NEW JERSEY INSTITUTE OF TECHNOLOGY

RESEARCH

LINKING LABORATORIES TO LIVES

NJIT

100 years
NEWARK COLLEGE OF ENGINEERING
NEW JERSEY INSTITUTE OF TECHNOLOGY

Photo: Oscar Masciandaro

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As we celebrate the 100th anniversary of Newark College of Engineering this year, it's exciting to see how engineers are now engines of advancement in so many important endeavors in modern life. With research that is both fundamental and applied, they are developing efficient diagnostic devices, next-generation battery technologies, smart transportation infrastructure and ingenious ways to send information around the globe.

But it is in the arena of sustainability that engineers, working on multidisciplinary teams with computer scientists, data analytics experts and life scientists, among others, are making some of their most critical contributions. And what exactly does sustainability mean in 2019? It has certainly evolved since the 1980s, when it referred largely to economic growth and development that did not tax resources or harm the planet. I would suggest a much broader definition, one that encompasses multiple sectors.

In health care, for example, technologists working together are not just devising devices to treat patients, but to help them maintain their health. These measures also represent huge cost savings to society that will allow us to invest in crucial needs in other arenas. By developing predictive and proactive data analytics technologies, we can help businesses — and indeed, entire sectors — better manage risks in the long and short term to avoid potentially massive economic dislocations that throw us off course. There are truly urgent matters on the horizon, such as climate change, that require our full attention.

And do these devices meet the 1980s definition of sustainability? Elegantly and inexpensively designed in ways that consume the fewest resources, I would say they do!

In this issue of the New Jersey Institute of Technology Research Magazine, we focus first on the important work that our researchers across disciplines are doing to improve the sustainability of our water, infrastructure, health and medicine, and data analytics and information systems. They include methods to capture emerging contaminants in our water supply, pollutants at their point-of-use and oil that has been spilled in our waterways; technology to extend battery life, to optimize power distribution and create resilient building materials; new materials to save teeth, restore heart tissue and develop biosensors that fine-tune selectivity and sensitivity in diagnostic devices; new means to make telecommunications networks more energy efficient, to optimize collaboration between machines and people and to bring diverse talent into STEM fields.

Elsewhere in this issue, we include snapshots of our current research in many other areas: in transportation infrastructure, in computer accessibility for the disabled, in brain-inspired computing, and in enhancements to data and information security that inspire the trust of users' personal, corporate and defense communications.

Just as we did 100 years ago at the founding of our engineering college, we take our mission seriously to train students to be the highly skilled workers society needs. But more than that, we also want them to be dreamers, visionaries and inventers — to not just make things well, but to make them new. That's why 350 undergraduate students a year spend significant time working closely with our researchers in the campus's more than 93 research institutes, centers and laboratories. Soon enough, we may be asking them to once again redefine sustainability — to not just moderate the damages of industrial society, but to reverse them.

By forming larger research clusters focused on complex problems, such as our new Institute for Space Weather Sciences, we are able to harness the talents of researchers and their students from across the campus. Linking our solar scientists with powerful computing and mathematical capabilities, we will deepen our knowledge of the bursts of solar electromagnetic radiation, energetic charged particles and magnetized plasma known as space weather, while protecting our increasingly complex engineered systems, both on land and in space, from harm.

Atam P. Dhawan
Senior Vice Provost for Research
Distinguished Professor of Electrical and Computer Engineering

Photo: Oscar Masciandaro

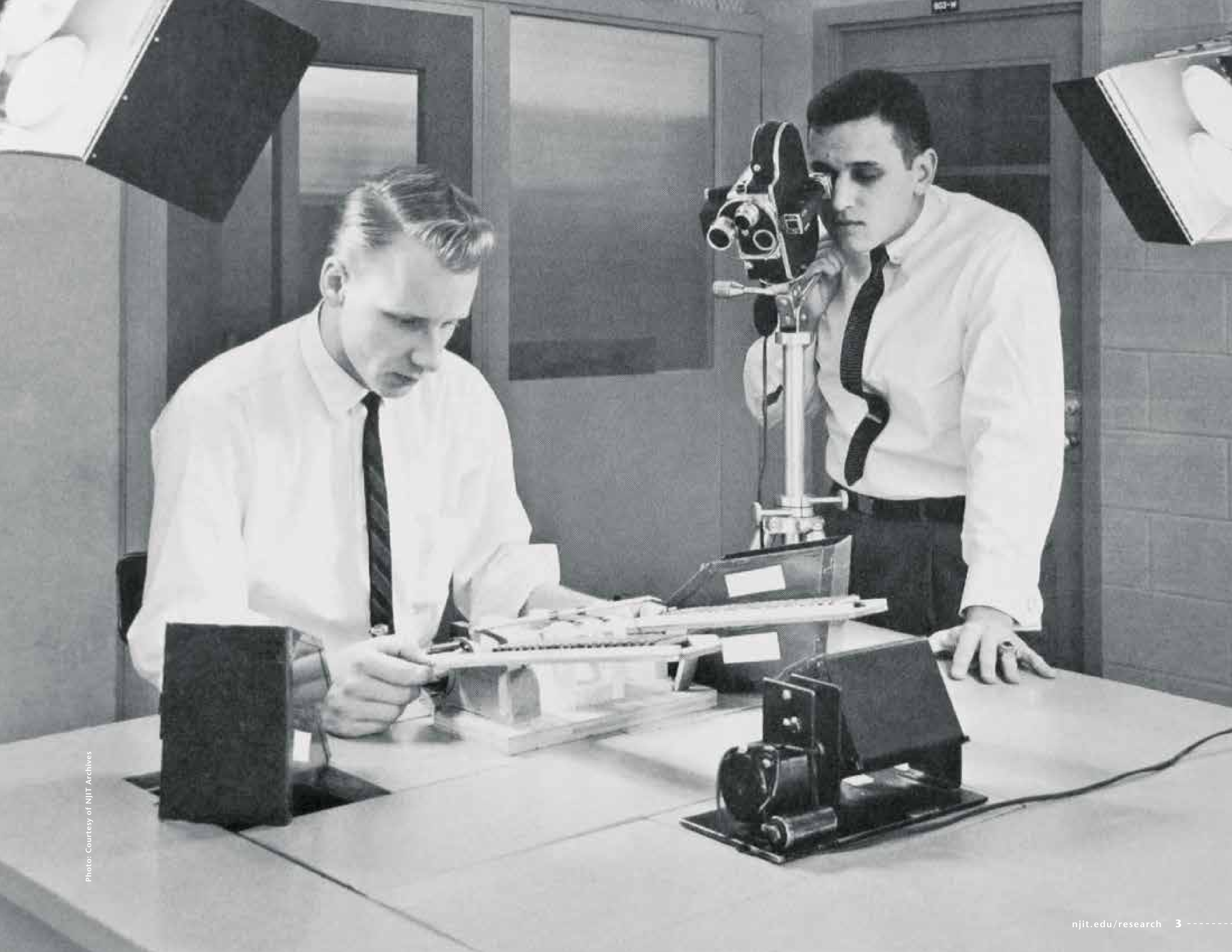


Photo: Courtesy of NJIT Archives

Relieving Planetary Stress With Sustainable Technologies

The 21st century is rapidly resetting the goalposts for sustainable life on Earth. Within five years, the world population is projected to reach 9 billion; by 2050, nearly 70 percent of people will live in urban areas. All the while, climate change is adding stress on both natural ecosystems and built environments.

Increasingly, technologists see their mission as twofold: to continue advancing living standards, while ensuring their innovations do not harm the planet. Designing devices that are inexpensive, simple to use and widely applicable is a guiding principle. Sustainability from creation, to use, to end-of-life is the gold standard.

With these criteria firmly in mind, work on sustainable systems at NJIT focuses on four main facets of modern life: water, health and medicine, infrastructure and data.

WATER

Researchers in this cluster use sensors, nanotechnology-enhanced filters and chemical, biological and physical processes to protect and remediate water at several points of contact: from oceans and inland waterways, to industrial and municipal water systems, to pipelines. A primary goal is to better understand the behavior of water pollutants, including interactions among chemicals and natural materials. Modelers track the path of pollution as it disperses. Among a variety of remediation methods is the use of reactive membrane filtration devices to degrade contaminants of emerging concern, pathogens and viruses at the point of use.

WHILE TECHNOLOGISTS increasingly focus on preserving the planet and its people, they also bring their talents for planning, designing, measuring and organizing to diverse fields. NJIT alumni reflect this range: a chemist who brought electricity to remote parts of the world; a biomedical engineer and entrepreneur who developed new methods for joint implants that maximize mobility; an electrical engineer who became a judge; and a chemical engineer — and four-star general — who led the Air Force Materiel Command.

SUKLA CHANDRA M.S. '96

As managing director of GE Ventures India, SUKLA CHANDRA is responsible for technology transfer and licensing collaborations for GE Technologies in India. In a prior position, she developed and executed product and commercialization strategies for GE's Rural Electrification Platform, and in that role led measurable progress toward providing electricity in remote parts of the world. Chandra currently serves on the board of the Alliance for Rural Electrification, based in Belgium.

ROBERT COHEN '83, '84, '87

ROBERT COHEN, an NJIT trustee, is the vice president and general manager of the global research and development business unit in the Joint Replacement Division at Stryker Orthopaedics. He leads all joint replacement division implant and robotics product development, research and development operations, regulatory affairs, clinical outcomes research and advanced technology groups. Earlier, as a health care industry entrepreneur, he envisioned the convergence of advanced materials, new fabrication methods and robotic-assisted surgery to maximize motion restoration.

SOHAIL MOHAMMED '88

When he was appointed to the bench of the Superior Court of Passaic County in 2011, SOHAIL MOHAMMED, a former electrical engineer, became the first Indian-American judge in the state of New Jersey. Prior to his appointment, Mohammed was an immigration lawyer who won the respect of fellow lawyers, law enforcement officials and human rights advocates well beyond the state's borders for defending immigrant Muslim clients detained by the FBI after Sept. 11.

ELLEN M. PAWLIKOWSKI '78

In 2016, ELLEN M. PAWLIKOWSKI was promoted to the rank of four-star general in the U.S. Air Force. She was just the third woman in the history of the Air Force to receive a fourth star. She went on to direct the 80,000-person Air Force Materiel Command for the U.S. Air Force, which included managing city-sized military bases and leading the Air Force's investment in weaponry technologies — from hypersonics, to lasers and high-powered microwaves, to automated devices.

Photos (left to right):
Courtesy of Michele Hickey '14
Courtesy of Stryker Orthopaedics
Courtesy of Sohail Mohammed
Courtesy of U.S. Air Force

HEALTH AND MEDICINE

This research cluster focuses on neuroscience, neural engineering, regenerative and rehabilitative medicine and point-of-care technologies that detect disease at early stages. Imaging experts, computer scientists and biomedical engineers are working together to devise therapies and devices that will sustain lives by improving motor, cognitive and organ functions. Tissue engineers seek to replace dysfunctional cells with regenerating cells and tissues, prompting the body to heal itself. At the systems level, our researchers improve health care information systems and management involving primary care, hospitals and emergency care resources and protocols.

INFRASTRUCTURE

In this wide-ranging cluster, research areas include 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. Energy sustainability is also a key focus, with the goal of gleaning efficiencies at every level of use, from battery storage, to communication networks, to energy purchasing models. The scope of nanotechnology research includes scientific and engineering phenomena at the minutest and most fundamental levels in order to develop technologies to remediate and protect the environment.

DATA

In this broadly interdisciplinary cluster, researchers focus on bioinformatics, medical informatics, image processing, data mining, solar-terrestrial physics, transportation, financial management, life sciences and health care. The cybersecurity group designs secure cyber systems and improves cyber information and communications technology to improve the safety of traditional systems while enabling the rise of new decentralized enterprises. But our researchers also focus on the human end of the equation by ensuring that there is a diverse technology workforce that works comfortably and efficiently with the machines that power our increasingly automated society.

Legacy pollutants from the industrial age and emerging contaminants from the new millennium jeopardize the safety of our drinking water. Relentless development and climate-driven drought threaten supply. Engineers are tackling these macro challenges to oceans, ecosystems and urban water networks with increasingly diverse approaches: biologically active filters, reactive membranes and precise pollution modeling.

Photo: Oscar Masciandaro

Containing New Contaminants Before They're Unmanageable

LISA AXE, *Director of the Environmental Systems Laboratory*

problem:

While not yet regulated by the U.S. Environmental Protection Agency, contaminants of emerging concern (CECs) include a host of potentially hazardous compounds that are increasingly entering the water cycle, and are derived from using everyday products — from pharmaceuticals to personal care items.

solution:

Lisa Axe, a professor of chemical and materials engineering, is developing an advanced treatment process for CECs that involves converting existing traditional filters and adsorbents at water treatment facilities into biologically active filters, rich in contaminant-degrading microbes.

how it works:

Axe's lab recently applied microbial films to two processes typically used in municipal water treatment plants — granular activated carbon (GAC) and anthracite/sand media filtration. The team measured their filters' performance using 16 "indicator compounds" that represent the vast array of CECs being detected throughout the water cycle. The lab observed greater than 80 percent removal of CECs using their GAC biologically activated filter. Axe's group is collaborating with the lab of her NJIT colleague, chemist **Mengyan Li**, to isolate bacteria responsible for degrading these compounds. Future research includes launching pilot demonstrations of their filters over the next year.

"Wastewater treatment plants are not generally designed to treat CECs," says Axe. "We have taken granular activated carbon normally used for polishing water or removing organic matter in the treatment plant, and we've designed a cost-effective, natural and sustainable biologically active filter that effectively removes CECs derived from antibiotics, steroids, beta blockers and even pesticides like DEET."

Photo: Oscar Masciandaro

Degrading Pollutants With Reactive Membranes

WEN ZHANG, *Co-director of the Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory*

problem:

An increase in CECs, chemical co-contamination and aging pipelines, as well as waterborne viruses and pathogens that are evolving to survive widespread use of antibiotics and vaccines, all present new safety and reliability challenges and added costs for centralized water treatment facilities.

solution:

Wen Zhang, an associate professor of civil and environmental engineering, is designing novel reactive membrane systems for point-of-use (POU) water treatment devices that degrade CECs, pathogens and viruses not captured by standard filtration at centralized water treatment facilities.

how it works:

Zhang's laboratory explores POU devices that employ filters with functionalized membrane surfaces — membrane surfaces coated with contaminant-degrading nanoparticles or nanomaterials as catalysts that are activated through chemical processes. Once activated, the membranes serve as a highly reactive barrier to destruct water pollutants on contact, providing a self-cleaning filtration system that also mitigates membrane fouling issues.

Zhang's laboratory researches three types of reactive membrane system technologies: reactive electro-chemical membrane systems that are activated by DC power sent to the membrane surface; photocatalytic reactive membranes activated by external UV or visible light irradiation; and microwave-activated membrane filtration systems, a novel technology Zhang's team is developing that involves sending microwaves to the filter's membrane surface to enhance contaminant degradation on contact.

In laboratory tests, Zhang's team observed removal of 99.9 percent of harmful bacteria and other organic matters using each of their three approaches.

"Water pollution is increasingly complex, thus pushing us to think about the next generation of water treatment solutions," says Zhang. "With our new technologies, we aim to reduce the burden downstream at water plants, while providing individual users access to safe drinking water."

Photo: Courtesy of Center for Natural Resources at NJIT

Predicting the Path of Oil Spills Before They Occur

MICHEL BOUFADEL, *Director of the Center for Natural Resources Development and Protection*

problem:

There are thousands of marine oil spills in the United States every year, each with a distinct set of physical and environmental variables that must be accounted for in order to properly track and mitigate their spread — from smaller fuel transfer accidents, to massive off-shore events such as the 2010 Deepwater Horizon spill.

solution:

Michel Boufadel, a professor of chemical and materials engineering, develops and applies computational models — also used by the National Oceanic and Atmospheric Administration and the U.S. Coast Guard — for predicting how different sizes and types of oil droplets migrate through various water systems.

how it works:

Boufadel's lab investigates the complex hydrodynamics of on- and off-shore oil spills using large-scale wave tanks located at the U.S. Naval Weapons Station Earle in Monmouth County, N.J., which simulate environmental conditions that impact the transport of oil droplets in water. His team is now analyzing ways to better understand the uncontrolled pipeline flow that took place during the Deepwater Horizon well discharge. Last year, they discovered a process that occurred during the well discharge called churn flow — whereby oil and gas tumble violently within the pipe, creating a sputtering discharge that influences the fate of petroleum compounds in the marine water column.

"Locally above the pipe's orifice, we found that the churn flow process changes the flow dynamics and makes the droplets smaller," says Boufadel. "This has an effect on their buoyancy, how they transport through the water and how we might prepare dispersants for mitigation."

As the data revolution gathers speed, transforming sectors ranging from business, to health care, to environmental policy, ensuring the movement is inclusive, efficient and environmentally sustainable is paramount. Diversifying the pool of technologists and optimizing the relationship between humans and machines are critical first steps. Cutting energy consumption will ensure its longevity.

