NJIT
New Jersey Institute of Technology

First Annual

NJIT RESEARCH CENTERS AND LABORATORIES SHOWCASE

MONDAY
NOVEMBER 16, 2015

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 ground-breaking 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 $110 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. Last year, 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 $300 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 four years, we have hired nearly 70 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 Pierre Deek

Fadi P. Deek
Provost and Senior Executive Vice President

Welcome to the inaugural Research Centers and Laboratories Showcase, a milestone event that for the first time at NJIT brings together in one room the university's most potent and promising engines of innovation. The more than 40 labs and centers represented here today reflect the steady, strategic growth in the university's research enterprise. Over the past three years alone, more than 20 new labs have been created; by 2020, the annual research showcase will feature no fewer than 50.

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 three newest centers ably illustrate our approach. The Center for Injury, Bio-Mechanics, Materials and Medicine (CIBM3), which focuses on understanding, diagnosing and treating brain injuries and concussions using experimental and computational methods, brings together biomedical engineers, neuroscientists and computer scientists at NJIT with collaborators in medical schools and Veterans Administration hospitals. The Center for Computational Heliophysics, which studies the impact of solar physics on Earth's atmosphere, combines the expertise of computer scientists, mathematicians, and physicists at NJIT with the NASA Advanced Supercomputing (NAS) Division at the NASA Ames Research Center. The NJIT Cybersecurity Research Center, which develops new methods for understanding how modern cyber systems fail and new methods to secure them, works closely with partners in the U.S. military, in industry and at other universities.

So I urge you to view the showcase as an opportunity to step out of your 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. You may even find future collaborators.

Atam P. Dhawan
Vice Provost for Research

Research is an integral part of a strong academic experience. NJIT's *2020 Vision* identifies "Scholarly Research" as a strategic priority. The implementation of *2020 Vision-A Strategic Plan for Research at NJIT* aligned with the university's *2020 Vision* focuses on achieving a national and international prominence in research through new discoveries, as well as basic, applied and translational research.

A seamless integration of collaborative synergy at all levels with faculty, staff and students will be developed. With the goal of increasing the external academic research funding to $40 million, it is essential to recruit faculty in key areas with the availability of external funding opportunities coinciding with future trends, existing strengths, and strategic directions as identified by the *Strategic Plan for Research at NJIT* developed with collective input from faculty, chairs and deans. It is important to note that our *Strategic Plan for Research at NJIT* organizes 13 research focus groups into four research clusters. Comprised of an average of 14 active research members, these clusters include:

LIFE SCIENCES AND ENGINEERING

This research cluster includes both basic and applied research in the areas of neuroscience, neural engineering, regenerative medicine and point-of-care technologies. Research at NJIT includes understanding 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. Regenerative medicine research deals with the process of replacing dysfunctional cells with regenerating cells, tissues or organs to restore normal functions.

The Life Sciences and Engineering cluster also represents healthcare information systems and management involving primary care, hospitals and emergency care resources and protocols. The National Science Foundation (NSF) report on university research and development (R&D) shows more than $20 billion in research funding from federal resources in these areas. The scope of the proposed cluster includes research areas that are aligned with the National Academy of Engineering (NAE) and National Academy of Science (NAS) Grand Challenges in "reverse engineering of the brain," "tools for scientific discovery" and "engineer better medicine."

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 modelling and simulation. The area also focuses on the water-energy nexus to investigate the impact of ocean levels on the environment, as well as the development of technologies for clean water and energy resources such as biofuel cells. The scope of nanotechnology is to understand all scientific and engineering phenomena at the minutest and fundamental levels to develop technologies for environmental and pharmaceutical applications. The interdisciplinary group on engineered material 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 is focused on developing new methods and technologies for design innovation and process automation. A specific emphasis is to develop new processes and tools for pharmaceutical manufacturing. The NSF report reveals more than $8 billion in university R&D expenditures in 2011 for sustainable energy, renewable energy and community resilience. 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 focus groups are engaged in bioinformatics, medical informatics, image processing, data mining, solar terrestrial physics, transportation, financial management, life sciences and healthcare.

The cybersecurity group studies how to design secure cyber systems and to improve cyber Information and Communications Technology (ICT). ICT is shaping many aspects of society and the economy and is evolving rapidly to provide access to unprecedented amounts of information, anytime and anywhere, from any type of device. The NSF report indicates more than $13 billion in university R&D expenditures in 2011. 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 NEA and NAS Grand Challenges including secure cyberspace, virtual reality and tools for scientific discovery.

