Transforming the Research Enterprise

When I arrived at Rensselaer in 1999, we focused on transforming Rensselaer to live up to its full potential, both in education and research. With the Rensselaer Plan, we put in place a roadmap for such a transformation, encompassing the people, programs, platforms, and partnerships required to remake Rensselaer into a top-tier technological research university with global reach and global impact.

When it came time to refresh that plan a dozen years later in anticipation of the 200th anniversary of our founding, with the Rensselaer Plan 2024, we had succeeded in transforming Rensselaer, and now could focus on our external and internal impact—on being transformative in our research, teaching, and in the lives of our students.

To ensure that we remain and are even more nationally competitive and globally recognized, within an intellectual framework we term The New Polytechnic, we remain focused on the greatest challenges that the world faces—such as climate change; humanity’s food, water, and energy supplies; our need for resilient, sustainable infrastructure; and national and global security. These are challenges that cannot be addressed by a single person, no matter how brilliant—or by a single discipline or sector, working alone. So, we have positioned Rensselaer Polytechnic Institute as a great intergenerational crossroads, where essential connections can be made to take on intricate and networked problems, and to improve lives on a grand scale.

Three pillars undergird this vision: first, the world-class interdisciplinary platforms we have created here, such as the Curtis R. Priem Experimental Media and Performing Arts Center, Center for Biotechnology and Interdisciplinary Studies, and Center for Computational Innovations.

Second, are extraordinary new tools and technologies, many of them being developed at Rensselaer, in fields such as genomics, data science, and cognitive and high-performance computing—tools with applications in many disciplines, that give us a new capacity to address complex challenges, and that power collaborations. We created the Rensselaer Institute for Data Exploration and Applications, or the Rensselaer IDEA, in recognition of the crucial role of data science and big data in driving new insights in every field.
The third factor undergirding this vision is our world-class faculty, which includes four members of the National Academy of Engineering, three members of the National Academy of Inventors, one member of the National Academy of Sciences, 176 fellows of technical and professional societies, 63 CAREER Award recipients, and numerous recipients of national and international awards.

Our faculty members have done transformative work, often collaborating with each other, and forging new ground at the interstices between disciplines, particularly within the Rensselaer signature thrusts in multidisciplinary research in...

- Biotechnology and the Life Sciences
- Computational Science and Engineering
- Media, Arts, Science, and Technology
- Energy, Environment, and Smart Systems
- Nanotechnology and Advanced Materials

At Rensselaer, our faculty belong to a great tradition of groundbreaking research, innovative teaching, and unwavering respect for the potential of the next generation of discoverers and innovators.

We are proud of the remarkable research that our faculty contribute to the world—and of the recognition they bring to Rensselaer. It is their dedication and focus that is allowing our vision for Rensselaer as The New Polytechnic to be realized—and for the university to serve as a crossroads for collaborations across disciplines that address the great challenges of our day.

Shirley Ann Jackson, Ph.D.

PRESIDENT, RENSSELAER POLYTECHNIC INSTITUTE
The most significant transformation at Rensselaer over the past two decades has been the creation of a research portfolio of a size, significance, quality, and prominence that positions us to impact global challenges.
We have a broad, collaborative, and vibrant research community, focused on the growing interface of the basic sciences, social sciences, and engineering. This provides the basis for innovative solutions to today’s global challenges, including: mitigating disease; providing clean food and water; developing new sources of clean and renewable energy; and establishing a sustainable and resilient national and international infrastructure. We are inventing new routes to advanced manufacturing that lead to new products and processes. We are developing new materials for advanced computing, energy storage, and medicine. We are pioneering new technologies to manage the explosion of data from new communication networks and control systems. We are working to understand human cognition in communication and culture and to navigate the complexity of global markets.

Rensselaer has solidified its place among the important technological universities of the 21st century by investing in top-notch researchers, broad-based programs, sophisticated research platforms, and strategic partnerships. Important new research has emerged from strategic investments in the Institutewide signature research thrusts.