Photo: Courtesy of Darleen Gearhart/ Sussex Avenue Renew School

Diversifying the Technology Workforce

MICHAEL LEE, *Director of the Gender Inclusive Design, Game and Educational Technology ("GIDGET") Laboratory*

problem:

The country's burgeoning computer and information technology industry is projected to add nearly 560,000 jobs by 2026. Filling those positions with tech-savvy workers able to meet the future needs of diverse populations in areas such as health care, energy and education poses a challenge: young people, particularly from under-resourced communities, often lack opportunities to pursue their interest in these fields.

solution:

Michael Lee, who invented a computer game called "GIDGET" (helpgidget.org) that has taught thousands of people worldwide to code by solving debugging puzzles, has developed a program to engage middle and high school students in Newark, N.J., in computing and programming projects that will sustain their interest throughout school.

how it works:

Working with the Urban League of Essex County and Newark Public Schools, Lee, an assistant professor of informatics, is helping to set up a learning center called the Coding House, open from 4:30 p.m. until midnight daily, where students from NJIT's Ying Wu College of Computing and Albert Dorman Honors College will teach everything from programming to mobile app development. The Coding House is a response to the collaborators' recent, successful Newark Kids Code (NKC) program, which drew Newark middle schoolers over 11 Saturday sessions to create their own webpages and music video animations. The students reported both increased confidence and an eagerness to continue coding. Under the new program, graduates of NKC will become peer participants and mentors to other students at the Coding House.

"We can't take a one-off approach in providing learning resources — a camp session here, a fun demo there and then nothing else until they graduate — if we want these students to succeed," Lee says. "And without their participation, the technologies we create will not fully reflect the needs of the diverse people who use them."

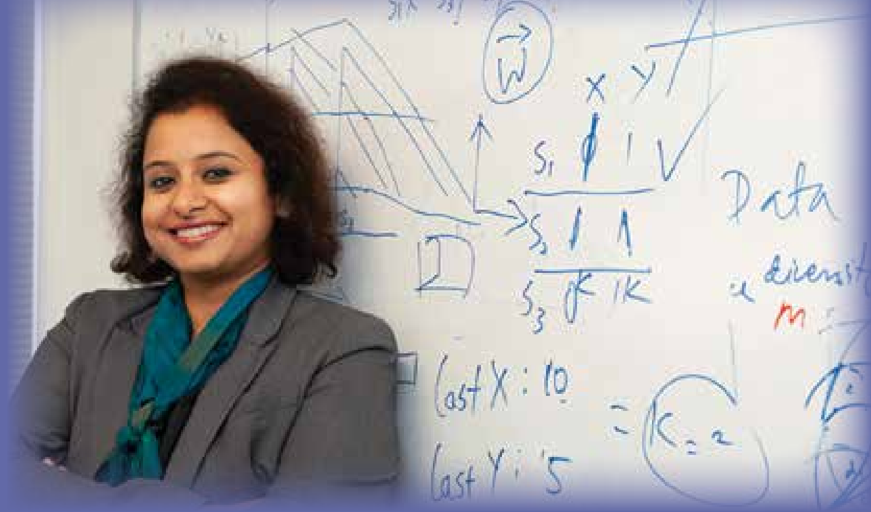


Photo: Oscar Masciandaro

Optimizing Human-Computer Collaboration

SENJUTI BASU ROY, *Director of the Big Data Analytics Laboratory*

problem:

For speed and accuracy, large-scale analytics requires input from both humans and computers. Machines operate quickly and comprehensively, but fail on some knowledge-intensive tasks. People work slowly, but discriminate in ways machines can't. They are best at detecting malicious emails, for example, and sifting through "noise," such as slight name variations that refer to the same person. But they can also introduce biases.

solution:

Senjuti Basu Roy is developing frameworks to optimize collaboration among humans and computers by determining which tasks are best assigned to each and how to coordinate them in processes ranging from cleaning and labeling data — a key quality-control step in predictive modeling — to deriving new features that aid modeling and ad-hoc data exploration, to designing new data exploration techniques. She deviates from traditional assumptions that consider humans as "rational agents" by acknowledging and adapting for bias and error.

how it works:

Among other applications, Basu Roy is looking at independent species observations from naturalists, citizen scientists and biologists to develop a model that will help them predict the distribution of animals and plants under varying environmental features. When the data, such as a wildlife photo, is uploaded to a crowdsourcing platform, her framework determines whether a machine can identify the species or if a human is needed; if the latter, it would indicate what level of expertise would be required.

"We have a responsibility to ensure that data is used effectively, but also fairly — free from intentional bias or unwitting ignorance," says Basu Roy, an assistant professor of computer science who works in multiple domains, from biodiversity, to biology, to disaster management. "When humans and machines work hand-in-hand, the framework should enable both parties to review and correct each other's bias and error."

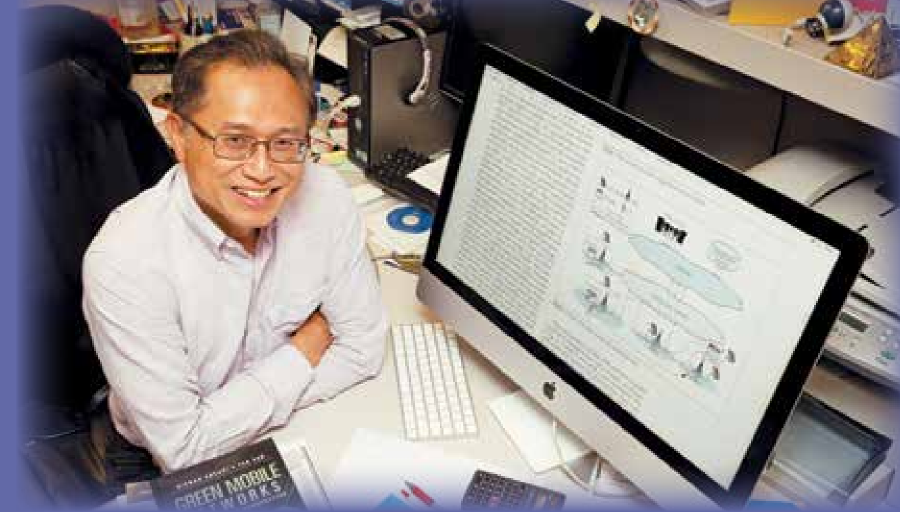


Photo: Oscar Masciandaro

Designing Smart and Green Data Networks

NIRWAN ANSARI, *Director of the Advanced Networking Laboratory*

problem:

The surge in power-draining electronic communications over the past decade has put new stress on the country's energy supply and the environment. To compound these strains, a significant amount of energy is lost on the way to the user as it moves across the transmission and distribution lines of the grid.

solution:

With his Greening At The Edges project, **Nirwan Ansari '82** is developing mechanisms to make the so-called "last mile" of the telecommunications system — the section of both optical and mobile networks that connects to consumers — more energy-efficient.

how it works:

To ensure round-the-clock reliability, communications components are often left on continuously. Base stations, which are signal relay hubs, are particular energy guzzlers, even when there is little signal traffic. Ansari has developed an intelligent system for automatically putting communications components, such as optical network units, sectors of a base station and even an entire base station, to sleep. Passive optical networks such as Verizon's Fios system primarily consist of two major types of components: optical line terminals (OLTs) located in a central office and optical network units (ONUs) located close to the end-users. These components are active regardless of the traffic load. Ansari's team has developed an intelligent protocol to place an ONU in the sleep mode when no traffic is destined to it, and to wake the component up automatically when traffic starts arriving.

"Service providers and network operators focus on delivering reliable services to customers in order to grow their subscriber base; this seems benign when energy is plentiful and cheap," notes Ansari, a professor of electrical and computer engineering. "However, as the infrastructure expands to provision communications among rapidly growing users and things, the energy cost is eroding the profit margin of these operators."

The United Nations Intergovernmental Panel on Climate Change sounds a shrill alarm: The window for making systemic changes to avert irreversible damage is closing fast. The agency calls new technologies "perhaps the most robust and effective" tool. Engineers are making a full-court press by rethinking batteries, proactively determining energy needs, and designing resilient and long-lasting infrastructure.

Ushering in a Carbon-Neutral Economy With Next-Generation Batteries

SIVA NADIMPALLI, *Director of the Micro and Nano Mechanics Laboratory*

problem:

The stakes for next-generation batteries that are high-capacity, long-lived and affordable could not be higher; the promise of a carbon-neutral economy depends on their success. While newer batteries can store 10 times as much energy as their graphite predecessors, they fade too quickly. The breakdown occurs at the interfaces between the polymers and the active materials that sustain electrochemical reactions; when these particles become electrically isolated, a battery's charging capacity and overall longevity are both curtailed.

solution:

Siva Nadimpalli, who specializes in fracture mechanics, uses novel in-situ experimental techniques to reveal how battery electrodes break down in real time, rather than after they degrade. His experiments will advance the development of multiphysics mathematical models, which capture a battery's mechanical behavior and the electrochemical activity of its electrodes, to predict how mechanical forces impact chemical reactions in battery materials, and to assess their corresponding electrical performance on, say, the current supplied by batteries at any voltage.

how it works:

Nadimpalli, an assistant professor of mechanical and industrial engineering, uses a custom-made cell that enables electrochemical and stress measurements simultaneously. By using thin-film electrodes that are 10,000 times thinner than a human hair, he captures real-time, uniform readings when a cell is running. The electrodes expand or contract upon reacting with lithium, which bends the substrate on which the film is deposited; the curvature change is measured by a multibeam optical sensor. By integrating his apparatus with an additional optical setup, he will also observe the failure phenomenon in real time. He is currently testing a lithium-ion battery with next-generation anode materials.

"By solving these problems, new generations of battery-powered machines such as electric cars can become commercially viable," says Nadimpalli.

Optimizing Power Distribution With Purchasing Transparency

HAIM GREBEL AND ROBERTO ROJAS-CESSA, *Researchers with the Center for Energy Efficiency, Resilience and Innovation*

problem:
The ability to proactively determine energy needs in order to distribute them optimally is a growing challenge. When demand spikes or disaster strikes, the energy grid is vulnerable to breakdowns, including blackouts; distribution dilemmas principally arise not when the power goes off, but when it comes back on, because the surge can create further problems, including potentially dangerous equipment failures.

solution:
Little has changed over the past century and a half — the country's electrical grid cannot assess demand in real time, but rather as it develops. When a light switch is flipped, there is no advance "grid alert." Energy still flows in one direction — from generator to user. **Haim Grebel** and **Roberto Rojas-Cessa**, both professors of electrical and computer engineering, are designing a proactive approach to determine users' needs ahead of time and to optimize power distribution by enabling information about energy demands and the energy itself to flow digitally in two directions.

how it works:
Much like ordering digital packages for mobile phones, consumers would issue a request to the energy provider for precise energy quanta, a process carried out automatically by a local micro-controller. In the team's proposed digital grid, energy would be sent in packets that carry the requested power for, say, a washing machine. Through a handshake protocol, the two sides would negotiate the amount and price of energy before delivery and it would be routed and rerouted through digital power switches directly to the home.

"Knowing energy demands ahead of time, even for a fraction of a second, will make the grid more reliable and energy efficient because there will be fewer surprises and therefore more order," Grebel notes. Rojas-Cessa adds, "In a grid with limited amounts of energy, power could be allocated during disasters or demand surges to critical loads rather than diluted among them all."

Photos: Oscar Masciandaro

Designing Infrastructure for a Dynamic and Unpredictable World

MATTHEW ADAMS AND MATTHEW BANDELT, *Co-directors of the Resilient and Sustainable Infrastructure Materials and Structures Laboratory*

problem:
The material building blocks of civilization — the asphalt, concrete and steel that compose highways, bridges and tunnels — face a daunting challenge: to hold up past the standard 50 to 75 years of service life amid rapid urban growth, and into a future in which extreme weather caused by climate change has made their performance dynamic and unpredictable.

solution:
Matthew Adams and **Matthew Bandelt**, assistant professors of civil and environmental engineering, are developing analytical tools, using computer modeling and experimental characterization techniques, to simulate the deterioration of various concrete mixes and to establish protocols for choosing construction materials suitable for severe environments and urgent repair situations.

how it works:
Collaborators on a new U.S. Department of Transportation grant, Adams, an expert on infrastructure material chemistry, and Bandelt, a mechanics and resilience modeler, are assessing the durability and performance of rapid-repair, damage-resistant ductile cementitious materials. These new materials are designed to improve constructability, reduce failure-related delays and extend periods between required maintenance. Bandelt develops computer simulation tools that predict their performance under scenarios that vary in temperature, weather volatility, chemical applications such as de-icing salts, and loading conditions. Adams uses advanced experimental characterization techniques to understand the material behavior under various environmental conditioning methods. Their colleague, civil engineer **Bruno Goncalves da Silva**, works on a related project to determine how fire spreads in tunnels, as well as methods to maintain structural integrity when they occur.

"The characterization techniques I use assess how the materials respond and describe how their structure is developed," notes Adams. "Dr. Bandelt then takes this information to build a more realistic computer model that simulates many more scenarios than in the lab."

Technologists on the front lines of health care share a common ideal: the simple fix. Rather than transplant an organ, they would restore the original, and avert emergency rooms with accurate point-of-care diagnostics. These methods are more broadly sustainable by reducing the cost of hospital stays, the risks of complex operations, and the waste of time, materials and money spent on unnecessary procedures.

Photo: Oscar Masciandaro

Sparing Teeth From the Root Canal's Death Sentence

VIVEK KUMAR, *Director of the Biomaterial Drug Development, Discovery, and Delivery Laboratory*

problem:

Each year, dentists in the United States perform about 15 million root canals, a procedure that involves removing infected tooth pulp and replacing it with inert polymeric materials. What remains is a brittle mineral scaffold instead of a living tooth capable of regenerating tissue.

solution:

Vivek Kumar and his lab members have created an injectable hydrogel designed to recruit autologous (a person's own) dental pulp stem cells directly to the disinfected cavity after root canal therapy. The tooth would be regenerated in part by prompting growth of the necessary blood vessels to support the new tissue.

how it works:

Kumar, an assistant professor of biomedical and chemical engineering, has created a novel delivery system, a Lego-like peptide composed of common amino acids with a biological agent attached at one end. The mechanism is sufficiently sturdy and resilient that it can be injected through commonly used syringes in the dentist's clinic; the molecules then reassemble after injection into the dental pulp cavity. The biological agent spurs growth of dental pulp stem cells.

Using a similar approach, Kumar's lab has developed a peptide-based therapy armed with antiangiogenic capabilities that target diabetic retinopathy, an ocular disease affecting more than 90 million people worldwide. People with the disease form immature blood vessels in the retina, obstructing their vision. The hydrogel can be injected directly into the vitreous gel of the eye, where the peptide interacts with the endothelial cells in the aberrant blood vessels, causing them to die."What makes the peptide hydrogel platform distinctive as a tissue regeneration device is the universality of its application, the ease of injection and the biocompatibility of the material," Kumar notes.

Photo: Courtesy of Viviena Meraviglia

Tracking the Heart's Microscopic Repair Crew in Real Time

ALICE LEE, *Director of the Cardiovascular Tissue Engineering and Stem Cell Laboratory*

problem:

Unlike most biological tissues, heart cells do not regenerate or proliferate. Following a heart attack, damaged tissue is not so much restored as slightly reconfigured; it becomes stiffer and less functional. Researchers pursuing cell-based therapies to repair cardiac tissue face a substantial hurdle: They do not understand on the cellular level how these regenerative therapies work. Existing models largely mimic a healthy cardiac environment with the goal of providing a living surgical replacement.

solution:

Alice Lee, an associate professor of biomedical engineering, has devised a novel in-vitro model for studying the multiphase biological mechanisms of transplanted cells in a diseased myocardial environment.

how it works:

In petri dishes in her laboratory, Lee is developing colonies of cardiac cells, formed into chambers, that pump and contract like a human heart. Derived from stem cells, these primitive organs will help her achieve a research milestone: to observe in microscopic, real-time detail how the heart repairs itself after injury. She must first induce an "attack" by damaging the tiny proto-hearts with a frozen rod, thus mobilizing sequential, cell-based repair crews that clear the injury site of debris, and then in a second phase, recruit materials and tools from the neighboring tissue to mend the damage.

"We see how different cell types in the heart interact during the repair process in the immediate aftermath of a heart attack — the period that offers the best chance for successful cell-therapy interventions," says Lee, who is currently working in the Netherlands with stem cell expert Christine Mummery at the Leiden University Medical Center on techniques that will inform new bioassays for drug and target discovery.

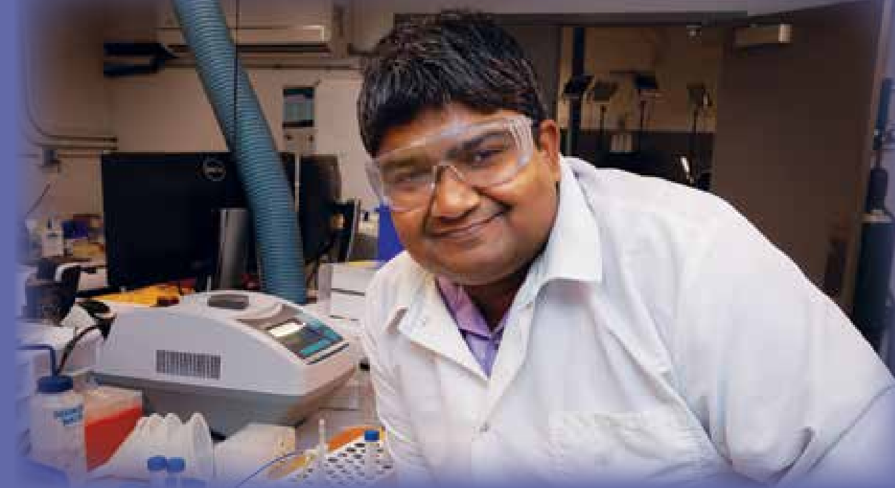


Photo: Oscar Masciandaro

Fine-tuning Selectivity and Sensitivity in Point-of-Care Diagnostics

SAGNIK BASURAY, *Director of the Opto and Microfluidics Laboratory From Diagnostics to Therapeutics*

problem:

The ability to quickly, accurately and affordably diagnose infectious diseases such as HIV, and detect cancers before they progress — anywhere, anytime — is essential to saving lives and mitigating global pandemics. Many of the biosensors used in point-of-care devices such as dipsticks, for example, suffer from either limited specificity — the ability to identify a particular disease — or sensitivity — the ability to detect it at low levels of expression.

solution:

Sagnik Basuray is developing a blood test that balances selectivity and sensitivity — if one is emphasized, the other is often compromised — improving both to reduce false positives and negatives. His devices are "like a radio with two knobs that we can tune accordingly." They can distinguish among diseases with very similar proteins and detect slight mutations in DNA in what are called microRNAs, messenger molecules dispatched by DNA to regulate gene expression. The latter are predictors of cancer.

how it works:

Basuray, an assistant professor of chemical engineering, is developing a new electrochemical sensing method that uses a nanoporous electrode technology. By packing nanostructures between electrodes, he is able to generate high-shear forces capable of dislodging one object or material from another. Finely tuned, these forces would ensure that the so-called capture molecules deployed in the test bind with the targeted disease molecules, and that others, which represent test noise, are washed away. Similarly, the device would capture mutated RNA, while knocking off healthy genetic material.