TRANSDISCIPLINARY AREAS

This cluster includes research centers on mathematical sciences, transportation systems, as well as science and technology's impact on society. These three areas have a broader multidisciplinary and interdisciplinary scope over a large number of applications, including life sciences, smart cities and societal behavior to develop enabling technologies for market needs. The NSF report confirms more than $7 billion in university R&D expenditures in 2011 in these fields. The scope of this proposed cluster addresses NEA and NAS Grand Challenges in urban infrastructure, smart transportation, tools for scientific discovery and advanced personalized learning.

PROGRAM

Noon - 12:30 p.m.	Lunch and Networking Session
12:30 p.m. - 12:45 p.m.	Introductions and Welcome Fadi P. Deek, Ph.D. Provost and Senior Executive Vice President Atam Dhawan, Ph.D. Vice Provost for Research
12:45 p.m. - 1:30 p.m.	Keynote Address Grace Peng, Ph.D. Program Director Division of Discovery Science & Technology (DDST) National Institute of Biomedical Imaging and Bioengineering National Institutes of Health
1:30 p.m. - 4 p.m.	Poster Session and Networking

KEYNOTE SPEAKER

Grace Peng, Ph.D.
Program Director

Division of Discovery Science & Technology (DDST)
National Institute of Biomedical Imaging and Bioengineering
National Institutes of Health

Grace C.Y. Peng received a B.S. degree in electrical engineering from the University of Illinois at Urbana, and M.S. and Ph.D. degrees in biomedical engineering from Northwestern University. She performed postdoctoral and faculty research in the department of neurology at the Johns Hopkins University. In 2000, she became the Clare Boothe Luce professor of biomedical engineering at the Catholic University of America. Since 2002, Dr. Peng has been a program director in the National Institute of Biomedical Imaging and Bioengineering (NIBIB), at the National Institutes of Health. Her program areas at the NIBIB include mathematical modeling, simulation and analysis methods, and next-generation engineering systems for rehabilitation, neuroengineering and surgical systems. In 2003, she brought together the Neuroprosthesis Group (NPG) of program officers across multiple institutes of the NIH. Also in 2003, Dr. Peng led the creation of the Interagency Modeling and Analysis Group (IMAG), which now consists of program officers from 10 federal agencies of the U.S. government and Canada (imagwiki.org). IMAG has continuously supported funding specifically for multiscale modeling (of biological systems) since 2004. IMAG facilitates the activities of the Multiscale Modeling (MSM) Consortium of investigators which started in 2006. Dr. Peng is interested in promoting the development of intelligent tools and reusable models, and integrating these approaches in engineering systems and multiscale physiological problems.

LIFE SCIENCES AND ENGINEERING

Center for Brain Imaging
Bharat Biswal, Director

The long-term goal of the Center for Brain Imaging is to better understand human brain function using integrative neuroimaging and statistical and computational modeling methods. We have four research themes: human brain functional patterns and their development in health; reliable neuroimaging measures; functional patterns in animal models; and a combination of the above information to explore how specific aspects of psychological processes associate with brain function and how mental and neurodegenerative diseases disrupt normal brain functioning. Our work is based on the principle that understanding the complexity of brain function and its development will prove helpful, and perhaps even necessary, in the search for effective treatments. We use modern neuroimaging techniques (MRI, fMRI, PET, fNRIS), and we map the three levels of the intrinsic architecture within the brain function (i.e., region, subnetwork and entire brain). We then direct our investigations to brain development within different life spans, to computational simulation on brain connectome and to clinical psychology and psychiatry guided by our neuroimaging results. We are working on several disease models including aging, Alzheimer's, schizophrenia and autism, as well as on spinal cord injury subjects. Our research is currently funded by the National Institute on Aging and the National Institute of Biomedical Imaging and Bioengineering, both divisions of the National Institutes of Health, the National Science Foundation, the New Jersey Commission on Spinal Cord Research and the Governor's Council for Medical Research and Treatment of Autism.