Our research efforts are undergirded by an integrated network of major research platforms, including: the Center for Biotechnology and Interdisciplinary Studies; the Center for Computational Innovations; the Curtis R. Priem Experimental Media and Performing Arts Center; and the Center for Materials, Devices, and Integrated Systems.

Rensselaer has developed a broad and unique network of outstanding research centers, including the NSF Center for Lighting Enabled Systems & Applications Engineering Research Center; the Rensselaer Institute for Data Exploration and Applications; the Lighting Research Center; the Center for Modeling, Simulation, and Imaging in Medicine; the Scientific Computation Research Center; the U.S. Army Research Laboratory—Social Cognitive Networks Academic Research Center; the Center for Cognition, Communication, and Culture; the Bioengineered Heparin Consortium; the Center for Architecture Science and Ecology; the New York Center for Astrobiology; the Center for Automation Technologies and Systems; the Center for Future Energy Systems; and more.

Collectively, the signature research thrusts, centers, and platforms provide the basis for significant contributions in the years ahead.

I hope you enjoy the Rensselaer Research Report: Focus on Centers, which highlights some of the breakthrough work being done on the Rensselaer campus.

JONATHAN DORDICK, PH.D.
Vice President for Research, Howard P. Isermann Professor of Chemical and Biological Engineering
RENSSELAER HOSTED THE FIFTH ANNUAL CONFERENCE ON ADVANCES IN COGNITIVE SYSTEMS IN MAY, featuring presentations from researchers at organizations including Naval Research Lab, MIT, Google, Georgia Tech, and IBM.

As part of the event, the Cognitive and Immersive Systems Laboratory (CISL) at Rensselaer hosted a related workshop on cognitive and immersive systems, including a demonstration of the “situations room” the lab is developing as part of an ongoing collaboration between Rensselaer and IBM.

CISL aims to advance cognitive and immersive environments for collaborative problem-solving in situations like board rooms, classrooms, diagnosis rooms, and design studios.

“This is the first time the CISL has hosted a workshop for researchers in multiple academic institutes to discuss and define the research agenda for cognitive and immersive systems,” said Hui Su, director of CISL. “It was an opportunity to demonstrate CISL research results and articulate CISL’s cross-disciplinary research agenda to our peer academic institutes.”

The annual conference brings together researchers with an interest in building computational artifacts that focus on high-level cognition and decision making, reliance on rich, structured representations, and incorporation of insights about human thinking.

The “situations room” CISL is developing is an example of an application for cognitive systems. The vision for the room is a space where humans can interact naturally with computers in collaborative situations like making business decisions, diagnosing medical issues, handling emergency response, and learning.

As an initial milestone, CISL has developed a prototype that ties together multiple technologies in a functioning space where humans can interact naturally with computers in collaborative situations like making business decisions, diagnosing medical issues, handling emergency response, and learning.

Within Studio 2, sensors detect human activity, such as a change in the position of an occupant of the room, speech, and head movement. Absent the CISL architecture, each of the cognitive technologies acts in solitude, responding to a specific activity detected by a single type of sensor and provided to the computer for interpretation. A sensor provides an input, and the computer provides an output. The interaction between human and machine is based on a single action with a finite duration.

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Research by the numbers

12 billion data points mapping the lake bottom and watershed in 3-D

100 million sensor measurements after two years

41 smart sensor platforms

30+ experiments completed

71 undergraduate students

307 species identified

The Jefferson Project at Lake George—A Partnership Between Rensselaer, IBM Research, and The Fund for Lake George—combines Internet of Things technology and powerful analytics with science to create a new model for environmental monitoring and prediction. Based at the Rensselaer Darrin Fresh Water Institute, the project is building a computing platform that captures and analyzes data from a network of sensors tracking water quality and movement. These sensor data are combined with other monitoring and experimental data to create a thorough understanding of the factors that drive the lake’s food web and overall water quality. Scientific insights and technology created for the project will not only help manage and protect one of America’s most famous lakes, but also will create a blueprint to preserve important lakes, rivers, and other bodies of fresh water around the globe.