"The idea is that anyone can use these devices. In remote settings with little health care infrastructure, people often wait days for a diagnosis," says Basuray. "And by saving trips to the hospital to monitor chronic diseases, we hope to cut treatment costs."

Q&A

Photo: Courtesy of Deric Raymond

Conversation's the Thing

David Isbitski '98

Chief Evangelist for Alexa and Echo at Amazon

Q: HOW DID YOU BECOME A TECHNOLOGY EVANGELIST?

A: Since grade school, when I used my first computer, the Commodore VIC-20, I've been very interested in whatever new technology came my way. I would describe my personality as open-minded, extroverted and assertive. So I was always very excited about new things and needed to tell people what they had to have! But I was a business consultant for many years before I applied in 2007 for a job as a developer evangelist for Microsoft. I was then able to use my "developer personality" to educate people on how to think about and use web- and mobile-based technology. In 2015, I was the first employee of the Alexa skills kit group. I remember sitting around a table talking about our first 10 skills. We recently reached 70,000.

Q: IS THERE AN "AHA!" MOMENT WHEN PEOPLE EMBRACE A NEW TECHNOLOGY?

A: There is always an adoption curve which has early adopters followed by mass adopters. The meaningful change occurs when I see people use a new technology throughout daily life — they don't just want it at home, they want it everywhere. I have an [Echo] Dot that I take with me when I travel — I call for Alexa in my hotel room.

Q: HOW IS VOICE TECHNOLOGY A DISRUPTOR, BOTH PRACTICALLY AND SOCIETALLY?

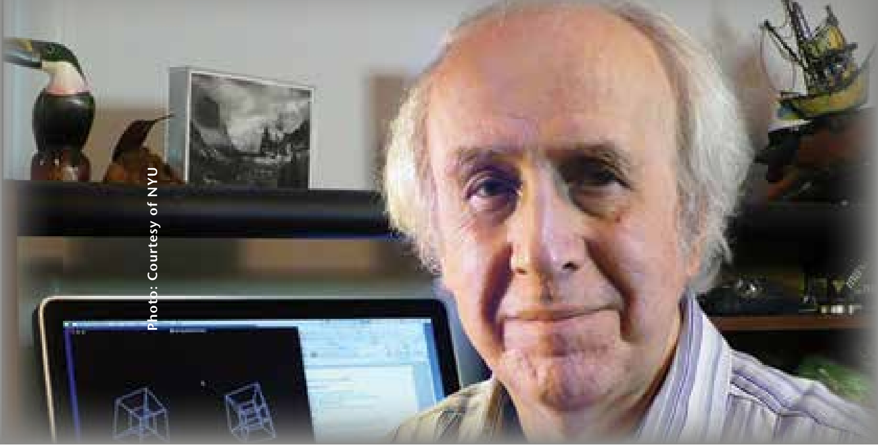
A: I don't think it is. But I never look at things as disruptors — I see time as the disruptor. As it goes by, things change, while I see voice technology as timeless. I think it actually returns things to us we've lost. For example, I use Alexa's Drop In feature to talk to my mother. She doesn't have to get up to answer the phone — my face just appears on the speaker, creating an ad hoc family connection that's missed when people are far away. We put Alexa in retirement homes and a 93-year-old man once told me that just hearing another person's voice — in his case, that of his son and daughter-in-law — got him through the day. And for me personally, once a day I say, 'Alexa, thinking time,' and she dims the lights by 20 percent, turns them sky blue and turns on classical music. This helps me with creative work, and especially my writing.

Q: WHAT ARE SOME OF ALEXA'S GROWING PAINS?

A: What's really changed in text-to-speech technology is an understanding not just of intention, but of context. It's called NLU — natural language understanding. And here's one of the challenges for that technology: learning that human conversation takes place within a specific culture — it's not just about programming written code, but building models based upon real conversations. In Japan, for example, you don't interrupt people. We've held forums to see what Alexa gets wrong and crowdsourced answers. Alexa's understanding is phonetic, but she also learns voices and individuals' language choices over time. When I ask for Top 10 hits, it's very different from when my teenage daughter asks. Alexa gets smarter every day, and learning context is part of that.

Q: HOW IS VOICE TECHNOLOGY CHANGING THE WAY WE THINK ABOUT MACHINES?

A: Rather than teach people to talk to machines, we've taught machines to understand people. The most exciting thing for me is that people have conversations with their technology. That Alexa can now understand intention is huge. That's the sea change. But I think it's also changing our connection to ourselves and other people, as well as the way we use conversation. I imagine the future as very much like the holodeck in "Star Trek," where the crew was able to bring back digital personalities like Einstein. I want my children to not just be able to say, 'I know Dad felt very strongly about this issue,' but to see me before an audience defending my beliefs.



Engineering Is the Spark

A. Michael Noll ’61
Former Bell Labs Engineer, Professor Emeritus, Author, Archivist and Biographer

Q: WHAT DREW YOU TO ENGINEERING?

A: I spent a lot of time during high school listening to classical music. That led to an interest in hi-fi audio equipment, and I picked electrical engineering at Newark College of Engineering to work on electronics. Back then, everyone wanted a job at Bell Labs, and I got one the summer after my junior year designing and building an amplifier. After graduation, I was hired by Bell Labs to work in a human factors department, where I shared an office with two Ph.D. psychologists, on sidetone: how people hear their own speech on the phone. Later, I was transferred to research to work on methods for compressing speech to save bandwidth, some of the same techniques used in voice encryption. Today, I find internet radio one of the most impressive things, allowing me to listen to classical radio stations from all over the planet!

Q: HOW DID A COMMUNICATIONS ENGINEER BECOME A PIONEER IN DIGITAL COMPUTER ART?

A: I stumbled into digital art. A colleague’s computer program at Bell Labs went haywire one day, and the random mess of the misplotted data looked like abstract art. We jokingly called it computer art. I decided to do it deliberately, and went on to write a formal memorandum in 1962 on the use of computer graphics to create random drawings. In 1965, a colleague and I took part in a very early public exhibit of digital art at the Howard Wise Gallery in New York City. Inspired by Balanchine’s ballet “Apollo,” I choreographed a computer-generated stereoscopic ballet — again, randomly — using stick figures that represented the male and female dancers. The idea was to use technology to create something new. Randomness is a source of surprise.

Q: WHAT INSPIRED YOUR PEOPLE-MACHINE TACTILE DEVICE, DESCRIBED AS A FORERUNNER OF VIRTUAL REALITY?

A: I was interested in exploring the potential of new sensory modalities as new communication channels between people and machines in applications where graphical communication would not be sufficient or appropriate. The idea was to use force-feedback to depict surfaces and objects which would be difficult to display visually. Today, this force-feedback is called haptic communication, and it can give a better feel for computer graphics. At Bell Labs, I was working on 3D graphics and getting into interaction, using a joystick, for example, to specify a point in 3D space.

Q: HOW DID YOU END UP WORKING ON SCIENCE AND TECHNOLOGY POLICY IN THE NIXON ADMINISTRATION?

A: I was in my office at Bell Labs one day and the phone rang. It was Bill Baker, vice president for research, calling me! I actually stood up. ‘Periodically, we send our people to Washington,’ he said. ‘How would you respond to that opportunity?’ It quickly became clear that he wanted an answer before he hung up. I told him it would be my patriotic duty, having no idea what I’d be doing. As it turned out, I was to work on computer security, and on evaluating technology exports to the Soviet Union. I went to a lot of meetings. The Department of Commerce wanted to sell computers to the Soviets, but the Defense Department didn’t. Later in the Nixon administration, U.S. technology scholars began meeting with Soviet scholars as part of new policy aimed at opening up the Soviet Union.

Q: HOW DID YOU COME TO BECOME AN ARCHIVIST AND A HISTORIAN?

A: When I was teaching at the Annenberg School in L.A., I returned to New Jersey in summers and would chat with Bill Baker. Around 2003, he asked me to take a look at his archival materials and instructed me to tell the story of Bell Labs. In going over his papers, I was also amazed to discover that his mother was the premier turkey breeder in the U.S. Those archives are now in the library of Princeton University. Baker directed research during what some people consider the golden years of Bell Labs in the ’50s and ’60s. People forget it was the forerunner of what is today Silicon Valley and that New Jersey was the center of all this.

(Left to right) Ron Taglieri, chief engineer for the Liberty Science Center in Jersey City, N.J., Paola Amato, the director of operations, and Govi Rao, CEO of energy services company Noveda Technologies, showcase an array of solar panels installed as part of the center's comprehensive energy infrastructure upgrade.

Managing Energy Consumption With Building 'Fitbits'

Liberty Science Center employs an energy dashboard that provides real-time consumption data akin to an EKG or fitbit for buildings. The system shows consumers not only where they are using energy at any given time and from what sources, but how that consumption compares to prior periods at their own facilities, as well as to national averages.

Like a watchful parent, Ron Taglieri, chief engineer for the Liberty Science Center in Jersey City, N.J., wants to know what the complex has been up to overnight when it was supposed to be sleeping soundly. Every morning, he consults a colorful monitor filled with energy charts to find out.

"When the building wakes up, I check to see that it's been running on 300 kilowatts an hour through the night. If it's above that, I know something was left on that shouldn't have been," Taglieri notes. Throughout the day, he and his crew eye the monitor, which displays the center's real-time energy usage down to the minute, while also comparing it to the previous year's performance. "Without it, there is no way we'd have a handle on our consumption," he says.

Their vigilance has paid off. Over the past 10 years, Taglieri and Paola Amato, the director of operations, have shaved more than $100,000 off the center's monthly electricity bill by spotting areas of high energy use and modifying it with timers, efficient equipment and renewable systems — shrinking the complex's carbon footprint by more than 40 percent in the process.

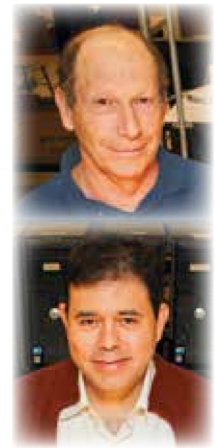
Spooked by signs of global warming, from frequent flooding to extreme-heat days, cities across the country are now also looking to curtail their impact on the planet, while reaping savings for residents. In late 2017, Newark, N.J., Mayor Ras J. Baraka joined dozens of mayors nationwide in signing the "Chicago Climate Charter," a pledge to meet the standards set by the Paris Agreement to reduce carbon emissions in their cities.

Before they adopt policies that specify where and how to improve their operations, they will first face a daunting hurdle: identifying consumption patterns throughout their facilities at a granular level — from system to system, building to building and even, in some cases, room to room.

A multidisciplinary team of engineers and data scientists from academia and industry now is working with facility managers in businesses, nonprofits and school systems throughout cities in the New York metro region to meet both goals. By providing systemwide data analytics and information feedback loops, they are identifying areas of high consumption and suggesting ways to reduce it.

Housed within New Jersey Institute of Technology, the Center for Energy Efficiency, Resilience and Innovation (CEERI) offers, among other services, a system that provides real-time consumption data akin to an EKG or fitbit for buildings. Developed by one of CEERI's members, Noveda Technologies of Bridgewater, N.J., the system shows consumers not only where they are using energy at any given time and from what sources, but how that consumption compares to prior periods at their own facilities, as well as to national averages.

Photos: Oscar Masciandaro



Haim Grebel (top), a professor of electrical and computer engineering, is a director of the Center for Energy Efficiency, Resilience and Innovation, a collaboration between NJIT and industry that focuses on identifying and implementing measures to reduce operating costs and environmental impacts in the deployment of technologies and applications related to energy and water. Roberto Rojas-Cessa (bottom), a professor of electrical and computer engineering, is collaborating on the research.

Operators, including automated systems, then use the data to improve the system's performance in terms of consumption, generation, distribution and storage, integrating traditional as well as renewable sources.

"Some facility managers are using this information to set very aggressive targets, including net zero energy consumption. The system is designed to engage all stakeholders and drive behavior modification. Without this information, managing a building's energy usage is like driving an automobile without a dashboard," says **Govi Rao**, CEO of Noveda Technologies, the company that supplied the monitoring system at the Liberty Science Center in 2008, just as the complex reopened after a lengthy renovation.

Taglieri agrees, noting that the first hurdle he and Amato faced was that "no one understood the lighting system, and some lights were on 24 hours a day." They now have the capability to monitor floor occupancy and start winding down the building's systems accordingly, particularly at the end of the day.

"While the idea of the smart grid has been around for quite some time, its implementation has been slow. There is an urgent need for transformational changes that should be conducted as coherent and integrated efforts across communities, specifically involving businesses, academic campuses and governments," Rao adds, noting that the next major iteration of the dashboard will be an artificial-intelligence model that can forecast energy use and offer recommendations.

A team of electrical engineers, computer scientists and data analytics experts at NJIT is working on new methods to make the systems smarter and more responsive through sensing networks, deep-learning models and other internet of things devices. New devices for storing energy will also play a critical role.

Another group of NJIT engineers is developing proactive approaches to help consumers determine their energy needs ahead of time so they can optimize consumption. They would accomplish this in part by enabling information about energy demands and the energy itself to flow digitally in two directions. **Haim Grebel**, one of CEERI's directors, likens the approach to ordering digital packages for mobile phones.

"Consumers would issue a request to the energy provider for precise energy quanta, a process carried out automatically by information networks," Grebel says. "Energy would be sent in packets that carry the requested power for, say, a particular building or device. Through a handshake protocol, the two sides would negotiate the amount and price of energy before delivery and it would be routed and rerouted through digital power switches directly to the user address."

As more cities and companies join, CEERI plans to establish a collaborative platform to leverage best-in-class practices among companies and other organizations.

In general, methods for tinkering with consumption are still fairly crude.

"In developing countries, there are periods where power is shut off in homes so that industry can use it. In developed countries, demand-dampening devices such as surcharges have been applied on an ad hoc basis, but with no scientific modeling," notes **Atam Dhawan**, NJIT's senior vice provost for research and one of the architects of CEERI.

A renewed sense of urgency, driven by the negative impact of climate change, is altering energy planning on the ground. New Jersey, for example, has recently adopted a new renewable portfolio standard that requires the state to meet 50 percent of its electricity needs from renewable sources by 2030.

"This is no longer a federal initiative, but one that is being taken up at the mayoral and city level," notes Dhawan. "While we realize the diverse needs of energy utilization in different industry, business and social sectors across the globe, the vision behind CEERI is to develop technologies to help specific users to understand the underlying patterns of their energy needs and to help them manage both energy production and utilization."

100 years NEWARK COLLEGE OF ENGINEERING NEW JERSEY INSTITUTE OF TECHNOLOGY

From Governor McClellan's Mandate to the NJIT Makerspace — Engineering at NJIT Shows No Sign of Slowing Down

Moshe Kam
Dean, Newark College of Engineering

On Jan. 11, 1881, the New Jersey Senate heard the annual message of the 24th governor of the state. The message was delivered just four days before the term of the governor, George B. McClellan, was to expire. McClellan, well known for his role as a military commander in the Union Army during the Civil War, spent a central portion of his speech on motivating the legislature to support industrial education in New Jersey.

Using data from the New Jersey Bureau of Labor and Industries, McClellan argued that 12 emerging branches of industry, amounting to $75 million in annual value and providing $18 million in wages to approximately 47,000 employees in the state, require "technical or artistic skill, and frequently both." These emerging branches included steam engines and machinery, silk manufacturing, textiles, potteries and jewelry products. "Skilled labor and a considerable amount of technical and artistic knowledge are indispensable for the preservation and development of these industries, which do so much to ensure the general prosperity of the state."

Sounding like many leaders in New Jersey today, McClellan lamented the scarcity of industry-relevant skills in the working-age population, due to the "practical abolition of the system of apprenticeship, and the lack of technical schools." He concluded that "the establishment of schools for technical and artistic instructions — for both sexes — seems the only practical solution for a pressing problem." Assembly Bill No. 272, approved later that year, addressed the governor's call for action. It provided "for the establishment of schools for industrial education" in the state, using joint funding by the state and private industry.

The Newark Technical School (today's Newark College of Engineering) was the first to be established under this legislation, though it was not until 1916, 25 years after the school had opened, that its trustees used the word "engineer" in their deliberations for the first time. In 1920, a year after the school started offering programs toward baccalaureate degrees in engineering, it became Newark College of Technology and 10 years later it changed its name again, to our current name, Newark College of Engineering (NCE).