Center for Injury Biomechanics, Materials and Medicine (CIBM3)
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 have also raised serious health concerns. Specifically, through novel blast tube and drop tower facilities, we examine what type of helmets, pads and configurations offer the right protections to soldiers and players. We study when and how concussions are caused and if there are simple diagnostic methods to determine concussions. We use animal models and mechanical surrogates to examine the role of blast pressures and the height of falls to relate insult to 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 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 (CMEMT)
Kamalesh K. Sirkar, Director

The Center for Membrane Technologies (CMEMT) investigates problems in which membrane technologies achieve the separation and purification of 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 interest.

Rehabilitation Engineering Research Center
Richard Foulds and Sergei Adamovich, Co-Directors

NJIT and the Kessler Foundation are collaborators in the Rehabilitation Engineering Research Center, working on wearable robots for independent mobility and manipulation for individuals with stroke, spinal cord injury and muscular dystrophy. The Center has three research and two comprehensive development projects, plus a portfolio of training activities. Two of the research projects employ commercially available, lower-extremity exoskeletons currently in use at Kessler. One explores the potential of simultaneous spinal cord stimulation to improve exoskeleton use by individuals with spinal cord injury. The

second studies improvements in gait after stroke by using exoskeletons early in the rehabilitation process. The third project, which employs a new upper extremity exoskeleton being developed by NJIT, studies the benefit of home-based robotic rehabilitation of the upper extremities in people who have had a stroke. The first development project explores the application of robotic admittance control as a means of allowing users of a lower-extremity exoskeleton to have complete control over the movement of their legs. The users make walking-like movements with their hands or fingers which are sensed and used to control the movement of the exoskeleton legs. Haptic feedback of the leg movement, conveyed to the hands, provides essential feedback to the user. The project also explores the ability of additional powered degrees of freedom to allow a combination of autonomous and user-initiated balance. The second development project extends the NJIT-developed upper-extremity orthosis to meet the needs of children with muscular dystrophy and people of all ages with incomplete tetraplegia due to spinal cord injury. The Center is developing a new continuing education course for clinicians and physicians on wearable robotic applications and a new graduate course for engineering students on the design of wearable robots. Material from the RERC will enhance NJIT's existing graduate courses on biorobotics, neuromuscular engineering and neurorehabilitation, as well as infuse wearable robot experiences into MS theses, undergraduate Capstone design projects and the mentoring of pre-college students.

Fluid Locomotion Laboratory
Brooke Flammang, Director

In the Fluid Locomotion Laboratory we use a multidisciplinary approach, integrating comparative anatomy and physiology, biomechanics, hydrodynamics 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 research topics currently ongoing in our lab. One major initiative focuses on the functional morphology of the remora adhesive apparatus with applications in defense, healthcare and research technologies requiring long-term reversible attachment in wet conditions. Other projects include studying the swimming behaviors of living reptiles and robotic models to interpret the functional morphology of extinct ichthyosaurs, modelling 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.

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.

Neural Prosthetics Laboratory (NPL)
Mesut Sahin, Director

The primary research thrust of the Neural Prosthetics Laboratory is to develop novel and translational neural prosthetic approaches to help restore function in people with disabilities resulting from injuries to the central nervous system, such as a spinal cord injury, traumatic brain injury and stroke. The accompanying neuroscience motivation is to increase our knowledge about the role of the spinal cord and the cerebellum in motor coordination and sensory-motor integration.

Opto and Microfluidics Laboratory from Diagnostics to Therapeutics
Sagnik Basuray, Director

The research efforts of the Opto and Microfluidics Laboratory are to establish a synergy between novel nanostructures, optics (plasmonics and photonics), biology and electro-kinetics (microfluidics and nanofluidics) and to integrate them to develop transformative and disruptive new technologies using cost-effective tools. This will be instrumental in the

development of a fundamental understanding of interfaces and surface physics arising out of the interaction of metallic/dielectric atoms with biological molecules in an energy landscape. The areas of expertise of the Opto and Microfluidics Laboratory include developing chemical and biological sensors using nano/microfluidics and nanotechnology platforms; studying metal/dielectric/bio interfaces like SERS and Plasmonics; conducting electrodynamic and electrohydrodynamic simulations from bulk to nano. The lab is currently researching techniques to develop a lab-on-a-chip technology for an electro-chemical, label-free, cost-effective, carbon nanotube and shear discrimination-based diagnostic device; a nano-fluidic-based label-free, electrochemical sensor as an alternative to gel electrophoresis and chromatographic separations. We are also working on a fundamental platform to show the dependence of nonlinear electrokinetic effects on the dielectric biomolecule and design assays based on these physical insights. Several interdisciplinary projects are currently in progress with collaborators outside the lab that include: developing a multidisciplinary platform for single-cell analysis using microfluidics, biomedical imaging, computation, drug delivery, galvanotactics with Roman Voronov at NJIT; a two-layered microfluidic device with nanofluidics gates, µTRANS – micro total-analytical neurological system with James Haorah at NJIT; µFILMS to study pharmaceutical films with Ecevit Bilgili and Rajesh Davé at NJIT; investigating additive manufacturing techniques, chiefly 3D printing for making microfluidics devices with circuits with Wen Zhang and Gal Haspel at NJIT.