To better understand Lake George, researchers are collecting massive amounts of data within the watershed. A network of sensors on land, in streams, and in the lake measures a diverse array of variables related to weather, water runoff, water circulation, and water quality. Individual sensors communicate with one another and IBM and Rensselaer researchers, helping to make decisions about what to sample, where to sample, and how often to sample.

Thirty-five years of monitoring the chemistry and algae in Lake George by scientists at the Darrin Fresh Water Institute, with support from The FUND for Lake George, have demonstrated that the lake is changing. Chloride inputs from road salt have tripled, algae have increased 33 percent, and invasive species have taken hold. The critical question is: How do those changes relate to the past, present, and future of Lake George? By creating a high-resolution view of the lake’s ecosystem, the Jefferson Project provides the knowledge that enables informed decisions to protect the Queen of American Lakes.

The Margaret A. and David M. Darrin ’40 Fresh Water Institute, led by Rick Relyea, the David M. Darrin ’40 Senior Endowed Chair, who also leads the Jefferson Project, is a multidisciplinary environmental research center dedicated to understanding the structure and function of aquatic, terrestrial, and atmospheric systems. The primary focus is on the ecological consequences of environmental perturbations due to human activities.

Road Salt “Masculinizes” Frogs

Naturally occurring chemicals found in de-icing road salts can alter the sex ratios in nearby frog populations, a phenomenon that could reduce the size and viability of species populations, according to a new study by scientists at Yale and Rensselaer. In a series of experiments, Jefferson Project researchers found that the proportion of females within populations of tadpoles was reduced by 10 percent when exposed to road salt, or sodium chloride, suggesting that the salt has a masculinizing effect. They also found that exposure to the leaf litter from a common tree species, oak, significantly altered the sex ratios in the frog populations and, in some cases, the size of individual females. Maple leaf litter, on the other hand, had no effect.

More than 22 million metric tons of road salt is applied on U.S. roads each year. Maple and oak trees are dominant trees throughout temperate North America.
“An important mission of the center is to advance research that spans the range from fundamental discovery to systems-level assembly and manufacturing.”

ROBERT HULL, cMDIS DIRECTOR
CENTER FOR MATERIALS, DEVICES, AND INTEGRATED SYSTEMS  
[cMDIS]
From fundamental to transformative

BUILDING ON THE STRONG CULTURE OF INTERDISCIPLINARY RESEARCH AND ACADEMICS AT RENSSELAER, the Center for Materials, Devices, and Integrated Systems (cMDIS) aims to advance next-generation electronic and optical devices, manufacturing and robotics, integrated biomaterial devices, energy harvesting and storage, electric transmission/distribution, responsive and adaptive built environments, and nanostructured composite materials, among other leading-edge technologies.

“We take a multidisciplinary, multi-perspective approach to broaden our net on the types of complex problems and issues we can address,” says cMDIS Director Robert Hull, the Henry Burlage Jr. Professor of Engineering.

Hull, who came on board as the first director of cMDIS in 2014, is known for his research in academia and the private sector in the fundamental growth mechanisms of semiconductor films, the self-assembly of nanostructures, and for his work in exploring potential applications of these films and structures for future nanoelectronic devices.

“An important mission of the center is to advance research that spans the range from fundamental discovery to systems-level assembly and manufacturing,” he says.

Established in 2014, cMDIS builds off its predecessor, the Center for Integrated Electronics. The mission of the cMDIS is to provide a unified voice among Rensselaer’s physical, chemical, and engineering sciences as well as to support excellence in existing research strength areas and promote new areas of intellectual discourse and research.