It is instructive to inquire as to the differences between the road map presented to the New Jersey legislature on industrial education 136 years ago by Gov. McClellan, and the motivation and practice that leaders of NJIT and NCE exhibit today.

- As we did in the 1880s, NCE continues to have a major focus on industrial education, production and manufacturing. NJIT developed and expanded several units, such as the Engineering Technology Department and the new 10,000-square-foot NJIT Makerspace, whose primary domain of interest is industrial education. Needless to say, the applications have changed. We are not doing much with silk and pottery at NCE today — our current interests are in medical devices, avionics, communications, aerospace, robotics and transportation.

- As in 1881, government-industry partnerships continue to be the cornerstone of industrial education.

- While production and manufacturing continue to be an important part of NCE's portfolio, we are also addressing the needs of service industries. NCE is involved in algorithm and methodology development and in support of many service industries, including those engaged in finance, media, pharmaceuticals, environmental remediation, fashion, transportation, communication and information. The transition of many societies from manufacturing-centric economies to service economies had a fundamental impact on NCE's interests, teaching and research.

- We are more science-based and science-focused since NCE's inception. Many of our classes and research groups are

Photo: Anuoluwapo Akeredolu

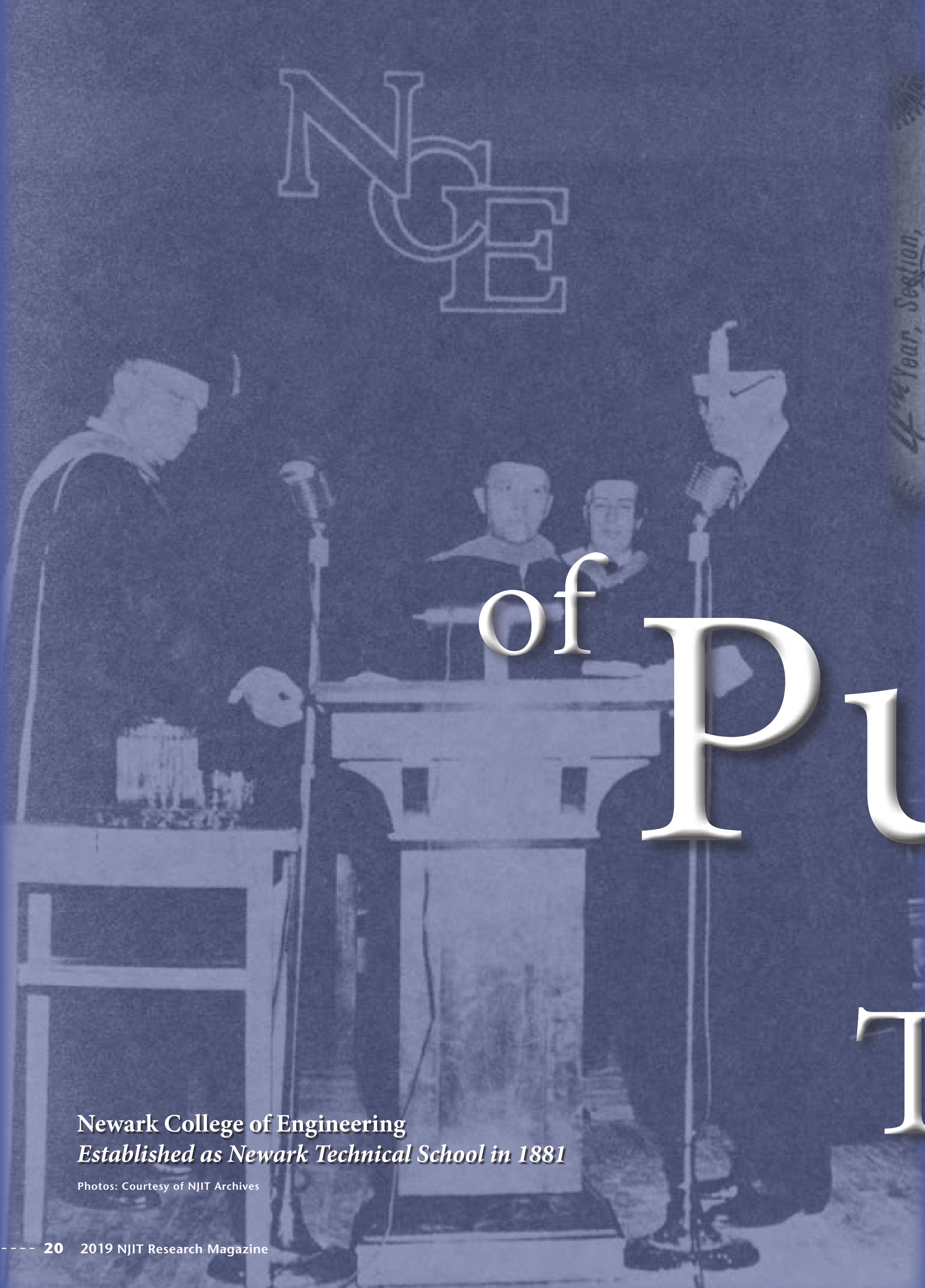
are immersed in theoretical work, often closer to applied mathematics than to traditional industrial product development. We recognized that a deeper theoretical background — in mathematics, physics, chemistry and, increasingly, the life sciences — is essential for modern engineers and for continued progress of the profession.

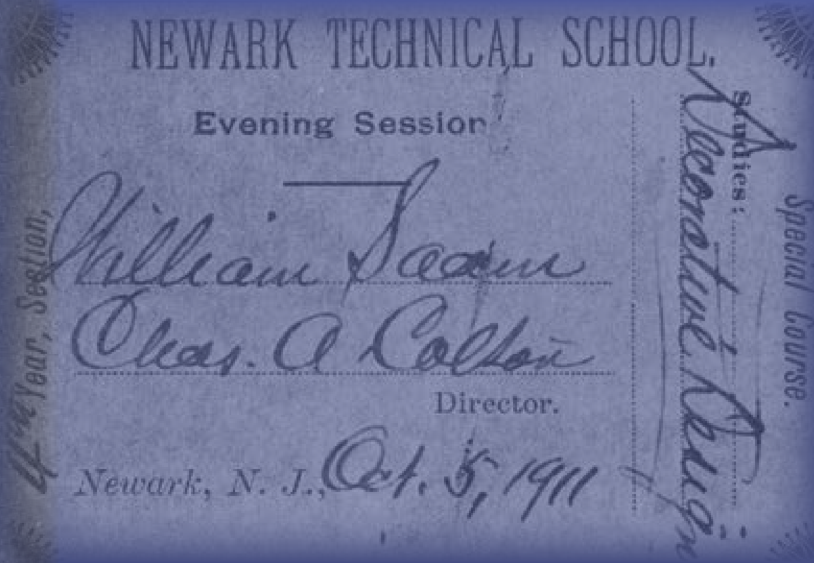
- When NCE launched its first baccalaureate degree programs in 1919, automated computation and computation machinery, especially computation enabled by electricity and electronics, did not exist. The ubiquity of computation and communication networks today has transformed all branches of engineering. Engineers of all disciplines and application areas require an understanding of algorithms, programming, computation techniques, computer and communication networking, data processing and data security, and even computation and communication hardware. The bedrocks of engineering education now include (or at least should include) the fundamentals of computation, at a level that is not less central than calculus-based physics.

- We experience and practice increased blending and "amalgamation" of the engineering disciplines. Individuals from different branches of engineering (and other professions) develop devices, systems and procedures together. This trend runs contrary to the increased specialization that characterized engineering education from the mid-1960s to the mid-1980s, when narrower tracks and compartmentalization were heavily favored.

Regardless of the fundamental shifts that engineering has experienced since NCE was established a century ago, engineering and technology were then, as they are now, exciting, appealing and ever expanding. They are intellectually deep and critical to the fostering of human welfare and human development. Engineering and technology possess the potential to improve human health, well-being, comfort, safety and work efficiency (but also have the potential to unleash destructive forces by badly motivated actors). Engineering and technology can also assist humanity in resource management, sustainable development and environmental protection. These are noble causes.

Review of what the profession has accomplished during the last century, and what NCE and our graduates have achieved during the same period, provides a strong sense that our discipline is still in its infancy. Some of what Gov. McClellan told us in 1881 still rings true, but the technology and industry that he addressed then are not nearly the ones we know today. Likewise, ours are likely to be nowhere near the technology, engineering and industry that will be celebrated at NCE's bicentennial in 2119. The main adventures in engineering and technology are still ahead of us.





# of Public Through

Newark College of Engineering
Established as Newark Technical School in 1881

Photos: Courtesy of NJIT Archives

A Century Service Engineering

1881

Newark Technical School is established.

1885

Photo: Courtesy of NJIT Archives

NEWARK TECHNICAL SCHOOL WELCOMED THE INAUGURAL CLASS OF 88 NEWARK RESIDENTS TO A RENTED BUILDING ON WEST PARK STREET. ALTHOUGH THESE YOUNG MEN HAD TO PAY FOR BOOKS AND OTHER SUPPLIES, TUITION WAS FREE FOR THOSE WHO LIVED IN THE CITY.

1886

Director Charles A. Colton (top) laid the cornerstone for Newark Technical School's first dedicated building, later named Weston Hall in honor of Edward Weston (bottom), an early benefactor and a prominent inventor who was a rival of Thomas Edison. The three-story structure stood at High Street and Summit Place.

Photos: Courtesy of NJIT Archives

1897

MARGARET BRYCE, A HIGH SCHOOL TEACHER, WAS THE FIRST WOMAN TO ENROLL AT NEWARK TECHNICAL SCHOOL, WHERE SHE STUDIED CHEMISTRY.

1919

As New Jersey became a center of leading producers in the manufacture of chemicals after World War I, Newark Technical School began offering undergraduate degree programs in chemical, mechanical and electrical engineering under the name Newark College of Technology, which changed to the College of Engineering of the Newark Technical School in 1920. A civil engineering degree program followed in 1927.

1920–1947

Photo: Courtesy of NJIT Archives

ALLAN R. CULLIMORE LED THE INSTITUTION, OVERSEEING THE TRANSFORMATION OF THE SCHOOL INTO NEWARK COLLEGE OF ENGINEERING (NCE) IN 1930. CULLIMORE WAS LATER NAMED PRESIDENT.

1930

Edythe R. Rabbe became the first woman to receive a degree from NCE. She studied chemical engineering.

Photo: Courtesy of NJIT Archives

1940s

LILLIAN MOLLER GILBRETH — NCE'S FIRST FEMALE PROFESSOR, A PIONEER IN MOTION STUDY AND AN EFFICIENCY EXPERT — WAS KNOWN AS THE "FIRST LADY OF ENGINEERING" AND BECAME THE FIRST FEMALE MEMBER OF THE NATIONAL ACADEMY OF ENGINEERING. HER MANY OTHER HONORS INCLUDED BEING FEATURED ON A U.S. POSTAGE STAMP AND BEING INDUCTED INTO THE NATIONAL WOMEN'S HALL OF FAME.

Photo: Courtesy of NJIT Archives

WWII YEARS

Photo: Courtesy of NJIT Archives

Throughout World War II, NCE helped educate students for the war effort. Degree programs were accelerated to fill the military's need for more engineers. Some students switched to night school and went to work in defense plants and military research programs. NCE also served as a technology training site for soldiers. Although class sizes waned in the latter years of the war, returning veterans swelled the enrollment again, with veterans making up 75 percent of the freshman class in 1946.

1956

NCE STUDENT AND FRESH GRADUATE YURIY TARNAWSKY '56, ELECTRICAL ENGINEERING, PUBLISHED HIS FIRST VOLUME OF POETRY, "LIFE IN THE CITY" (IN UKRAINIAN). IN TIME, TARNAWSKY ESTABLISHED HIMSELF AS A MAJOR WRITER AND LINGUIST, WRITING FICTION, POETRY, PLAYS, TRANSLATIONS AND CRITICISM IN BOTH UKRAINIAN AND ENGLISH. HIS WORKS HAVE BEEN TRANSLATED INTO AZERBAIJANI, CZECH, FRENCH, GERMAN, HEBREW, ITALIAN, POLISH, PORTUGUESE, ROMANIAN AND RUSSIAN.

1962

Photo: Courtesy of NJIT Archives

Beatrice Hicks '39, founder of the Society of Women Engineers in 1950 and a member of the National Academy of Engineering, produced a seminal innovation in the field of gas sensor devices, outlined in U.S. Patent No. 3046369, which was used in NASA's Apollo Moon Landing missions. She was inducted into the National Inventors Hall of Fame in 2017.

1962

MECHANICAL ENGINEERING GRADUATE THOMAS JOSEPH O'MALLEY '36 WAS A CHIEF TEST CONDUCTOR FOR THE CONVAIR DIVISION OF GENERAL DYNAMICS, AND WAS RESPONSIBLE FOR PUSHING THE BUTTON ON FEB. 20, 1962, THAT LAUNCHED THE MERCURY-ATLAS 6 SPACE FLIGHT CARRYING ASTRONAUT JOHN GLENN, THE FIRST AMERICAN IN ORBIT.

1962

Photos: NASA

Walter Marty "Wally" Schirra Jr., an NCE student in the early '40s, flew the six-orbit, nine-hour Mercury-Atlas 8 mission, becoming the fifth American, and ninth human, to travel into space. Later, in October 1968, he commanded Apollo 7, the first manned launch for the Apollo program. He was the first astronaut to go into space three times, and the only astronaut to have flown in the Mercury, Gemini and Apollo programs. In total, he logged 295 hours and 15 minutes in space.

1964

NCE awarded its first doctoral degree in 1964, in chemical engineering, to Edwin Otto Eisen. His dissertation was titled, "Salt Effects in Liquid-Liquid Equilibria." Eisen also earned bachelor's and master's degrees in chemical engineering from NCE.

1966

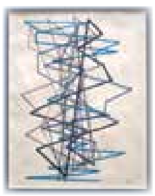


Photo: Courtesy of A. Michael Noll

NCE electrical engineering alumnus A. Michael Noll '61, then employed at Bell Labs, published "Computers and the Visual Arts" in Design Quarterly. *This was one of the first public explorations of digital computer art.*

1968

NCE established EOP (the Engineering Opportunity Program, renamed the Educational Opportunity Program in 1975). The program identifies, recruits and provides financial assistance and academic support to underserved students who are residents of New Jersey, so that they may be able to attend institutions of higher education.

1973

Photo: Courtesy of R&D Council of New Jersey

John J. Mooney '60, who earned a master's in chemical engineering, co-invented the three-way catalytic converter, which has played a dramatic role in reducing pollution from motor vehicles since the mid-1970s. The Society of Automotive Engineers considers this one of the 10 most important innovations in the history of the automobile. In 2002, President George H. Bush presented Mooney, together with co-inventor Carl D. Keith, with the National Medal of Technology and Innovation "for the invention, application to automobiles, and commercialization of the three-way catalytic converter."

Photo: Courtesy of iStock/mipan

1975

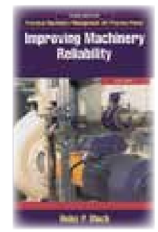
Effective Jan. 1, 1975, NCE changed its name once again and became known as New Jersey Institute of Technology (NJIT), to reflect both the breadth of its scientific and technological developments, as well as the founding of the architecture school. Alumnus Joseph Anderson '25 came up with the new name.

1977

Photo: Courtesy of iStock/Best_Shop

Michael J. Pappas '59, '64, professor of mechanical engineering at NJIT, and Dr. Frederick F. Buechel, clinical professor of orthopedic surgery at New Jersey Medical School, introduced a new Low Contact Stress Knee System. Known as "The New Jersey Knee," this model became the basis for knee replacement systems and devices implanted in hundreds of thousands of patients over the years.

1982



NCE alumnus Heinz P. Bloch '62 B.S., '64 M.S., mechanical engineering, published "Improving Machinery Reliability," the first of 20 books by Bloch on practical machinery. His books have appeared in 45 editions — in English, Spanish and Portuguese.

1991

Photo: Courtesy of Ying Wu

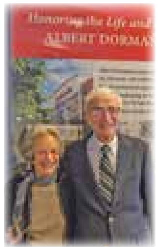
Ying Wu '88, '16 HON, an electrical engineering master's graduate, founded Starcom Networks, which merged with Unitech in 1995 to create UTStarcom, a global telecom infrastructure provider headquartered in Hong Kong. Also chair of China Capital Group, he was named by China Central TV as one of the "Top 10 Most Influential Persons" in China's economy in 2003. He led his company, UTStarcom (China) Ltd., in developing the "Little-Smart" wireless communication system, which made mobile phone services widely accessible.

1993

Richard Sweeney '82, an industrial administration graduate and retired vice president of engineering and operations at Keurig, became co-founder of the "K-Cup" pod for the Keurig Single-Cup Brewing System.

Photo: Courtesy of NJIT Alumni Relations

1995



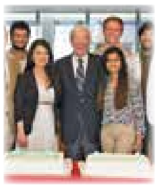


Photo: Courtesy of Brittani Brundage

Mechanical engineering alumnus Albert Dorman '45, the founding CEO of the multinational engineering and design firm AECOM, established an endowment for the NJIT Honors College, enabling the renamed Albert Dorman Honors College to expand from 230 students in 1995 to over 700 today.

1998

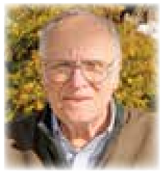


Photo: Courtesy of Gerard J. Foschini

Employed by AT&T Bell Laboratories, Gerard J. Foschini '61, electrical engineering, published a paper introducing his Bell Laboratories Layered Space-Time (BLAST) concept, one of the most widely examined techniques in wireless communications research. In 2009, Foschini was elected to the National Academy of Engineering.