SwarmLab

Simon Garnier, Director

The SwarmLab is an interdisciplinary research unit that studies the mechanisms of Swarm Intelligence. We study how information is exchanged and transformed during interactions between members of a group and how this can lead to the emergence of "intelligent" and "less intelligent" group behaviors. We focus on understanding 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 complex problems such the organization of pedestrian traffic or the control of miniature robotic swarms. We collaborate with biologists, social scientists, physicists, mathematicians and computer scientists from three different continents in order to elucidate the fundamental principles that underlie collective behavior across levels of biological and social organization.

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 appropriate cues to stem cells, either already present within the body or implanted, to affect their behavior. Functional biomaterials are materials that provide biological cues to stimulate tissue growth. 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 complex with growth factors to simulate tissue growth and piezoelectric materials provide electrical activity to cells in response to mechanical deformation. 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 negatively impacts the activities of daily living. Symptoms include double/blurred vision, eyestrain and headaches during reading or other near work that negatively impacts activities of daily living. CI is present in 4 percent of the population where approximately 27 percent of CI patients do not improve even with validated therapy. This project studies two potential mechanisms causing CI which may be improved via validated therapy by quantifying phoria adaptation, neural substrates and behavioral eye movements. This knowledge can lead to targeted therapeutic interventions, improved success rates, reduction in the time to remediation, and reduced healthcare costs.

SUSTAINABLE SYSTEMS

Center for Building Knowledge
Deane Evans, Director

The Center for Building Knowledge (CBK) is a 25-year-old research, training and technical assistance institute affiliated with the College of Architecture and Design at NJIT. CBK is dedicated to generating new knowledge to improve the built environment and enhance the planning, design, construction and operation of facilities. Led by Executive Director Deane Evans, CBK's mission is to help individuals and communities make better-informed decisions concerning the performance, sustainability and resilience of buildings nationwide.

Center for Natural Resources Development and Protection
Michel Boufadel, Director

The Center for Natural Resources Development and Protection investigates sensible approaches to environmental and energy resource utilization. Research projects at the NRDP Center include assessment and remediation studies of pollution in natural settings and the evaluation of natural resources for the potential production of energy, especially the production of renewable energy.

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 an interest in understanding the effects of the Sun on the geospace environment. CSTR operates the Big Bear Solar Observatory (BBSO) and Owens Valley Solar Array (OVSA) in California, the Jeffer Observatory at Jenny Jump State Forrest in New Jersey and the Automated Geophysical Observatories (AGOs) distributed across the Antarctic iceshelf. The Center also manages a large number of instruments at South Pole Station, McMurdo Station, across South America and across the United States. CSTR is one of the principal investigator organizations in NASA's Van Allen Probes mission and houses the Space Weather Research Laboratory (SWRL), 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 potential influence on Earth. Such unique instrumentation and data resources enable scientific studies spanning from the Sun's surface, to the Sun's extended atmosphere and into the Earth's atmosphere.

Center for Solar-Terrestrial Research—Big Bear Solar Observatory (BBSO)
Dale Gary, Director

The Center for Solar-Terrestrial Research (CSTR) operates the Big Bear Solar Observatory 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 the highest resolution views of the Sun's surface features, such as sunspots, filaments, faculae and granulation. Its instruments measure the magnetic fields and motions of these features to understand the basic physics of solar activity, which affect the Earth and near-Earth technological systems. With the BBSO telescope's unrivaled resolution, NJIT scientists explore 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 improves our ability to predict the occurrence and outcomes of such solar activity on Earth.