The cMDIS houses two prominent facilities. The Micro and Nanofabrication Clean Room is a state-of-the-art, 10,000-square-foot, Class 100 multi-user facility with tools and infrastructure. It is located in the Low Center for Industrial Innovation. The clean room currently performs end-to-end device fabrication, characterization, metrology, and testing services to users from universities, local startups, and industrial institutions for research, education, and economic development. The facility has recently been upgraded to 8-inch wafer size with over $4 million in tools and infrastructure. While the facility is an 8-inch operation, it routinely processes 2-inch to 8-inch wafers for high-speed electronics, power devices, ICs, and microsystems.

The second major center is the Nanoscale Characterization Core, which contains more than a dozen instruments to interrogate the structure and properties of materials at the atomic level and to understand their function at the most basic level.

Micro and Nano Fabrication Clean Room
Rensselaer's nanopatterning and fabrication clean room is a state-of-the-art, 10,000-square-foot, Class 100 multi-user facility with tools and infrastructure. It is located in the Low Center for Industrial Innovation. The clean room currently performs end-to-end device fabrication, characterization, metrology, and testing services to users from universities, local startups, and industrial institutions for research, education, and economic development. The facility has recently been upgraded to 8-inch wafer size with over $4 million in tools and infrastructure. While the facility is an 8-inch operation, it routinely processes 2-inch to 8-inch wafers for high-speed electronics, power devices, ICs, and microsystems.
576 independently controllable speakers in EMPAC’s wave field synthesis audio system

5.8 cm between each speaker head

1 Pulitzer Prize nomination for an EMPAC-produced project (Kate Soper’s opera *Ipsa Dixit*)

28 media projects developed at the center over the past year
The Curtis R. Priem Experimental Media and Performing Arts Center (EMPAC) at Rensselaer is **WHERE THE ARTS, SCIENCES, AND TECHNOLOGY MEET UNDER ONE ROOF.** Four exceptional venues enable audiences, artists, and researchers to inquire, experiment, develop, and experience the ever-changing relationship between our senses, technology, and the worlds we create around us.

Designed by London-based Grimshaw Architects, EMPAC opened in fall 2008. The 220,000-square-foot building includes many firsts in the fields of acoustics, performing arts infrastructure, and architectural engineering. The integration of these features with audio, video, lighting, computer, and stage rigging networks makes EMPAC an ideal environment for human interaction with digital media. In 2016, EMPAC debuted a unique new system that explores the relationship between sound and space.

“Think of it like a pebble dropping into a pond,” says EMPAC’s lead audio engineer Todd Vos, describing the way a sound wave emanates from one of the speaker heads in the system. Now picture 500 tiny speakers arranged in a continuous ring around the room. As every one of those speakers casts sound into the room, the waves overlap and intersect, creating a dense, three-dimensional, immersive sound environment for a listener to explore.

This is a simple way to imagine the effect of “wave field synthesis”—the math behind the concept is significantly harder. Even harder is the process of constructing such a system, of which only a handful exist in the world.

To distinguish wave field synthesis from other more common types of surround sound, EMPAC director Johannes Goebel uses a photographic analogy. Most audio systems create something like a snapshot of sound, mixing discrete elements together to imitate what is heard in real life. Wave field synthesis actually models the sound environment in its full complexity—more like a hologram. Within the wave field, there is no “sweet spot” where the mix is just right; one may actually move around in the sound space and find equal resolution in all places, the same as if one were to walk around a concert hall during a live performance.

What is significant about EMPAC’s new system is the very small size of the speakers and their very close proximity (5 centimeters apart). This allows the system to integrate a higher frequency range into the wave field (up to 6 kilohertz). This high range is important because it is the higher frequencies of human hearing that allow us to spatially locate the source of sounds around us.
Cognitive computing is poised to transform every profession, industry, and economy, and IBM is committed to helping to solve the world’s biggest health challenges. We are excited to collaborate with Rensselaer on the development of the HEALS research center to advance precision medicine with the help of Watson technologies and to help improve the quality of care clinicians can deliver to individuals.