1998

Engineering alumnus Eshan Bayat '86 established Afghan Wireless, Afghanistan's first wireless communications company. By 2017, Afghan Wireless was the largest private employer in Afghanistan, having around 5 million clients and providing coverage in all of Afghanistan's provinces.

1999

NJIT announced the first class of Academic Scholars within the Ronald E. McNair Post-Baccalaureate Achievement Program. The program prepares eligible participants for doctoral studies through involvement in research and scholarly activities. Participants are from disadvantaged backgrounds and have demonstrated strong academic potential.

2001

NCE established the Department of Biomedical Engineering. William Hunter (1946-2019), a specialist in cardiovascular mechanics who joined NJIT from Johns Hopkins University, was instrumental in designing the undergraduate curriculum, established a joint biomedical engineering program with Rutgers New Jersey Medical School leading to a Ph.D. degree, and as chairman, led the new program to accreditation in 2006.

2004

Photo: NASA/JPL-Caltech

As chief engineer at Honeybee Robotics, Thomas M. Myrick '84, mechanical engineering, developed Rock Abrasion Tools (RATs) — instruments used to study rocks from Mars — that were mounted on two NASA rovers, "Spirit" and "Opportunity," that landed on Mars in the winter of 2004.

2004

NCE alumnus and Distinguished Professor of Physics at the University of Florida, Pierre Ramond '65, electrical engineering, received the Oskar Klein Medal for his work on superstring theory. Ramond delivered the 2004 Oskar Klein Memorial Lecture, sponsored by Stockholm University and the Nobel Committee of the Royal Swedish Academy of Sciences.

2004

Photo: Courtesy of the Tissue Engineering and Applied Biomaterials Laboratory

Treena Arinzeh, professor of biomedical engineering at NJIT, received the Presidential Early Career Award for Scientists and Engineers. She focuses on stem cell tissue engineering and applied biomaterials, specializing in the development of functional biomaterials to accelerate the repair of bone, cartilage and other related musculoskeletal tissues, as well as nerve tissue, specifically the spinal cord.

2010

The Institute of Electrical and Electronics Engineers (IEEE) established the IEEE Council on Superconductivity Carl H. Rosner Entrepreneurship Award in honor of NCE alumnus and superconductivity pioneer Carl H. Rosner '55.

2011

Photo: Courtesy of Judea Pearl

Master of Science in electrical engineering alumnus Judea Pearl '61, credited with inventing Bayesian networks, a mathematical formalism for defining complex probability models, earned the Association for Computing Machinery's 2011 A.M. Turing Award, the highest distinction in computer science, "for fundamental contributions to artificial intelligence through the development of a calculus for probabilistic and causal reasoning."

2014

Photo: Courtesy of U.S. Air Force

U.S. Air Force General Ellen M. Pawlikowski '78, chemical engineering, was elected to the National Academy of Engineering "for leadership in the development of technologies for national security programs including spacecraft operations and the Airborne Laser."

2015

Mengchu Zhou, distinguished professor of electrical and computer engineering, received the 2015 Norbert Wiener Award for "fundamental contributions to the area of Petri net theory and applications to discrete event systems" at the 2015 IEEE International Conference on Systems, Man, and Cybernetics held in Hong Kong.

2015

Photo: Courtesy of Virginia Sulzberger

Electrical engineer Virginia Sulzberger '66, was the first woman in the United States elected by the National Academy of Engineering into its Electric Power and Energy Systems Engineering section. At the North American Electric Reliability Council, Sulzberger was instrumental in developing the first comprehensive planning standards for the high-voltage electric power transmission systems in North America.

2015

Atam Dhawan, distinguished professor of electrical and computer engineering, was the first NJIT engineer inducted as a Fellow into the National Academy of Inventors. He was followed in 2016 by Kamalesh Sirkar, distinguished professor of chemical and materials engineering, and in 2017 by Yun Q. Shi, professor of electrical and computer engineering.

2016

Photo: Oscar Masciandaro

Distinguished Professor and electrical engineering alumnus Nirwan Ansari '82 received the IEEE Communications Society Technical Recognition Award "for advancing the field of ad hoc and sensor networks."

2016

NCE mechanical engineering alumnus Clifford M. Samuel '88, who serves as senior vice president of Gilead Sciences, was inducted into the College of Fellows of the American Institute for Medical and Biological Engineering. The citation is "for pioneering new approaches to providing medicines in developing countries, thereby redefining access standards and averting millions of HIV/AIDS deaths."

2016

NCE Dean Moshe Kam received the Haraden Pratt Award for outstanding volunteer service to the Institute of Electrical and Electronics Engineers (IEEE), "for original and high-impact contributions to IEEE's Educational Activities, expanding IEEE's global reach and effectiveness."

2017

Photo: Courtesy of the Baja SAE Team

The Baja Race Car appeared at the New York International Auto Show, billed as a showcase for the latest in "cutting-edge design and extraordinary innovation." The single-seat, off-road vehicle, "handcrafted" by a team of ambitious mechanical engineering students, went on to compete around the country and, in California, made NJIT history by winning the challenging four-hour endurance race to propel the university into the top rank of Baja design teams.

2017

Photo: Courtesy of Deric Raymond

NJIT opened its Makerspace, a training-focused, rapid prototyping facility that is central to both the university's hands-on learning mission and its growing relationship with New Jersey's manufacturing community. The 10,000-square-foot space operates equipment ranging from small 3D printers to large industrial machining centers, such as precision measurement and laser-cutting machines.

2018

Photo: Courtesy of the Vision and Neural Engineering Laboratory

An NJIT team of engineers, game designers, artists and clinicians, led by Professor of Biomedical Engineering Tara Alvarez, won two major international awards for its vision therapy platform "VERVE" (Virtual Eye Rotation Vision Exercises), including "Most Innovative Breakthrough," at the 2018 Augmented World Expo Europe, the leading industry conference for augmented reality technology. Alvarez also won the "Woman Laureate" award, which recognizes project leadership skills.

2018

The NCE School of Applied Engineering and Technology (SAET) was established to meet growing demand in the job market for applied engineering technologists in industries reliant upon production, manufacturing, process control and instrumentation. When fully implemented, SAET will serve close to 2,000 students and will have roughly 30 full-time instructors and faculty members, as well as approximately 100 auxiliary faculty and adjunct professors from industry.

Peddling for Power in a Remote Haitian Village

The technology that engineering students **Matt Reda** and **Rudolph Brazdovic** installed last April in the remote, hilly community of Milot, Haiti, was simple enough: a modified bicycle with a back wheel that turns a generator, producing 20 watts of electricity. What was less straightforward, they quickly learned, was how to manage it.

Unlike devices for individual dwellings, such as water filters, the NJIT Light Cycle is a public service: a cellphone charging station for the approximately 50 people living within a mile of a regional gathering place.

"Once we left, the residents had to take responsibility for it — to operate the machine properly so it didn't break down, to maintain it, to allocate the service fairly and to guard against theft," explains Reda, president of NJIT's chapter of Engineers Without Borders and the cycle's lead designer. "We needed to set it up like a business, and this was something we hadn't thought about while we were designing it back on campus in New Jersey."

The pedal-powered generator helps to bridge a major infrastructure gap in the farming region a few miles from Haiti's northern coast. There is no electrical power in Milot, and yet nearly everyone has a cellphone. For years, residents have been traveling by "tap-tap" — a motorbike with a trailer for passengers — 10 miles, or approximately a half hour, to the much larger Cap-Haitien in order to charge their phones. Many of them own 15-year-old flip phones with tiny batteries.

Reda's and Brazdovic's first task was to identify a safe and central place to install it; they chose the tap-tap station, an afterwork rendezvous for finding friends and catching up on local news. The team then needed to find and train someone to run it during the day at a steady "casual stroll," as Reda puts it, so that it wouldn't burn out, and to take the generator home at night for safeguarding. Local leaders chose a manager who was then involved throughout installation and testing.

The contraption produces electricity through a generator mounted on the bike frame. The pedals are connected to a sprocket and chain, which turns the sprocket on the back wheel. With the back tire removed, they attached a second sprocket and chain to the generator on the frame. The gearing from sprocket to sprocket to generator is calculated to give the proper gear ratios to spin the generator at the appropriate speed. The generator is mounted in a way that it can be removed at night and remounted in the morning.

"Our innovation is the combination and the application of the technique. People have been making electric generators for a long time; ours is designed for safe positioning and for the ability to produce power out of a wall outlet," Reda says.

Once in Milot, they worked with residents to secure the bike onto the concrete slab of the tap-tap station and to figure out how to optimize it for local needs. They then held training sessions for the five main participants and for another 15 to 20 people assisting in more minor roles.

The settled part of the region, composed largely of one-story concrete buildings, is surrounded by fields spotted here and there with bananas, mangoes, citrus fruits, cocoa and coffee. The community is perfumed by the scent of lime trees and harvested cocoa beans drying on the town's black streets. There are national landmarks nearby such as the 19th-century Sans Souci Palace built by Henri I, now a graceful ruin, that are viewed as potential tourist destinations.

"There is a lot of construction in Milot — our host wants to build guest houses, for example — and people need to communicate," he notes.

NJIT students have been making engineering trips to Milot for more than a decade, bringing sustainable systems for human waste, energy and water purification, including a portable clay pot filter that runs water through sand and gravel.

Photos: Courtesy of the NJIT chapter of Engineers Without Borders

"With our filters, the key was to develop an efficient production method that yields consistently performing filters with the use of locally available material and simple, inexpensive tools," notes **Jay Meegoda**, a professor of civil and environmental engineering, and adviser to the student chapter. "With the Light Cycle, the aim was to provide an inexpensive energy source to be used day or night and rain or shine to charge their cellphones."

The team plans to refine the service over the coming months."One of the best ways to ensure buy-in and compliance is to provide incentives for the people who run it and use it. We are still debating a number of elements, including fees, the merits of expansion and whether it's best to have a few larger units that would be managed or multiple smaller units," Reda says. "We plan to continue our involvement with the community as these issues are decided and implemented."

DAY 1: Shortly after arriving in Milot, the NJIT Engineers Without Borders team begins assembling the student-designed cellphone charging device, known as the Light Cycle, at the taxi station designated by the villagers to house it.

DAY 2: A small crowd assembles as team members mull one of the first substantial decisions: the optimal number of chargers to build into the device. They opted for a high amperage charging block that powers up one phone at a time, but very quickly.

DAY 3: The team tinkers with the Light Cycle's generator, adding lubricant and attaching gears.

DAY 4: The NJIT students take a day off while Milot residents practice operating the cellphone charging station. They conduct an audit of about 20 bio-sand water filters built and distributed throughout the village by a previous Engineers Without Borders team from NJIT.

DAY 5: After final testing, NJIT engineers (Matthew Reda, left, and Rudolph Brazdovic, fourth from left) officially hand off the Light Cycle to the Milot team. Several weeks later, they were pleased to hear it was running well and are now working on an improved model "for the next trip down," Reda says.

Civil Engineers Join Newark's Volunteer Climate Action Brigade

Photo: Oscar Masciandaro

Over the past several months, civil engineering students in the campus chapter of the American Water Works Association (AWWA) have traded in their calipers and hardhats for safety gloves and paint brushes as part of a citizen's campaign against flooding in Newark.

Beginning last spring, the group joined the city's Prepared Together Program by "adopting" three catch basins in the University Heights neighborhood that they regularly clean of debris, plucking plastic bottles and pieces of broken glass caught in the grill and from sidewalks and streets in their immediate vicinity.

"By making sure that water can flow freely into the sewers, we're reducing street flooding and pollution. It's a major problem, which also degrades our infrastructure," says CASSANDRA FERRARA '20, the campus AWWA's volunteering and community outreach coordinator.

This fall, the group painted water-related murals on the cisterns to raise awareness of pollution control measures – and volunteering. They received an award for their efforts from Newark Mayor Ras Baraka and the city's Office of Sustainability, which has recruited volunteers to shore up green infrastructure and ramp up disaster preparedness education and outreach to be ready for increasingly frequent extreme weather events.

"We want to solve the problems we complain about," Mayor Baraka noted at the ceremony, calling the city's collaborators "the secret sauce."

Photo: Courtesy of Tracey Regan

Reimagining Computing, Inspired by the Brain

Bipin Rajendran
Associate Professor, Electrical and Computer Engineering

Photo: Oscar Masciandaro

Advances in computing have enabled systems with astonishing capabilities that augment and even surpass human capacity in many facets of life. Two-legged humanoid robots currently walk adeptly enough to carry out search-and-rescue operations in hazardous environments; big data-analytics engines work alongside doctors to diagnose diseases and suggest treatment plans; and artificial intelligence-based machines have debated human competitors with their own persuasive arguments.

But there is a crucial gap in all of these awe-inspiring artificial systems: the enormous amount of energy they consume to perform their tasks. Did you know, for example, that the Watson supercomputer from IBM required 85,000 watts to challenge and ultimately vanquish two "Jeopardy!" champions? But Watson's conqueror, former U.S. Congressman Rush Holt, relied on a far more efficient machine — the human brain — which functions on a mere 20 watts.

I am developing computing systems that aspire to match the efficiency seen in nature by closely studying the workings of the brain. But just as the Wright brothers took inspiration from the shape of bird wings to design their Flyers, which stayed aloft without flapping, my collaborators and I are trying to decipher the important computational and architectural principles of the brain and not blindly mimic its features.

At the heart of these systems are artificial neural networks, which are mathematical models of the networks of neurons and synapses in the brain. In order to endow human-like intelligence in these artificial networks, vast troves of information are fed to them, and their internal parameters — the strengths of the synaptic connections between the neurons — are adjusted so that they learn the hidden relationships that underlie different parts of the data. A network trained in this fashion can generalize and create meaningful actions when it is presented with similar, but hitherto unseen data.

This approach could potentially help us bridge the efficiency gap, enabling our intelligent and agile electronic assistants to be widely deployed in our homes, roads, cities and natural environments. While machine-learning algorithms are capable of executing complex tasks such as controlling self-driving cars and interpreting a growing number of languages, use of these algorithms in mobile devices and sensors embedded in the real world requires new technologies that consume substantially less energy.

However, the implementation of these brain-inspired algorithms on conventional computers is highly inefficient, consuming huge amounts of power and time. Today's computers are built on an architectural scheme that was developed by John von Neumann in the early 1940s. In these machines, the data storage unit (memory) and the data processing unit (processor) are physically separated, and data continually shuttle back and forth during computations based on well-defined algorithms or programs. This is vastly different from the architecture in the brain, where logic units (neurons) and memory units (synapses) are seamlessly integrated in a dense 3D network.

Furthermore, our brain encodes and processes information in the time domain by issuing tiny electrical pulses known as action potentials, or spikes. For example, neurons in the retina spike at different times and frequencies depending on changes in visual inputs, and these spikes, in turn, trigger other neurons deeper within the brain to integrate this information and issue their own spikes. It is this event-triggered neuronal activity, as opposed to previously stored programs, that underlie the computations in the brain. In contrast, today's popular machine-learning algorithms use memory-less models of neurons for computing. It is true that we still don't know how exactly these time-based processes work in the brain, but there is sufficient evidence from neuroscience research that suggests spiking neural networks are fundamental to biological computation.

We believe that we can substantially improve computational efficiency by designing systems that seamlessly integrate storage and data-processing functions using devices that naturally capture timing-based correlations in data streams. Memristive devices, whose conductivity depends on prior signaling activity, are ideally suited for building such "in-memory computing" architectures. These novel devices eliminate, at least partially, the need to shuttle data back and forth, as several key computational steps can be implemented while the data resides in the memory.

We are also developing new algorithms and network architectures that naturally use the time domain for encoding and processing data. Working with my NJIT colleague, Professor **Osvaldo Simeone**, we have shown that new learning models can be constructed for artificial spiking neural networks that use the precise time of neuronal signaling to perform learning, with the potential for considerable savings in energy.

Our work, however, just scratches the surface of one of the grand challenges of our time — re-engineering the brain to understand how it computes so efficiently at low energies. What we do know is that there are fundamental differences between how nature has organized its thinking machines over millions of years of evolution and the way engineers have built computers over the past century. But I am optimistic that a holistic reimagining of the computational devices, algorithms and system architectures that are inspired by the fundamental organizing principles of the brain will help us begin to unravel this mystery in the coming decades.

Bridging the Accessibility Gap: A Shared Story of Technology and Disability Rights

Photo: Oscar Masciandaro

Photo: Courtesy of NJIT Archives

Elizabeth Petrick (above) has documented the historic work of Starr Roxanne Hiltz and Murray Turoff (both right center), whose collaboration led to new insights into how "computer conferencing" could benefit the lives of people with disabilities. The study would be described in the team's 1978 published work, "The Network Nation."

In 1974, NJIT researchers **Murray Turoff** and **Starr Roxanne Hiltz** embarked on a pioneering field study to explore how a new computer communication technology they had just developed might change the lives of people with disabilities. Their insights would prove relevant for millions of other technology users as well.

Turoff, an early developer of electronic communications systems, and Hiltz, a sociologist, brought typewriter-like terminals, capable of text messaging with one another through a centralized computer, to women at Daughters of Israel Pleasant Valley nursing home in West Orange, N.J., and children at the Cerebral Palsy Center of Belleville, N.J. They hypothesized the technology — then termed "computer conferencing" — might offer both groups a way to form human relationships beyond the walls of their institutional environment, despite significant disabilities of speech, poor health and limited mobility.