Center for Solar-Terrestrial Research: Expanded Owens Valley Solar Array (EOVSA)
Dale Gary, Director

The Center for Solar-Terrestrial Research (CSTR) operates the Expanded Owens Valley Solar Array in California, which is nearing completion of its major expansion to become one of the most capable solar-dedicated radio arrays in the world. The array consists of 15 antennas imaging solar flares at hundreds of frequencies over the frequency range 2.5-18 GHz in one second. Its ability to follow evolving radio emissions with such high frequency and time resolution allows us to capture 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, 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.

Electronic Imaging Center
Haim Grebel, Director

The Electronic Imaging Center is an interdisciplinary Center focused on nanotechnology, spectral analysis with sub-wavelength structures and energy. Nanotechnology is a field dealing with underlined phenomena at the nanoscale. It covers diverse phenomena that encompass molecular/biological interactions, interfacial science, as well as bulk and surface properties. The field is fast expanding into agriculture, energy and pharmaceutical industries. Spectroscopy with sub-wavelength 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.

Membrane Science, Engineering and Technology (MAST) Center
Boris Khusid, Director

The Membrane Science, Engineering and Technology (MAST) Center, a National Science Foundation Industry/University Cooperative Research Center (I/UCRC), 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 transfer between Center researchers and Center sponsors which include 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 (IAB). This Center is located at three university research sites: NJIT, 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.

New Jersey Center for Engineered Particulates (NJCEP)
Raj Davé, Director

Creation of advanced particulate materials and products through the engineering of particles is a major research focus of the New Jersey Center for Engineered Particulates (NJCEP). The Center is engaged in fundamental research combining experimental, computational and theoretical studies to achieve an understanding of particle properties at the individual particle scale in order to predict particle and product behavior at the macro-scale, resulting in unique added value. The work has industrial applications in the pharmaceutical, food, cosmetics, ceramics, defense, electronics and specialty chemicals industries. The Center's research infrastructure includes comprehensive equipment for the characterization and processing of particles and brings unique expertise and IP in various topics. An example of IP that has been licensed under a royalty bearing agreement is a patented solventless mechanical particle coating process. NJCEP is closely affiliated with the National Science Foundation – Engineering Research Center (NSF-ERC) and the Center for Structured Organic uParticulate Systems (C-SOPS), a partnership between four universities, including Rutgers, Purdue, NJIT and the University of Puerto Rico at Mayaguez, that is focused on improving the way pharmaceutical products are manufactured. As a part of the portfolio of technology platforms, NJCEP has developed a stripfilm real-time release methodology for delivering nano and micron-sized very poorly water-soluble activities in a well-dispersed state with full recovery of nanoparticles.

Advanced Energy Systems and Microdevices Laboratory
Eon Soo Lee, Director

The Advanced Energy Systems and Microdevices Laboratory's energy research is focused on the non-platinum group metal (Non-PGM) catalysts and their applications for electrochemical energy systems and industrial applications. Non-PGM catalysts have a huge potential due to the very low raw material cost compared to that of PGM catalysts in many applications spanning from catalytic devices in filtering systems or petroleum processing systems to electrochemical systems such as fuel cells or metal-air batteries. However, there is still huge gap between the PGM and non-PGM models to be filled by research. The major research activities of the lab include: synthesizing new non-PGM catalysts for new energy systems from carbon materials such as graphene with the addition of nitrogen, transition metals, and porous materials to modify the characteristics and enhance the catalytic performance of the synthesized catalysts; characterizing the physical, chemical and electrochemical properties of the new synthesized catalysts by XPS, Raman, SEM, TEM, XRD, RRDE and an electrochemical testing station; and investigating the reaction mechanism of the new synthesized catalysts through experimental methods for a fundamental understanding of the reaction mechanism. We are collaborating with Brookhaven National Laboratory, CUNY's Advanced Science Research Center, Rutgers' XPS facility center and with the Material Characterization Laboratory at NJIT's York Center for Environmental Engineering and Science on research that will provide a substantial pathway to the new cost-effective and fuel-efficient energy conversion system for the next-generation energy society. We are also applying micro and nano technology and new catalytic materials to biochip microdevices research for disease detection and diagnosis using both innovative sensing technology and unique microchip design developed in the lab in collaboration with researchers at Hackensack University Medical Center, Rutgers Medical School and Brookhaven National Laboratory.