JOHN KELLY III, SENIOR VICE PRESIDENT, COGNITIVE SOLUTIONS AND RESEARCH AT IBM

James Hendler Receives Inaugural Spotlight Award

James Hendler, director of the Institute for Data Exploration and Applications (IDEA) and the Tetherless World Professor of Computer, Web, and Cognitive Sciences, has been honored by the Association of Moving Image Archivists (AMIA) with its inaugural AMIA Spotlight Award. The Spotlight Award is given in recognition of significant contributions to the field of media preservation and access. Hendler’s visionary role in creating access to diverse content through semantic technologies and machine learning led the board’s decision to honor his accomplishments.

“Cognitive computing is poised to transform every profession, industry, and economy, and IBM is committed to helping to solve the world’s biggest health challenges. We are excited to collaborate with Rensselaer on the development of the HEALS research center to advance precision medicine with the help of Watson technologies and to help improve the quality of care clinicians can deliver to individuals.”

JOHN KELLY III, SENIOR VICE PRESIDENT, COGNITIVE SOLUTIONS AND RESEARCH AT IBM
IBM and Rensselaer team to research chronic diseases with cognitive computing

WE INCREASINGLY LIVE IN A DATA-DRIVEN, WEB-ENABLED, SUPERCOMPUTER-POWERED, GLOBALLY INTERCONNECTED WORLD, and this poses significant new challenges to scientists and engineers throughout all of their disciplines. Attacking these problems requires new technologies for sensing the environment, collecting and analyzing this data, using it to simulate engineered, biological, and social systems, and applying these results to provide effectors, physical or cyber, that can help solve critical global challenges.

The Rensselaer Institute for Data Exploration and Applications (IDEA) enables research across campus to access such technologies via the development of critical computational methodologies, including data-intensive supercomputing, large-scale agent-based simulation, and cognitive computing technologies.

IDEA has provided the impetus for a new partnership with IBM—the Center for Health Empowerment by Analytics, Learning, and Semantics, or HEALS. Located on the Rensselaer campus, the HEALS center is a five-year, $20 million effort to prevent the progression of chronic diseases such as diabetes and hypertension.

HEALS is bringing together big data analytics, state-of-the-art machine learning, and the technologies of the Semantic Web to find insights within data from many different sources, including clinical data, lifestyle data provided by the patient, health or wellness data from mobile fitness tracking devices, and social network data from shared online activities. The goal is to enable individuals to improve their own health by providing health information customized for their specific medical, environmental, and life situations.

The challenge lies in the personalized coupling of curated knowledge and individual data, according to James Hendler, director of the Rensselaer IDEA and the Tetherless World Professor of Computer, Web, and Cognitive Sciences, who also serves as director of the HEALS center.

“Recent studies show again and again that a doctor working with a medical computer will outperform the doctor alone or the computer alone every time,” Hendler says. “The same needs to become true for patients. With the new technologies we are exploring at Rensselaer, a patient with a cognitively enhanced computer will be able to stay healthy much better than a patient alone. If we could extend that to hundreds of thousands of patients worldwide, the impact on global health would be immeasurable.”
CCI houses the most powerful supercomputer at any private American academic institution and the 43rd most powerful system in the world.

Ability to perform more than one quadrillion ($10^{18}$) calculations per second

Network bandwidth of more than 4 terabytes per second across the system — more than the combined bandwidth of 2 million home Internet subscribers.
OVER THE LAST DECADE, UNPRECEDENTED CAPABILITIES IN COMPUTATION HAVE UNLOCKED ENORMOUS OPPORTUNITIES FOR DISCOVERY, INNOVATION, AND POLICYMAKING in areas ranging from energy, health, and manufacturing to the environment and cybersecurity.