A year later, the researchers presented their work at the 141st annual meeting of the American Association for the Advancement of Science in New York City, noting, "This type of communication offers tremendous potential for these individuals to lead more rewarding lives and to greatly decrease limitations imposed upon their mental capacity by the presence of inhibiting physical disabilities ... the opportunities that may be opened by computer conferencing for the handicapped are obvious."

Computer conferencing is regarded as an early precursor to today's popular chat rooms and conferencing technologies.

Elizabeth Petrick, an assistant professor and historian at NJIT, has documented the work of Turoff and Hiltz as part of a larger investigation into an understudied but influential chapter in the modern history of technology and engineering — the rise of accessible technology for people with disabilities.

"It is very much a story of technology changing along with cultural views toward disability," says Petrick. "In the 1970s, there were increasing civil rights protections for people with disabilities, and very gradually in the 1990s, there was an awareness by engineers and corporations that people with disabilities weren't just a charity case, but were actually a consumer market."

Petrick has documented more than 50 years of case studies, disability rights legislation and technological breakthroughs in her book, "Making Computers Accessible: Disability Rights and Digital Technology," which was awarded the 2017 Computer History Museum Prize by the Society for the History of Technology Special Interest Group for Computers, Information and Society.

"Along with the Disability Rights Movement in the 1970s and major computer technology taking hold between the 1960s and 1980s, there is also this growing dream of 'universal design' in the 1990s applied by engineers in fields such as architecture and personal technology," says Petrick. "The idea is that technology should be designed to suit everyone's needs and that it should allow people to do anything they can imagine, regardless of their body."

Of Turoff and Hiltz, she notes, "They did some of the earliest work with people with disabilities as intended users of 'Computer Conferencing' technology, a predecessor to today's online forums and chat rooms. It was an accurate vision of where the future would go with internet technology."

Their study, she adds, serves as a key case for "examining the computer as a universalizing technology of augmentation," illustrating that when researchers and engineers considered the needs of people with disabilities, they benefited the broader society.

"People with disabilities are paradigmatic technology users, as they span so many different types of needs," Petrick adds. "Companies such as Apple worked with disability rights activist groups to make the early Macintosh accessible. As a result, we see fundamental changes in technology design that we all use today, such as power buttons positioned at the front of devices, built-in zoom controls for screens and the development of universal plug-and-play technology."

Accessibility became enshrined in law with the landmark Americans with Disabilities Act of 1990 (ADA) — the first comprehensive civil rights law in the United States prohibiting discrimination against "a qualified individual with a disability" in areas of employment, access to places of public accommodation, services and programs, public transportation and telecommunications.

While the ADA now mandates the "accessible design" of public spaces — from wheelchair ramps to audible crosswalk signals at street intersections — Petrick says that the biggest civil rights challenge is now determining how ADA law applies to digital spaces and new digital technology. According to figures cited by The New York Times, more than 750 lawsuits in the United States have been filed specifically over the issue of web accessibility from January 2015 to October 2017. Until now, web accessibility has been resolved through individual lawsuits only.

"Still, there are growing opportunities for accessibility with technologies like 3D printing, which is capable of creating mouth-controlled input devices for operating touch-screen devices and other individualized technology that is adapted to the user's needs. Ultimately, I think we are finding ways to solve the fundamental challenge that has been there all along, which is growing awareness that technology users include much more than one type of person."

Leveling Up Ethical Research Through Smartphone Gaming

As lead engineer of a self-driving car project, you are tasked with teaching the Artificial Intelligence (AI) to drive. You realize that the AI may have to make a decision between putting the car's occupants at risk or prioritizing the safety of those outside the car. What do you do?

Photo: Oscar Masciandaro

Britt Holbrook, assistant professor of philosophy at NJIT, with "Apperception," a smartphone-based game for engaging young researchers in ethical decision-making.

The above scenario, adapted from a real-life case, is part of a game called "Apperception," a smartphone-based educational game developed by a team of ethics researchers led by BRITT HOLBROOK, an assistant professor of philosophy at NJIT. With funding from the National Science Foundation, Holbrook has introduced pedagogical gaming approaches such as "Apperception" to STEM students, aiming to instill a campuswide culture of responsible research conduct through collective gaming, rather than solely through traditional coursework in ethical theory.

"We think this gaming experience, which is accessible in terms of being played through smartphones, helps bridge the gap between the classroom and the larger campus culture," says Holbrook. "Once students see themselves in a live decision-making situation with others, we hope it takes hold and is more enjoyable in a way that having to take tests and merely having to comply with rules is not."

In "Apperception," up to six users are confronted with ethical dilemmas and must rank a set of three decision options from least ethical to most on their own, later reconsidering their rankings with their group. Points are awarded to each user's ranking choices as they confront scenarios, spanning areas of ethical technology design and responsible conduct of research.

Holbrook is seeking collaboration with assessment research teams to study the impact ethics gaming has on young researchers in real research settings, both near- and long-term.

"Many students take ethics because it's a required class, unaware that ethical questions are intimately interwoven with research they will pursue," says Holbrook. "We are trying to break this 'compliance attitude' and understand how these gaming scenarios might be more impactful to students throughout their careers."

Artificial Intelligence Takes to the Streets

Guiling "Grace" Wang is developing intelligent systems to reduce congestion and improve safety throughout the transportation grid – at intersections, in GPS blackouts, in ridesharing and taxi networks, and on roads that will soon be shared by human-operated and driverless cars.

Photos: Oscar Masciandaro

Traffic jams are as old as cities themselves. Rush hour in Pompeii? Gridlock, archaeologists tell us. Two centuries later, with urban populations booming and the impact of congestion spiraling, computer scientists have joined engineers, physicists and industrial designers in a technology-enhanced campaign against idling engines, fender benders and wasted time. Add climate change to that list.

Their principal tools are connected vehicles, intelligent sensor networks and smart mobile devices, and controllers that are capable of learning on the job to improve their performance. Prompting transportation signals to adjust dynamically to improve traffic flow is an early application.

"Now that we can collect lots of traffic data with tools such as vehicular networks and smartphones to feed to artificial intelligence [AI], these systems are evolving from infant to adult. We expect to see the impact of intelligent devices throughout our transportation networks in reduced congestion and enhanced safety," says **Guiling "Grace" Wang**, a professor of computer science who specializes in both distributed systems and deep-learning algorithms.

In the near future, she adds, these technologies have the potential to warn drivers about patches of black ice on the road, guide traffic flows through even larger grids in real time, and better distribute app-based ride services.

Wang is proposing intelligent systems throughout the transportation grid. Here are a few of her proposals:

Intersections

Wang and her collaborators are researching deep reinforcement learning algorithms that would improve traffic control at intersections by moving it more efficiently through lights, shortening delays and saving energy. "AI would be the brain in the intersection. Essentially, the AI controller would emulate a veteran traffic cop who learns over time and responds to conditions based on current inputs and experience," she notes.

Cameras and vehicular networks would capture real-time traffic information and feed it into a deep reinforcement learning system. The system would then calculate how to adjust the duration of the traffic light in the next cycle, and would receive feedback on its action."

"We know this kind of learning is effective to deal with problems with real-time interactions. We've seen it in games such as 'AlphaGo,' which was able to beat the best Go players," she says, noting that the team has evaluated its model through an urban mobility simulation program. Ultimately, they'd like to extend their deep networks to include multiple intersections, in which AI traffic policemen would communicate with each other about conditions in order to globally optimize flow throughout a region.

Sharing the Road With Driverless Cars

Wang is part of an NJIT team, including engineers **Cong Wang** and **Jo Young Lee**, that is developing a novel assessment platform to evaluate the impacts of connected and automated vehicles (CAVs) on drivers, passengers and pedestrians.

While the goal of CAV technology is to make driving safer and more efficient, there is still little information on human responses to these cars. Without understanding their sense of safety and comfort, as well as their physical reactions, such as steering and braking, it will be difficult to deploy them on the road.

Existing evaluations depend heavily on computer simulations, which can't fully capture reactions. With backing from a National Science Foundation grant, the NJIT team is proposing a platform between a simulation and a street test that would use a crowdsourced cyber-physical reality that relies on visual and force feedback from human subjects to improve upon it. It would connect the human testers with miniature environments through virtual reality and measure their responses.

Pinpointing Rider Demand

Transportation companies have a difficult time accurately predicting rider demand and thus struggle to optimize their resources — vehicles and drivers — to meet it. The result can be lengthy wait times and added congestion and pollution as drivers circulate without fares. But the problem is complex, as it is simultaneously influenced by many factors such as weather, time and conditions on the road, among others. Information on external conditions can be flawed, either inaccurate or imprecise, if sensor deployment is too sparse to gather sufficient data.

By fusing all related factors to model the complex interactions among them through a learning device invented by the team known as a "deep spatio-temporal fuzzy neural network," Wang and her collaborators aim to make accurate rider-demand predictions.

GPS Blackouts

Wang has proposed a grid-based localization system in which cars with and without accurate GPS would self-organize into vehicle networks that would allow them to exchange location and distance information, enabling all vehicles within a grid to calculate their location on a map.

"GPS navigators have been widely adopted, but they are sensitive to terrain and can be blocked in tunnels and in city neighborhoods with high-rises. Emerging from a tunnel, a driver can easily miss a turn if it's immediate, and get lost. We believe this has implications for safety, time and energy use," she explains.

The cars would be equipped with a wireless interface and self-organize within a defined area into a wireless mobile network. Cars without location information could request the help of cars with it through wireless communication. By measuring the distance to those cars, cars lacking GPS would be able to calculate their own location based on geometric relationships among the cars. The determined location could be used just as one obtained from a GPS receiver and provide those drivers with seamless service.

Defending the Defenders: Deflecting Attacks on Cryptographic Tools

A new form of cyberattack has injected urgency into solving a long-ignored challenge to digital security: The tools used to protect data can themselves be a target of subversion. By deploying a subtly altered version of a cryptographic tool that appears to function normally, attackers – from software providers to hardware device manufacturers – can compromise security in covert ways.

"Classical cryptographic research mainly focuses on algorithm and protocol design while ignoring their implementation, in which backdoors can be invisibly embedded," says QIANG TANG, an assistant professor of computer science at NJIT. "We discovered, for example, a subverted hash implementation – the main component in mining machines used to add transactions to secure public ledgers – that can allow the mining machine provider to take over an entire blockchain."

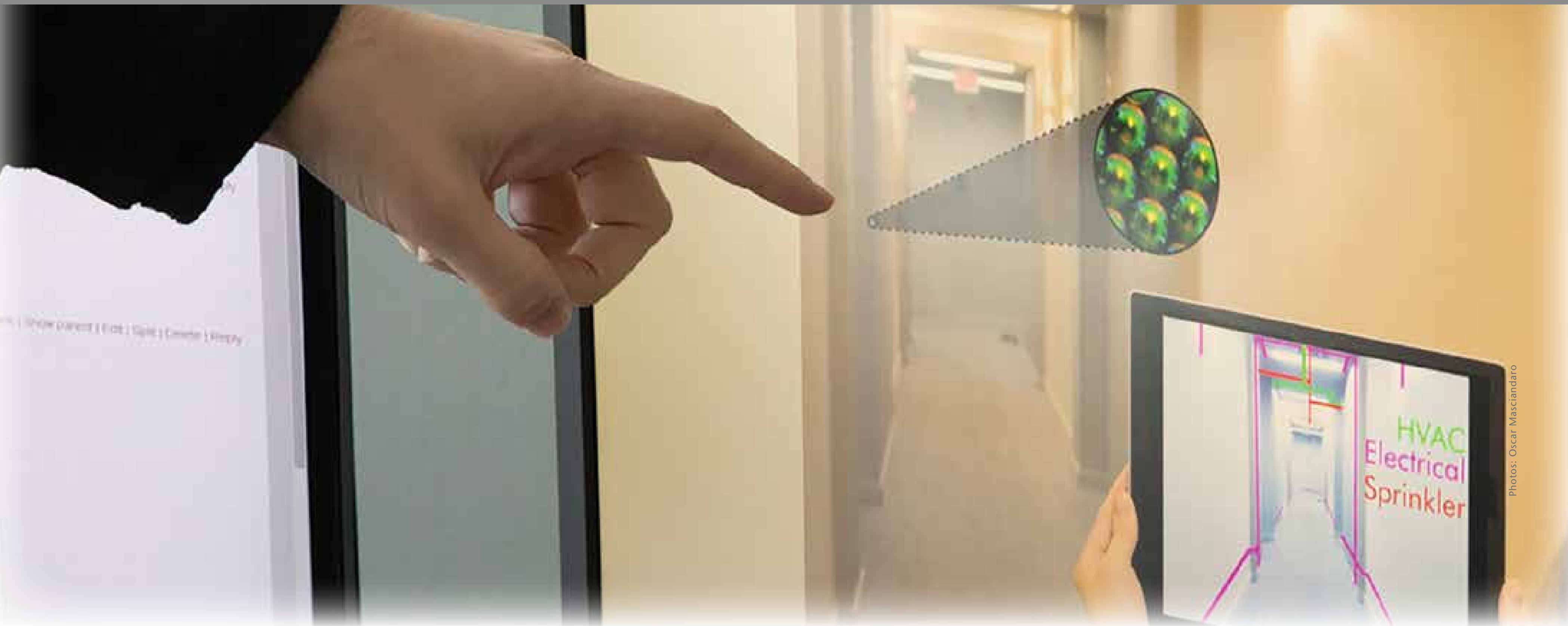
The major technical innovation behind Bitcoin, blockchain technology allows multiple partners engaged in enterprises over the internet to jointly maintain time-stamped, tamper-resistant digital ledgers.

With funding from the National Science Foundation, Tang is devising methods to identify and defend against malicious implementations throughout the field of cryptography, while also re-engineering existing infrastructure tools to harden them against these attacks.

In more directed blockchain research, he is collaborating with JD.com, China's largest retailer, and the Institute of Software at the Chinese Academy of Sciences to improve consensus protocols, privacy protections and security for these applications. The technology is not yet mature enough to support large-scale applications, and its speedy evolution in that direction is the focus of their joint lab.

"JD's enormous ecosystem will provide us many real-world problems that motivate better questions regarding blockchain research as we look to test and deploy our designs in large and complex industrial applications," Tang notes.

Closer to home, he is working with an NJIT colleague, GRACE WANG, on building private and anonymous decentralized crowdsourcing platforms that could serve as the base for a future decentralized sharing economy, and with Protocol Labs and Stevens Institute of Technology on better cryptographic tools to support the distributed storage network, Filecoin.



Photos: Oscar Masciandaro

Guiding Autonomous Vehicles With Invisible Cues

When an auto-piloted Tesla Model X collided with a truck in California last summer, the crash alerted the public to an unsettling reality: the near-total absence of dynamic "smart signaling" in the nation's transportation infrastructure. The car's onboard computer, safety inspectors determined, failed to distinguish between the white paint of the truck and the brightly lit sky behind it.

Navigator apps currently rely on GPS or triangulation, as well as maps loaded into a car's memory, but driverless cars otherwise have only the physical landscape to guide them. With the expected proliferation of these cars, as well as robots and drones in the public domain, there is new urgency in the search for ways to embed reliable traffic cues and alerts onto roads, vehicles and possibly even pedestrians.

An interdisciplinary team of physics, information-security, robotics and built-environment researchers is proposing an intriguing solution: a method for deploying novel optical coatings, or tags, which would be invisible to the human eye, but convey instantaneous messaging about a car's environment and objects within it in the form of reflected light.

While still scanning for visible information, an autonomous car would emit infrared light, comparable to flashes on a camera, that would be reflected back in a specific wavelength by the optical tags embedded in the environment. The car's sensor would recognize the particular signals and be able to identify, for example, the type and location of the car that sent it.

"The tags can be used as coded information, like a QR code, but invisible, and provide more information because they can have multiple layers within them," explains **Mathew Schwartz**, an assistant professor of industrial design, who is working with **Jan Lagerwall** and his team at the University of Luxembourg to identify a broad range of potential applications for their technology.

The tags are composed of tiny spherical shells of cholesteric liquid crystal (CLC). Liquid crystals are currently used in the flat screens of televisions, computers and other flat electronic

Mathew Schwartz is exploring applications for a new information technology: novel optical coatings, or tags, which would be invisible to the human eye, but convey information to machines.

devices; by using CLCs in a spherical shape, new properties arise, such as the ability to receive and reflect light in every direction. The shells can be manufactured to reflect only certain wavelengths of light, such as infrared, and they cancel out the ambient light so sensors only see the invisible tags. Each flash would have a specific wavelength and polarization matching a certain type of CLC shell.

"By controlling the polarization and selecting only a certain wavelength range, the emitting and sensing devices would see only the encoded information," Schwartz adds. "So if you send out a series of strobes of light from wavelengths of 700nm-1000nm inclusive, a particular shell will reflect only a narrow predefined wavelength, such as 750nm. And if you know that emergency vehicles have a 750nm wavelength coating, then you know that the reflection is coming from one of them. A different part of the sensor may see a wavelength of 800nm reflected, and that might identify a person or a bike."

Their material is not just for autonomous vehicles on the roads, but can be applied indoors as well. This leads to new modes of mobility, where smaller personal vehicles can navigate between indoor and outdoor space seamlessly. The same tags and methods can be used for augmented reality. Walking through a space with their phone or a future head-mounted display, people would be able to see layered information that is specific to their location; the system could identify products, while also showing people how to use them.

The shells can be manufactured to change their structure when they are exposed to certain external impacts such as pressure, heat or specific chemicals. "By integrating these properties with fabrics or products, you could have a hallway or path turn red based on the heat location," Schwartz notes. Working with computers to interpret these changes, they could also be used as pressure sensors in the fingertips of robots. Crucially, the tags require neither Wi-Fi, satellite communication nor electricity to operate.