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 are geared toward developing instrumentation for online and real-time monitoring analysis, environmental monitoring, field-portable instruments and microfluidic devices. In nanotechnology we work on nanoparticles, particularly carbon nanotubes, in applications such as batteries and solar cells and chromatography stationary phases. In water treatment our work is related to defluoridation, arsenic removal and desalination.

High Performance Concrete Laboratory
Methi Wecharatana, Director

High performance concrete has been a topic of global interest for the past 20 years. Started in the early 1980s by producing high-strength concrete with a strength of 15,000-20,000 psi that is five times stronger than that of normal concrete, research on advanced concrete materials has expanded into high- performance concrete. These areas include high durable concrete, impact resistant concrete, microdefect free (MDF) concrete, fiber-reinforced concrete, fly ash concrete, high performance carbon fiber reinforced concrete and high strength fiber reinforced plastics, among others. The High Performance Concrete and Structures Laboratory was one of the first research facilities in the U.S. that was funded by the National Science Foundation. Six closed-loop hydraulic MTS and Instron testing machines with capacity ranging from 25,000 to 1 million pounds were installed in our laboratory, making it one of the state-of-the-art materials and structural testing facilities in the U.S. The high-bay structural concrete laboratory in Weston Hall allows us to test full-scale, 12-ft. long columns with automated closed-loop hydraulic testing machines. The lab has two reaction walls that enable us to simulate lateral loads from both wind load and earthquakes. The recent addition of two new faculty members, Dr. Matthew Adams and Dr. Matthew Bandelt, in advanced concrete materials further expands our research programs into fatigue and durability of high-performance, fiber-reinforced concrete and microstructures of high-performance concrete using Scanning Electron Microscopes (SEM) and Transmission Electron Microscope (TEM). Past and ongoing funding for our research comes from government agencies such as the National Science Foundation, the U.S. Department of Energy and the National Oceanic and Atmospheric Administration, as well as 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 is when multiple physical phenomena are present in the response of a material, more than just 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 material 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 the material behavior over a wide range of environmental conditions; to develop constitutive models to capture that material behavior; to develop 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 laboratory for Micro and Nano Mechanics 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 the lab is to understand the role of stresses in the degradation of lithium-ion batteries which will enable durable and lightweight 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. The only other universities with this capability in the U.S. are Brown University and Harvard University. We also have the capability to carry out mechanical property measurements within high and low-temperature environments. We develop new nano and microscale testing setups to understand the mechanics at nano and microscale pertaining to the interface fracture, degradation and failure of solids.

DATA SCIENCE AND INFORMATION TECHNOLOGY

Center for Computational Heliophysics
Alexander Kosovichev, Director

The primary goal of the Center for Computational Heliophysics (CCH) is to develop data analysis and modeling tools in the area of heliophysics by combining expertise from the College of Computing Sciences (computer science department) and the College of Science and Liberal Arts (departments of physics and mathematical sciences) in partnership with the NASA Advanced Supercomputing (NAS) Division at the NASA Ames Research Center. The Center's work is focused on new 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.

Center for Wireless Communications
The Elisha Yegal Bar-Ness Center for Wireless Communications and Signal Processing Research
Alexander Haimovich, Director

The Elisha Yegal Bar-Ness Center for Wireless Communications and Signal Processing Research (CWCSPR) engages in research in diverse areas of communications, signal processing and radar. The Center serves as a collaboration hub of faculty, visiting scholars, postdoctoral fellows and both graduate and undergraduates students. Current main areas of research include cloud radio access networks, cooperative networks, distributed radar and acoustics communications. Cloud Radio Access Network (C-RAN) refers to the virtualization of base station functionalities in a cellular system by means of cloud computing. Our research explores novel cellular architectures and C-RAN inspired by network information-theoretic principles. In decentralized networked systems, one fundamental problem is to coordinate

activities of different nodes so they reach a state of consensus. We are interested in a generalization of this problem with 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. Our research focuses on the detection and tracking of ground-moving targets embedded in ground clutter with relatively simple sensors that are time-synchronized, but not phase-synchronized. The sensors communicate their observations to a central processing center. In the oil industry during drilling, for example, real-time transmission of important data such as temperature, pressure, torque and drilling direction from downhole to the surface is of high importance. Since boreholes are typically very deep, wired communication is very expensive and prone to failure. We research wireless communication by way of acoustic propagation to achieve high transmission rates.