Enter the era of high-performance computing (HPC), in which supercomputers and other advanced computational systems are computing, capturing, analyzing and interpreting, storing, transferring, and visualizing vast amounts of unstructured data into a tangible resource for major impact across society.

At Rensselaer, high-performance computing to process data in ever more efficient and enlightening ways has advanced rapidly in areas ranging from advanced manufacturing to new cancer screening tools. At the heart of all this activity across the university’s schools and disciplines is the Center for Computational Innovations (CCI).

A top 50 supercomputing center of any kind in the world, the CCI serves as a vital resource for providing the technical capability along with the expertise to perform low-cost, high-performance cluster computing, bringing together academia, industry, and government for major impact and global transformation.

“The CCI is a platform on which Rensselaer is building a world-class hub of computation and data-related research, innovation, and education,” says CCI Director Christopher Carothers.

The center, with its core 33 faculty, supports a large network of researchers, faculty, and students from 50 universities, government laboratories, and companies across a diverse spectrum of disciplines. Researchers perform a broad range of computational simulations, from the interactions between atoms and molecules all the way up to the behavior of a complete device. Industry collaborators include IBM, Boeing, GlobalFoundries, Intel, and Xerox, as well as many smaller companies.

A central feature of the CCI is the Advanced Multi-processing Optimized System (AMOS), the most powerful university-based supercomputer in New York state and the Northeast, and among the most powerful in the world. The IBM Blue Gene/Q petascale supercomputing system has the ability to perform more than one quadrillion calculations per second and has a network bandwidth of more than four terabytes per second across the system—more than the combined bandwidth of 2 million home Internet subscribers. Additionally, the CCI offers two state-of-the-art Intel processor-based compute clusters and provides over two petabytes of high-performance disk storage for its users.

With this unique computational and storage platform, the CCI plays a multifaceted role on campus. “These systems are designed to support the data analysis and simulations needs of Rensselaer faculty who are performing leading-edge research that addresses key scientific, societal, and industrial problems,” Carothers says. “The CCI also provides an environment for the development of next-generation data analytics and simulation methods.”

The CCI is home to Watson, a version of the IBM cognitive computing machine that became famous in 2011 for besting the all-time champions of the game show Jeopardy. Watson, which IBM provided to Rensselaer in 2013, has the ability to understand the nuances of human language and sift through vast amounts of data.

The CCI, which supports $60 million in research, has well-established partnerships with major federal research laboratories, state government-supported entities, and universities across the country.
$130 million external grant funding

218,000-square-foot modern facility

150 Ph.D. students

50 postdoctoral fellows

33 principal investigator laboratories

31,240 square feet of open research labs

25 visiting research scientists
A Blood Test for Autism

An algorithm based on levels of metabolites found in a blood sample can accurately predict whether a child is on the Autism spectrum disorder (ASD), based on a recent study. The algorithm, developed by researchers at Rensselaer, is the first physiological test for autism and opens the door to earlier diagnosis and potential future development of therapeutics. Systems biologist Juergen Hahn, lead author, is a professor and head of the Rensselaer Department of Biomedical Engineering. Autism Spectrum Disorder is estimated to affect approximately 1.5 percent of individuals and is characterized as “a developmental disability caused by differences in the brain,” according to the Centers for Disease Control and Prevention. The physiological basis for ASD is not known, and genetic and environmental factors are both believed to play a role. According to the CDC, the total economic costs per year for children with ASD in the United States are estimated between $111.5 billion and $60.9 billion. Research shows that early intervention can improve development, but diagnosis currently depends on clinical observation of behavior, an obstacle to early diagnosis and treatment. Most children are not diagnosed with ASD until after age 4 years.