In all of these cases, the tags function as precise forms of identification for new technology, without adding visual noise to the environment. While there are many transportation cues in the environment, including speed limit postings, stop signs and crosses on ambulances, they are designed for people, not machines, Schwartz notes. "We are now going in the opposite direction, needing information for machines, and not people. Using these new methods, information can be interpreted and redisplayed to a user in a customized way, albeit for the hearing or visually impaired, or through translation.

"And even if image recognition technology became perfect and instant, the issue would be adding more cues or detailed information to the environment. If you are not driving, for example, you don't need to see a sign on a bridge detailing how tall a vehicle can be to pass under it, but the vehicle does need to see it," he adds. "The technology's aim is not to replace all other methods, but rather to add an additional layer for improved safety and security, without the impact of a visually distracting built environment."

Testing the Real World Virtually

As a new virtual reality (VR) and augmented reality (AR) quickly mature, the need to connect the real and virtual worlds grows exponentially. In particular, it has become common practice to propose infrastructure plans in extended reality (XR), which combines real and virtual environments, and then after receiving meaningful feedback from future users, to translate them into construction projects.

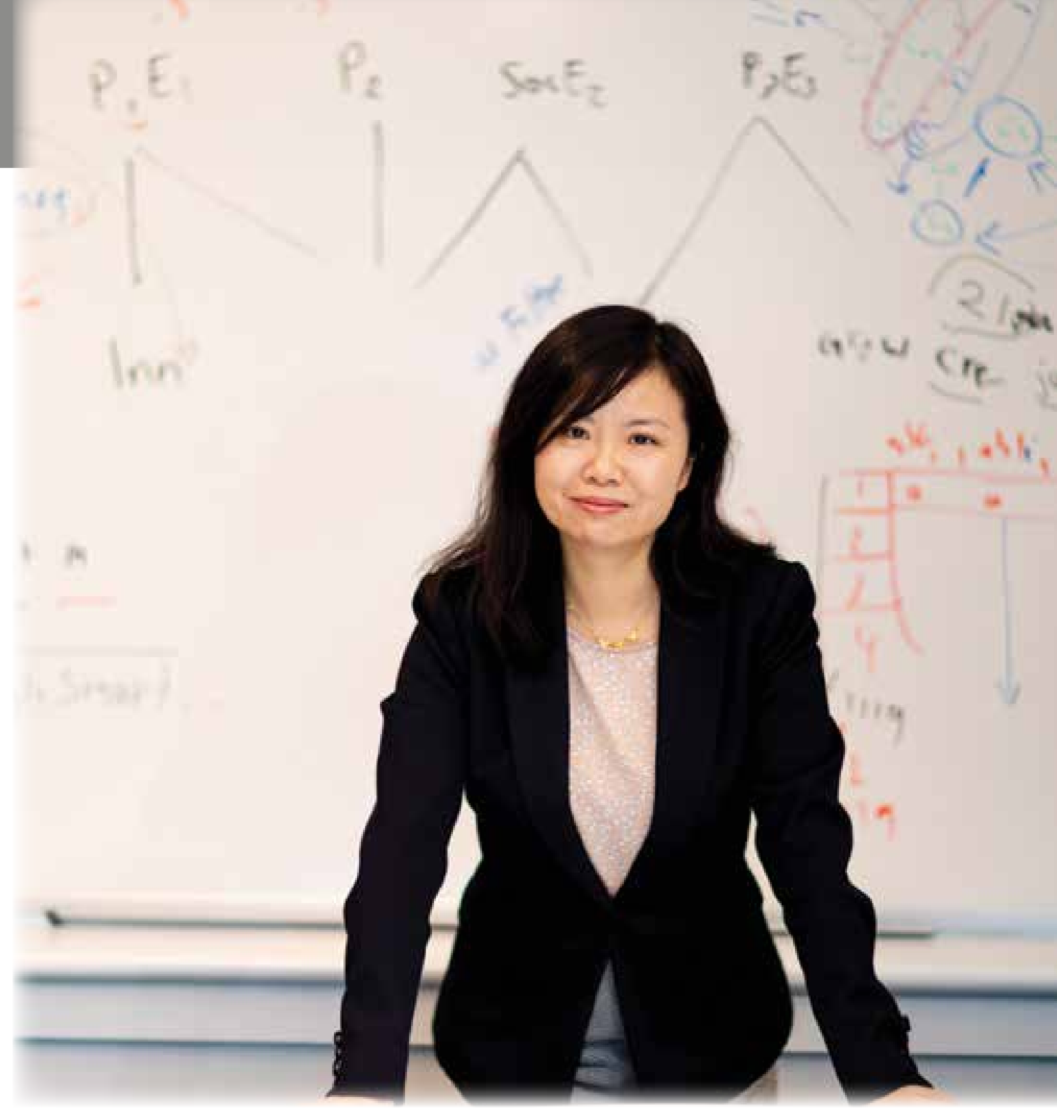
MARGARITA VINNIKOV, an assistant professor of informatics at NJIT, is working with the North Jersey Transportation Planning Authority to bring the transportation planners' vision to the public through VR. She and her team are modeling and simulating an upcoming roundabout project, which allows people to experience the new traffic circle during different traffic and weather conditions through a projection screen and on their mobile devices.

While working on infrastructure projects, Vinnikov is also collaborating with MATHEW SCHWARTZ, a colleague from the College of Architecture and Design, and a pair of students on an undergraduate research project intended to create an interactive 3D model of the NJIT campus for XR applications.

"If you're a prospective student who lives 200 miles away, you can take a virtual tour and get a firsthand look at the campus without leaving your house," she explains. "With augmented reality, you can also walk through the real campus and see things that are no longer there. For instance, there are a lot of historical buildings on campus, and in theory, if you have virtual models or characters, you can see how the campus looked 100 years ago."

Before joining NJIT in 2018, Vinnikov worked for the National Research Council of Canada as a human factor research officer specializing in cross reality and immersive displays, including flight and driving simulations. She assisted pilots and aircrew using XR and VR technology to improve the safe operation of helicopters and other aircraft under low-visibility conditions.

She notes, "Soon virtual and augmented capabilities are going to bridge the gap between real-world and digital content and allow us to see things through a completely different – and much deeper – perspective."



Leveraging Artificial Intelligence to Enhance Treatment Choices by Physicians *and* Patients

Electronic health records (EHRs) have become the chief tool for documenting a patient's medical care in today's changing health care landscape. Still, many physicians are reluctant to use this technology and when they do, they often leave behind an incomplete and incorrect file, primarily because the task of filling in the information is time-consuming and diverts attention from direct patient care. According to one study, "Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties," "during the office day, physicians spent … 49.2 percent of their time on EHR and desk work."

Yi Chen, a professor and the Henry J. Leir Chair in Healthcare, is using advanced machine-learning techniques to make the documentation process easier and more precise for these resisters — which in turn will free up time to spend with their patients and develop more targeted treatment plans. This work is in collaboration with the University of Maryland and Inovalon, a technology company empowering data-driven health care analytics with access to patient data from hospitals and insurance companies, which has made thousands of diverse patient medical records available to Chen for her research.

She describes the data as very "noisy," meaning it is corrupted or distorted, since the fields in the medical records are either wrong or not filled in, including diagnosis codes in particular. Rather than complete a structured medical record, many physicians choose to document patient information just in clinical notes, which is simpler and how they've traditionally practiced. Of the codes, Chen says, "That's the most precise and accurate description about the patient's condition. Insurance companies need the code to determine if the treatment is appropriate for the disease."

Industry makes a large expenditure every year hiring people trained to review medical records and confirm or input the right disease codes based on the physicians' clinical notes. Chen has developed an algorithm for machines to do this job, by leveraging advanced artificial-intelligence (AI) models for natural-language processing (NLP). The algorithm, which identifies specific diseases that a patient has through NLP on clinical notes, builds upon and combines the advantages of two deep-learning models: Convolutional Neural Network (CNN) and Long Short-term Memory (LSTM). CNN can learn to automatically recognize and rank in importance individual features of input data but ignores the sequential-order relationships among this data, while LSTM considers these relationships but disregards whether certain features are more important than others. Such deep learning enables machines to read clinical notes and assign codes.

While AI-powered NLP will never entirely replace humans, it can save a lot of labor, says Chen of the human-machine balance. "We can use machines to screen the data and ask human experts to check only the challenging cases. At the same time, after human experts provide feedback on those

Yi Chen is applying machine learning to patient medical records to ensure they are complete and diagnosis codes are correct, and to also make inputting information easier and more efficient for physicians.

Photos: Oscar Masciandaro

challenging cases, the machine can learn from the feedback to continuously improve the model."

Chen and her team are measuring results according to two matrices: precision (the fraction of machine-labeled correct codes over all codes labeled by a machine) and recall (the fraction of correct codes labeled by a machine over the total amount of correct codes). They have applied the algorithm to 2,000 clinical charts to date, with a precision of .78 and a recall of .60. These figures, notes Chen, represent significant improvement over support vector machines, a state-of-the-art learning algorithm, which realized a precision of .62 and a recall of .55. Support vector machines rely on predefined data features and were therefore unable to fully understand and classify disease mentions for coding.

By ensuring codes are entered and precise, Chen's machine algorithm also has the potential for making AI-based recommendations for care to the doctor, functioning as a type of physician assistant.

"All this depends on if we have enough facts in our knowledge base, based on complete and accurate medical records," offers Chen. "We don't think computers can replace doctors, but we do think computers can help doctors to make diagnoses and find the right treatment plan by learning from past evidence. We can develop AI technologies to identify similar patients and see if their diagnosis and treatment are applicable to the target patient."

Chen is also studying the use of advanced machine-learning technologies to improve patient decision-making. She has employed AI to review user-generated content on online health forums and, through NLP, differentiate between experience and perception when it comes to treatment. The "very ambitious, long-term project" is especially challenging, because there are more variables in consumer-health dialogue than in medical dialogue.

The goal is to turn the experiential content into recommendations for care for patients with similar health concerns, and work with health-forum owners to present this advice to forum users. In this way, patients can become more informed in their decision-making.

"It's all for better health outcomes," Chen remarks of her research. "The first project is to really help physicians make the best treatment choice in the long run.

"But patients have to be engaged," she adds, referencing the forum investigation. "We want to better understand them — what their concerns are, what they care about, and why they do or don't comply with treatment."

Predicting Successful Entrepreneurial Innovations

"The way we typically think about entrepreneurship is to write a business plan and then take it to a crowdfunding website or to venture capitalists to try to get funding," says RAJA ROY, an assistant professor of innovation and entrepreneurship at NJIT. "But how do you identify the opportunity that will capture value?"

The formula for success relies on several factors, Roy explains. To start, entrepreneurs need to consider value creation (the worthwhileness of their idea), as well as value capture (the ability of their idea to make money). "Just because you have value creation doesn't mean you'll capture value," he says.

Capturing value, he adds, depends to a large extent on whether large corporations will want to copy innovations and take a chunk of the market share. "If you can predict when a large company will not imitate your idea, that is opportunity identification for capturing value," he notes.

Roy studies the machine tool, industrial robotics and image sensor industries to determine what products were introduced by firms in these fields and when, as well as how they fared in the marketplace. For machine tools, he used product-introduction data from a variety of sources, such as the marketing flyers for all the machine tools manufactured between 1975 and 1995.

He is applying his findings, gleaned from both quantitative and qualitative methodologies including panel data and expert-corroborated business-history analysis, to explore how firms adapt to technological disruptions – to try to spot opportunities, from an entrepreneur's perspective, that large incumbents will likely find "unattractive."

"My goal is to create industry models for predicting what types of companies and innovations would likely succeed and be profitable, and under what circumstances."

Roy is using the findings from his research in a new course created with CESAR BANDERA, an associate professor of entrepreneurship, and others in NJIT's Innovation and Entrepreneurship cluster. This new course will be a precursor to business-plan writing.

DID YOU KNOW

The term "engineer" appeared for the first time in the minutes of the board of trustees of the Newark Technical School in 1916.

Newark Technical School opened in 1885 with 88 students. Tuition was free for Newark residents, and courses were available in science, mathematics and drawing.

Robert Dow '69, a fencer, competed in the 1972 Summer Olympics.

The board of trustees of the Newark Technical School first met July 1, 1884.

The New Jersey Gamma chapter of Tau Beta Pi, the national honor engineering fraternity, was established at NCE in 1941.

During WWII, academic programs accelerated to allow students to complete their degrees before entering the U.S. Armed Forces, and special engineering courses were introduced for defense workers.

Beatrice Hicks '39 served as a founding member of the Society of Women Engineers and was elected as its first president.

The Research Foundation was started in 1957 and incorporated at NCE in 1959.

Robert Wallace Van Houten '30 B.S., '70 Ph.D., was chosen as Allan Reginald Cullimore's successor as president and became the first alumnus to lead the college.

NCE Professor Mengchu Zhou received the IEEE Norbert Wiener Award "for fundamental contributions to the area of Petri net theory and applications to discrete event systems."

In 1919, the New Jersey State Board of Education recommended that Newark Technical School be given the authority to grant degrees under the name Newark College of Technology.

NCE established a Computer Science Department in 1969.

Edythe R. Rabbe became the first woman to graduate from NCE, with a degree in chemical engineering, in 1930.

Paul Charles Michaelis '64, '67 received the 1975 IEEE Morris N. Liebmann Memorial Award "for the concept and development of single-walled magnetic domains (magnetic bubbles), and for recognition of their importance to memory technology."

With the arrival of the NCE Class of 1953, the female population of the school increased 100 percent, from three women to six.

Judea Pearl '61 received the Association for Computing Machinery's A.M. Turing Award "for fundamental contributions to artificial intelligence through the development of a calculus for probabilistic and causal reasoning."

Thomas Joseph O'Malley '36, chief test conductor for the Convair Division of General Dynamics, pushed the button on launching the Mercury-Atlas 6 space flight carrying astronaut John Glenn, the first American in orbit.

Spring semester 1948 saw the formation of the NCE Student Branch of the Institute of Radio Engineers (later IEEE).

Newark College of Technology inaugurated programs toward baccalaureate degrees in chemical, mechanical and electrical engineering in academic year 1919-1920.

NCE alumnus Heinz Ludwig Chaim Ettlinger '50 was awarded the Congressional Gold Medal for his service to the nation in recovering and repatriating innumerable works of art looted by the Nazis before and during WWII.

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Did You Know?
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"Who's Who Among Students in American Universities and Colleges" extended its recognition to NCE for the first time in 1959. Twenty-six students were selected to appear in the book.

RICHARD SWEENEY '82 CO-FOUNDED THE "K-CUP" POD FOR THE KEURIG SINGLE-CUP BREWING SYSTEM.

Another NCE graduate, William Hazell '30, electrical engineering, succeeded Robert Wallace Van Houten as president.

Charles Adam Colton, a professor of chemistry and mineralogy at the Rose Polytechnic Institute, was Newark Technical School's first director.

NEWARK TECHNICAL SCHOOL'S FIRST DEDICATED BUILDING WAS A THREE-STORY STRUCTURE AT HIGH STREET AND SUMMIT PLACE THAT WAS NAMED WESTON HALL IN HONOR OF AN EARLY BENEFACTOR.

Allan Reginald Cullimore took over the directorship of the school in January 1920 and was later named president.

Milton Holmes, a chemical engineering student, was the president of NCE's first graduating class.

JOHN J. MOONEY '60 CO-DEVELOPED THE FIRST-PRODUCTION THREE-WAY CATALYTIC CONVERTER.

In 1920, Newark College of Technology changed its name to the College of Engineering of the Newark Technical School.

ELLEN M. PAWLIKOWSKI '78, A U.S. AIR FORCE GENERAL, WAS ELECTED TO THE NATIONAL ACADEMY OF ENGINEERING "FOR LEADERSHIP IN THE DEVELOPMENT OF TECHNOLOGIES FOR NATIONAL SECURITY PROGRAMS INCLUDING SPACECRAFT OPERATIONS AND THE AIRBORNE LASER."

For many years, "The Technician" was the official newspaper of NCE.

The Society of Manufacturing Engineers awarded NJIT a student chapter in 1978.

WITH THE INTRODUCTION OF THE 1945 G.I. BILL, ENROLLMENT IN NCE SOARED TO 6,000 STUDENTS. MORE THAN HALF WERE VETERANS.

Gerard J. Foschini '61 published "On Limits of Wireless Communications in a Fading Environment When Using Multiple Antennas," a paper that played a key role in advancing multiple-input multiple-output wireless systems.

The Baja Race Car appeared at the 2017 New York International Auto Show and went on to win the four-hour Endurance Race in California.

IN THE 1940S, LILLIAN MOLLER GILBRETH BECAME THE FIRST FEMALE PROFESSOR AT NCE. HER FAMILY'S STORY INSPIRED THE MOVIE "CHEAPER BY THE DOZEN."

Margaret Bryce was the first woman to enroll at Newark Technical School, in 1897, and studied chemistry.

NJIT opened a 10,000-square-foot Makerspace on campus in 2017.

Michael J. Pappas '59, '64, professor of mechanical engineering, co-developed "The New Jersey Knee," an artificial-knee system that became the basis for knee replacement systems and implantable knee devices worldwide.

In 1979, Saul K. Fenster became the institute's eighth president.

From 1919-2018, NCE granted 47,530 degrees.

NCE awarded its first doctoral degree in 1964, in chemical engineering, to Edwin Otto Eisen. His dissertation was titled, "Salt Effects in Liquid-Liquid Equilibria."