Cybersecurity Research Center

Kurt Rohloff and Reza Curtmola, Co-Directors

Cyber technologies are critical in modern society and include communication networks, handheld 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, securing cloud computing services, privacy technologies, improved software engineering techniques, better data encoding and communication protocols, human factors research and so on. The Center is primarily affiliated with the College of Computing Sciences (CCS) but is intended to be highly collaborative and inclusive, with the goal of including and supporting collaboration with cybersecurity relevant researchers outside of CCS, 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 (DARPA, AFRL, ARL, AFRL and others) and the National Science Foundation. Current collaborators include MIT, École Polytechnique Fédérale de Lausanne, Raytheon and the U.S. Navy's Space and Naval Warfare Systems Command (SPAWAR), 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 a financial bubble can be identified including its stages of development and what policies can best manage its 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 area of research focus for the School of Management. Outside of academia, we expect significant interest within the financial community and relevant government regulators.

NJ-HITEC

William O'Byrne, Director

As part of the New Jersey Innovation Institute (NJII) Healthcare Delivery Systems iLab, NJ-HITEC was formed in 2010 as New Jersey's regional exchange to support health information technology use by New Jersey providers. NJ-HITEC is one of the most successful Regional Extension Centers, established by the Office of the National Coordinator for Health Information Technology, in the country and is considered by New Jersey doctors to be their "trusted health IT adviser."

Structural Analysis of Biomedical Ontologies Center (SABOC)

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. These medical terminologies are hard to understand and contain inconsistencies. Understanding them and finding inconsistencies with textual representations is difficult, and graphical representations are therefore used. In a graphical representation, biomedical terminologies appear as networks where 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 topics 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 (EHRs), 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. ANL innovations are disseminated via patent disclosures, journal publications, conference presentations, and presentations to funding sponsors and prospective users. For example, ANL, in collaboration with NEC America, has made advances in Passive Optical Networks. The National Science Foundation (NSF) has supported investigations into finding a new way to provide services to a growing set of traffic classes in next-generation networks. ANL has led an international 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 NSF. Three other recent NSF projects include: FreeNet: Cognitive Wireless Networking Powered by Green Energy to the 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; and REPWiNet (Renewable Energy Powered Wireless Networks) to efficiently power future wireless networks by renewable energy.

Face Recognition and Video Processing Laboratory

Chengjun Liu, Director

The Face Recognition and Video Processing Lab develops advanced theoretical methods and applies them to solve problems such as facial recognition, image search, video retrieval, big data analytics and visualization. These areas have broad applications in Smart City areas such as security and the Internet of Things (IoT) and in face searches in social media and Web portals such as Facebook and YouTube. Specifically, we focus on pattern recognition, machine learning, image processing and computer vision research and development with applications in biometrics and security. We have developed advanced pattern recognition and machine learning methods, innovative similarity measures and novel color models, local image descriptors and patented face detection technology. Our methods have been successfully applied to face recognition, face detection, iris detection and recognition, image search and image category classification for homeland security, justice and law enforcement, as well as business applications.

TRANSDISCIPLINARY AREAS

Center for Applied Mathematics and Statistics
Michael Siegel, Director

The Center for Applied Mathematics and Statistics (CAMS) is an interdisciplinary research center dedicated to supporting research in the mathematical sciences. 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 and a summer program for graduate students.

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 combine the student, faculty and NJIT resources with a "know-how" network of subject matter experts, partnerships, resident company interactions, university/business/government collaborations as needed to assist resident companies with R&D tasks, meeting milestones, scaling their business and preparing to obtain access to capital.

Intelligent Transportation Systems (ITS) 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 goals of reducing congestion and improving mobility, safety, and the 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 between 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 a secure exchange of digital information, these new delivery systems improve the quality of care and foster new medical device technology to lower costs and improve outcomes.

- Biotechnology and Pharmaceutical Production: 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: 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 defense and national security, 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 (YCEES) offers core and shared research laboratory facilities as a resource for many interdisciplinary research programs and initiatives. The Center was the first building in the nation especially 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, the U.S. Department of Defense and from leading industries. The Center also provides Faculty Instrument Usage Seed Grants (FIUSG) for the use of core laboratories. The purpose of these grants is to promote research across campus by providing free instrument time to obtain preliminary results that will lead to the development of new ideas and grant proposals. The FIUSG initiative also aims to support the launch of new initiatives in core and interdisciplinary emerging areas aligned with NJIT's strategic interests.

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