THE CENTER FOR BIOTECHNOLOGY AND INTERDISCIPLINARY STUDIES (CBIS) IS UNIQUELY FOCUSED ON COLLABORATIVE RESEARCH AT THE FRONTIERS OF LIFE SCIENCES, PHYSICAL SCIENCE, INFORMATICS, AND ENGINEERING. One of the most advanced biotechnology research facilities in the U.S., CBIS is committed to innovative interdisciplinary research. It also offers a comprehensive academic suite of undergraduate, graduate, and postdoctoral education programs through Rensselaer’s Schools of Science, Engineering, Architecture, Lally School of Management, and Humanities, Arts, and Social Sciences.

“Biotechnology brings together Rensselaer’s rich traditions in science and engineering,” says Deepak Vashishth, CBIS director. “These strengths have allowed us to create a premier space for pioneering research in a unique building that was designed to encourage and enable multidisciplinary collaborations.” As a result of the center’s focus on both fundamental and applied research in biotechnology, new tools are being developed to delve into and better understand biology and ultimately to design new products and processes that will address key challenges and opportunities in healthcare, including drug safety, disease diagnosis and treatment, tissue engineering, and regenerative medicine.

Rensselaer has put its stamp on biotechnology research. In its first decade, CBIS scientists and engineers have created:

- Bioengineered therapeutics and antibacterial coatings for medical devices
- High-throughput diagnostic chips that enable rapid identification of drug candidates as well as toxins
- Bioengineered molecules, including a contamination-free form of the anticoagulant heparin
- Nanoscale therapeutics that inhibit anthrax toxins
- Stem cell bioengineering to aid in treatment of diseases including Alzheimer’s, osteoporosis, and osteoarthritis

CBIS has a dedicated 218,000-square-foot facility that is home to state-of-the-art laboratories and equipment. It offers eight core facilities that support the work of faculty, students, visiting faculty, and postdoctoral fellows to conduct groundbreaking investigations. These facilities are also available to other university researchers and to commercial enterprises.
Rensselaer has a broad, collaborative, and vibrant research community that is focused on the growing interface of the basic sciences and engineering. This provides the basis for innovative solutions to today’s Global Challenges, including: mitigating disease; providing clean food and water; developing new sources of clean and renewable energy; and establishing a sustainable and resilient national and international infrastructure.

**BIOTECHNOLOGY AND THE LIFE SCIENCES**
Creating new routes to drug discovery and development, and understanding the fundamental mechanisms of disease, from Alzheimer’s and diabetes to cancer.

**COMPUTATIONAL SCIENCE AND ENGINEERING**
Focusing on high performance computing, big data, and data analytics, which supports research and innovation across a broad front.

**ENERGY, ENVIRONMENT, AND SMART SYSTEMS**
Exploring renewable technologies, energy efficiency, and the understanding of global environmental change to preserve the biodiversity of the planet.

**MEDIA, ARTS, SCIENCE, AND TECHNOLOGY**
Facilitating new approaches to networking, advanced visualization, sensor design, haptics, and multiscale modeling and simulation, which are supported by the core capabilities of EMPAC.

**NANOTECHNOLOGY AND ADVANCED MATERIALS**
Developing robust, affordable, and sustainable methods for manufacturing new functional hybrid materials, and the hierarchical systems and products based upon them.
Patents and Inventors

Michael Amitay
Anna H. Dyson
Edward DeMauro '12Ph.D.
David Menicovich '13Ph.D.
Ajitth Rao '11Ph.D.
Peter Stark '89
Jason O. Vollen
Methods and systems of modifying air flow at building structures (Patent in South Africa)

B. Wayne Bequette
Bruce Buckingham
Kimberly Caswell
Eyal Dassau
Francis Doyle '77
Hyunjin Lee
Kalman Filter Based On-Off Switch for Insulin Pump (Patent in the United States)

Rajendra Dahal
Kuan-Chih Huang '14Ph.D.
James J. Q. Lu
Yaron Danon '90G, '93Ph.D.
Ishwara Bhat '81G, '85Ph.D.
Neutron-Detecting Apparatuses and Methods of Fabrication (Patent in the United States)