The School of Applied Engineering and Technology was established in 2018.

The college awarded its first bachelor's degrees in 1923: three in chemical engineering, three in electrical engineering, four in mechanical engineering.

Newark Technical School began as a three-year evening school.

Walter Marty "Wally" Schirra Jr., an NCE student in the early '40s, flew the six-orbit, nine-hour Mercury-Atlas 8 mission, becoming the fifth American and ninth human to travel into space.

Howard Michel '75 was elected president and CEO of the Institute of Electrical and Electronics Engineers (IEEE), effective 2015.

In 1953, the Gamma Kappa Chapter of the Eta Kappa Nu Association national electrical engineering society was founded at NCE.

Paul Sarlo '92, '95 was elected to the New Jersey Senate in 2003.

NCE awarded its first Bachelor of Science degree in civil engineering in 1927.

In July 2018, the inaugural VOICE technology summit took place at NJIT, drawing more than 2,400 attendees and hosting some 100 speakers.

Raymond Edward Blum '50 was a speed skater who competed in the 1948 Winter Olympics in Switzerland.

Daniel Russel Hodgdon succeeded Charles Adam Colton and instituted programs to help returning WWI veterans receive technical training.

NCE awarded its first Master of Science degree in 1949.

In 1930, the college again received a new name: Newark College of Engineering (NCE).

1975 brought a new, and lasting, name — New Jersey Institute of Technology.

Daytime classes were initiated at Newark Technical School in 1897.

In 1921, Shirley Dodman became the first woman admitted to NCE.

NCE has more than 40,000 living alumni.

New Faculty

COLLEGE OF SCIENCE AND LIBERAL ARTS

TRAVIS ASKHAM, assistant professor of mathematical sciences, focuses on problems in scientific computing. He develops algorithms used for data-driven model discovery in dynamical systems such as the climate, computer-aided small protein design and the simulation of fluid flow in complex regions.

PIER ALEXANDRE CHAMPAGNE, assistant professor of chemistry, employs experimental and computational methods to study reactive intermediates — transient chemical species that decompose readily. These compounds are then harnessed for use in new processes for synthesizing complex molecules, such as anti-cancer agents, in an efficient, modular fashion that also reduces waste.

HAO CHEN, professor of chemistry, conducts research on mass spectrometry, a biotechnology used to determine molecule mass. Key applications of this tool in the pharmaceutical, life sciences and environmental services industries include chemical measurement and imaging, protein sequencing and 3D-structure determination, and drug and pollution detection.

HYOMIN KIM, assistant professor of physics, studies the impact of solar radiation and charged particles on Earth's geomagnetic environment and human technologies. His analysis of magnetic field waves, caused by the interaction of solar wind with space plasma particles, shows how solar energy is transferred to Earth's upper atmosphere.

ENKELEIDA LUSHI, assistant professor of mathematical sciences, focuses on problems arising in soft matter and biological physics. She builds mathematical models and fast computer simulations to elucidate phenomena such as the self-assembly and guided transport of microscale colloids, and the collective behavior of microbes.

JAMES MACLAURIN, assistant professor of mathematical biology, studies how biological order and synchrony arise out of seeming randomness, such as biochemical fluctuations and variability at the microscopic level. Topics include neural networks, oscillations and synchrony in gene networks, and the mechanics of growing cancer tumors.

GARETH PERRY, assistant professor of physics, researches the interconnections between the ionosphere and the terrestrial magnetic field, whose coupling generates the aurora. His primary focus is to understand the nature of disturbances in the two systems and how they affect radio wave propagation and communications on Earth.

NEWARK COLLEGE OF ENGINEERING

MOHSEN AZIZI, assistant professor of electrical and computer engineering, develops advanced controllers and fault detection and identification systems for microgrids, robotics, mechatronics, aerospace and other large-scale systems. His algorithms are designed to ensure the resilience of these systems amid environmental uncertainties and system failures.

ASHISH BORGAONKAR, assistant professor of engineering education, develops and researches the impact of targeted academic programs and innovative teaching methods on students of various backgrounds, including underprepared and still-deciding students. His approaches include hands-on learning, peer instruction, boot camps, and student design showcases and competitions, among others.

BRANISLAV DIMITRIJEVIC, assistant professor of civil and environmental engineering, specializes in transportation systems analysis and planning, network optimization, and intelligent transportation systems. His current research focuses on integrated transportation and land-use modeling, integrated corridor management, smart mobility and connected vehicle applications in traffic operations management.

CARLOTTA MUMMOLO, assistant professor of biomedical engineering, specializes in the fields of dynamics, optimization, mechanisms and robotics, and biomechanics, with applications in locomotion and balance in robotics and biological systems. She has performed gait analysis, for example, with healthy, amputee and exoskeleton-assisted human subjects.

PRATEEK SHEKHAR, assistant professor of engineering technology, studies the translation of engineering education research into practice by examining barriers to instructional change in undergraduate programs. He also assesses student learning in entrepreneurship programs and investigates ways to increase the diversity of the students participating in these courses.

HONGTAO SUN, assistant professor of mechanical and industrial engineering, explores the intersection of energy science, advanced materials and nanomanufacturing. He assembles low-dimensional nanoscale materials into 3D macroscopic architectures or multi-component systems, and studies the physical and chemical phenomena that affect how these materials transport, store, convert and dissipate energy.

ANGELO TAFUNI, assistant professor of engineering technology and mechanical and industrial engineering, develops new features for particle methods used to study fluid-related problems in engineering environments. Applications include examining flow around mechanical systems such as ship hulls, propellers and spacecraft, liquid sloshing and free-surface hydrodynamics, and atmospheric circulation.

DAVID VENERUS, professor of chemical and materials engineering, examines transport phenomena in soft matter, polymer science and the rheology of complex fluids, such as polymeric liquids and biological fluids. He investigates, for example, the interaction of fluid flow and heat transfer in the processing of plastic materials.

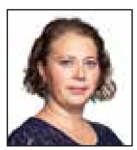
XIANLIAN ALEX ZHOU, associate professor of biomedical engineering, focuses on computational biomechanics, robotics and human modeling and simulation, injury prevention, and personalized medicine. He analyzes in vivo biomechanical forces on tissues under injury and disease conditions to develop protective measures such as helmets and wearable assistive devices.

YING WU COLLEGE OF COMPUTING

Department of informatics

FRANK BIOCCA, professor of informatics, specializes in human-computer interaction, including the development of virtual reality and augmented reality interfaces that allow for 3D full-body interaction in virtual environments. He explores ways in which virtual and augmented reality environments can support human decision-making, learning and persuasion.

ARITRA DASGUPTA, assistant professor of informatics, develops and studies interactive visualization techniques that help people understand and communicate with data. The goal of his research is to foster greater human-machine trust by using visualization as a transparent medium between computational methods and human decision-making.



MARGARITA VINNIKOV, assistant professor of informatics, specializes in cross reality and gaze-contingent displays. Her augmented and virtual reality platforms have been used to train helicopter pilots and aircrew to fly safely in low-visibility conditions, and to help researchers understand the driving behavior of people with visual impairments.

XINYUE YE, associate professor of informatics, combines social science and computational science to map relationships among individuals in networks, which he integrates with spatial and environmental factors. He models the geographical perspective of socioeconomic inequality and human dynamics for applications in domains such as economic development and urban crime.

Department of Computer Science

BARUCH SCHIEBER, professor of computer science, designs efficient algorithms for constrained-resource allocation problems and mathematical-programming techniques to obtain high-quality interpretable models. His models are used in vehicle routing and scheduling, production planning, supply chain management, budget allocation, and power outage recovery.

MARTIN TUCHMAN SCHOOL OF MANAGEMENT

XINYUAN TAO, assistant professor of finance, researches empirical asset pricing with a current focus on the effects of frictions — the difficulty with which an asset is traded— and behavioral factors related to investors' cognitive biases in finance. Her models enable better earnings forecasts in the presence of incomplete information.

COLLEGE OF ARCHITECTURE AND DESIGN

HANNAH KUM-BIOCCA, assistant professor of digital design, is a computer interface designer and an interactive media artist who specializes in video mapping, virtual and augmented reality, and interactive user-experience installations. Her commercial works include user interfaces for 3D printers and web information systems for government and media companies.

Faculty Accomplishments

NATIONAL SCIENCE FOUNDATION CAREER GRANT RECIPIENTS

ISMET ESRA BUYUKTAHTAKIN-TOY, associate professor of mechanical and industrial engineering, conducts theoretical and applied research on large-scale mathematical optimization. With her grant, she will design optimal intervention and resource-allocation strategies to protect ecological systems from the detrimental impacts of invasive species.

SHAWN CHESTER, assistant professor of mechanical engineering, specializes in soft solid materials, from smart gels used as sealants and valve controls, to plastics that degrade in the body and in compost piles. He is developing methods to precisely predict their load-carrying capacity as they degrade over time.

BRITTANY FROESE HAMFELDT, assistant professor of mathematical sciences, develops numerical methods for solving nonlinear partial differential equations. She's focusing on methods to design lenses and mirrors to precisely control the intensity pattern and phase of light beams in applications such as optical data storage, medical treatment and astronomy.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS; AMERICAN SOCIETY OF PHARMACEUTICAL SCIENTISTS, FELLOW

RAJESH DAVÉ, distinguished professor of chemical engineering, focuses on research in particle engineering and materials science to advance knowledge of drug particle formation and cost-efficient manufacturing. He has developed methods for raising the absorption rates of poorly soluble drugs and increasing patient compliance through medication taste-masking.

AMERICAN INSTITUTE FOR MEDICAL AND BIOLOGICAL ENGINEERING, FELLOW

TARA ALVAREZ, professor of biomedical engineering, studies the links between visual disorders and the brain, and develops novel devices to identify and treat them. Her team's vision therapy platform, which includes virtual reality games, won "most innovative breakthrough" at the 2018 Augmented World Expo Europe.

IEEE, FELLOW

ALI ABDI, professor of electrical and computer engineering, researches wireless communication and propagation modeling in underwater, radio and oil well drill string channels, and cell signaling, among other topics. He recently developed a new computational method to quantify decision-making "errors" in cells caused by noise and signaling failures.

NATIONAL ACADEMY OF INVENTORS, FELLOW

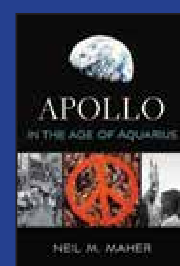
CRAIG GOTSMAN, distinguished professor and dean of Ying Wu College of Computing, develops groundbreaking software technologies for the creation and manipulation of 3D data, as well as data generated by depth cameras. His work, commercialized through startup companies, has been acquired by industry leaders such as NVIDIA.

INTERNATIONAL ACADEMY FOR MEDICAL AND BIOLOGICAL ENGINEERING, FELLOW

ATAM DHAWAN, distinguished professor of electrical and computer engineering, and senior vice provost for research, develops point-of-care technologies in health care. He focuses on optimal imaging devices to identify skin cancers, treat spider vein diseases and make in-situ measurements of hemoglobin, glucose and melanin through skin-imaging.

Books

Society for the History of Technology Special Interest Group for Computers, Information and Society, Computer History Museum Prize (2017)
Making Computers Accessible: Disability Rights & Digital Technology by Elizabeth R. Petrick, assistant professor of history



American Astronautical Society, Eugene M. Emme Astronautical Literature Award (2018)
Apollo in the Age of Aquarius by Neil M. Maher, professor and chair of the Federated History Department

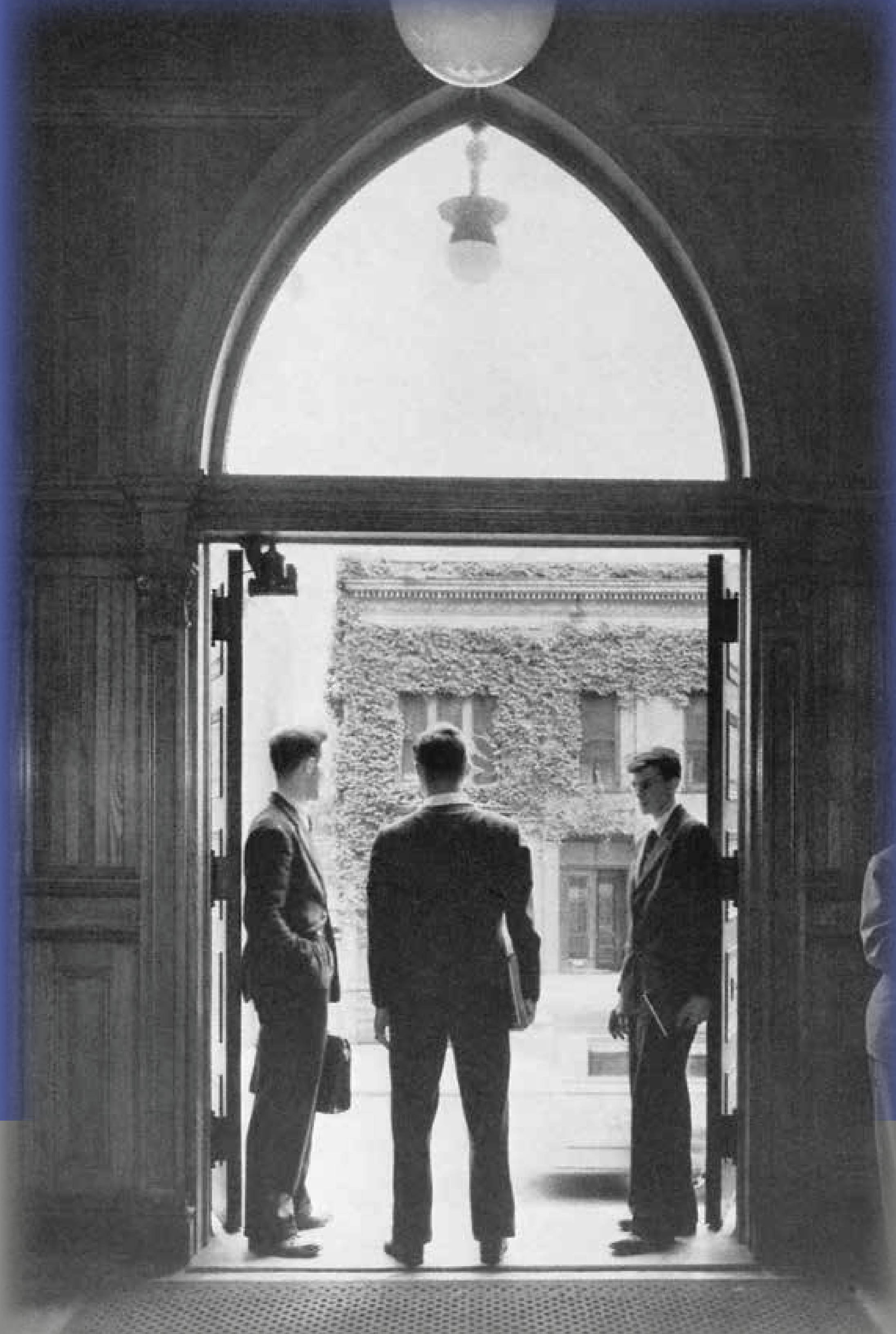
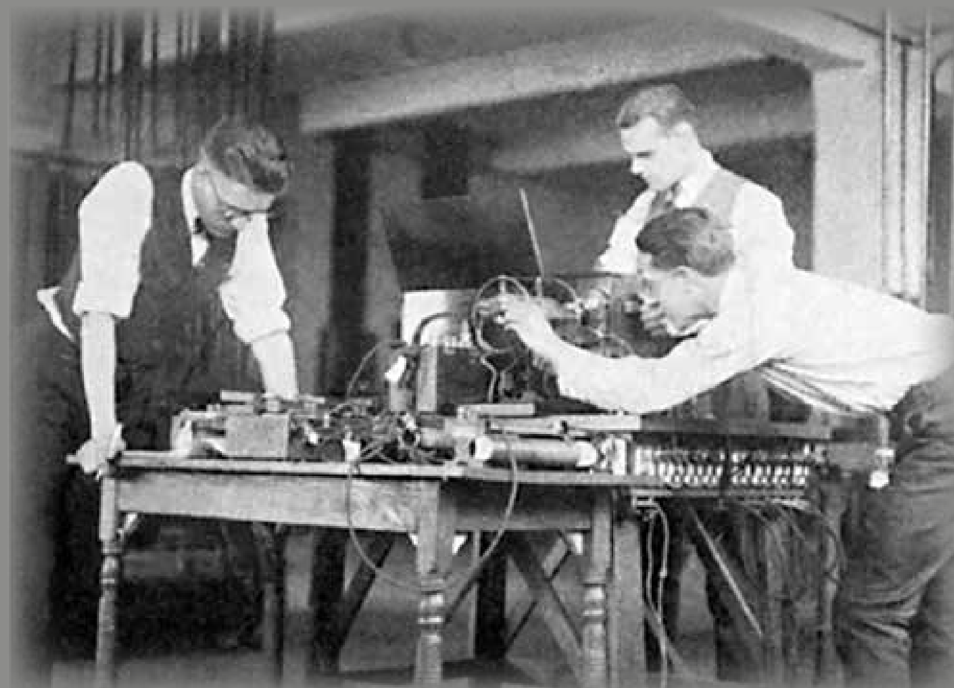


Photo: Courtesy of NJIT Archives



NJIT New Jersey Institute of Technology

100 years NEWARK COLLEGE OF ENGINEERING NEW JERSEY INSTITUTE OF TECHNOLOGY

njit.edu/research

University Heights, Newark, NJ 07102

Photo: Courtesy of NJIT Archives

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