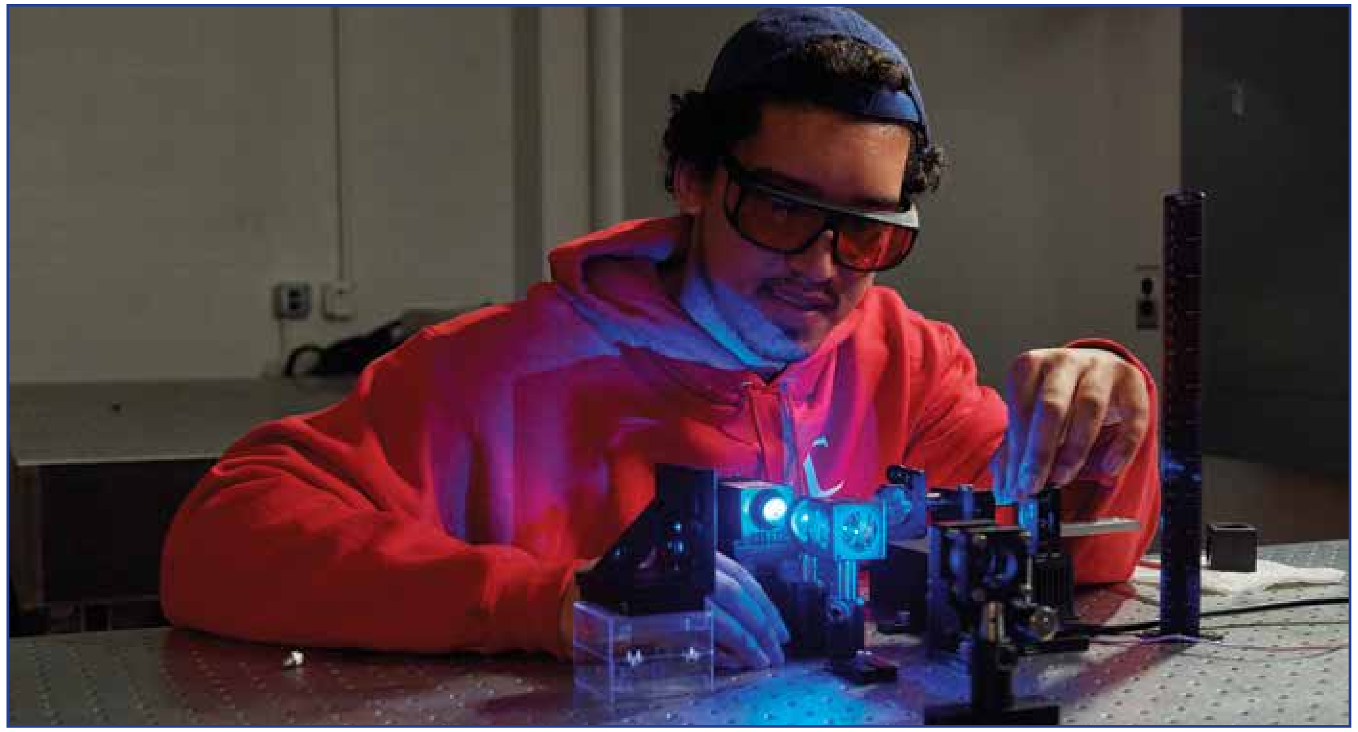
- **Biotechnology & Pharmaceutical Innovation:** NJII helps pharmaceutical companies develop and apply innovative, cost-saving manufacturing technologies and works with biotechnology firms to scale innovation from lab to commercial production.
- **Civil Infrastructure Policy & Planning and Smart City:** 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.

Otto H. York Center for Environmental Engineering and Science

Som 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 will provide additional shared laboratory space for interdisciplinary projects. The York Center provides 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 interdisciplinary emerging areas aligned with NJIT's strategic interests.

RESEARCH CENTERS AND LABORATORIES 2017



New Jersey Innovation Acceleration Center

Michael Ehrlich & Judith Sheft, Co-directors

The New Jersey Innovation Acceleration Center, 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 & Valuation, among other areas.

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