Jonathan Dordick
Prashanth Asuri '07Ph.D.
Ravindra Kane
Sandeep Karajanagi '06Ph.D.
Enhanced Stability of Proteins Immobilized on Nanoparticles (Patent in the United States)

Partha Dutta
Passivated Nanoparticles, Method of Fabrication Thereof, and Devices Incorporating Nanoparticles (Patent in Europe)
Room Temperature Growth of High Quality, Stable and Tuned Semiconductor Nanocrystals from Ammonia Containing Aqueous Solutions (Patent in Germany, France, Great Britain, and Netherland)

Partha Dutta
Srinibh Muralidharan
Multiplexed Pulse Modulation Using Superposition (Patent in the United States)

Anna H. Dyson
Michael K. Jensen
David N. Borton '72
Concentrating type solar collection and daylighting system within glazed building envelopes (Patent in the United States)

Robert F. Karliske Jr.
Charles S.S. Goodwin '01, '06G
Jian-Giang "James" Lu
Anton Tkachenko '15Ph.D.
Light Emitting Diodes and a Method of Packaging the Same (Patent in the United States)

Robert F. Karliske Jr.
Pankiti Butala
Li Jia '14Ph.D.
Thomas Little '83
Richard J. Radke
Sensory Lighting Systems and Method for Characterizing an Illumination Space (Patent in the United States)

Mei-Li Hsieh (Rensselaer visitor)
Yong Sung Kim
Shawn-Yu Lin
Integrated Polarized Light Emitting Diode With a Built-In Rotator (Patent in the United States)

Nadarajah Narendran
Yimin Gu '03G
Package design for producing white light with short-wavelength LEDs and down-conversion materials (Patent in Japan)

Nadarajah Narendran
J.P. Freyssinier '03G
Yiting Zhu '06G, '10Ph.D.
Scattered-photon extraction based light fixtures (Patent in Japan and China)

Tristan J. Lawy '07, '09G, '11Ph.D.
Gary J. Saulnier '80, '85Ph.D.
Kyle R. Witt '06, '12Ph.D.
Jonathan D. Ashdown '06, '08G, '12Ph.D., '14G
Henry A. Scarton
Andrew Gavens
Full-duplex ultrasonic through-wall communication and power delivery system with frequency tracking (Patent in United States)

Gary J. Saulnier '80, '85Ph.D.
Jonathan D. Ashdown '06, '08G, '12Ph.D., '14G
Tristan J. Lawy '07, '09G, '11Ph.D.
Kyle R. Witt '06, '12Ph.D.
Henry A. Scarton
Multi-Channel through-wall communication system using crosstalk suppression (Patents in United States and Georgia)

Mark Wentland
8-Formamido-2, 6-Methano-3-Benzazocines (Patent in Europe)

Large Substituent, Non-Phenolic Opioids and Method of Use Thereof (Patent in United States)
Quaternary Opioid Carbamoylides (Patent in Canada, Belgium, Europe, Ireland, Israel, Japan, and Switzerland)

Morphine Derivatives Containing a Carbamoyl Group as Opioid Receptor Ligands (Patent in Belgium, Europe, France, Germany, Great Britain, Ireland, Italy, Netherlands, Spain, and Switzerland)

8-Carbamoyl-2, 6-Methano-3-Benzazocines and 8-Carbamoyl-2, 6-Methano-3-Benzazocines (Patent in Belgium, France, Germany, Ireland, Italy, Netherlands, and Switzerland)
8-Substituted-2, 6-Methano-3-Benzazocines and 8-Substituted Morphinanes as Opioid Receptor Binding Agents (Patents in Great Britain and Spain)

To learn more, go to www.rpitechnology.com or email otc@rpi.edu.
Rensselaer Leadership

Shirley Ann Jackson
President

PRESIDENT’S CABINET
Craig A. Cook
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