SINCE 1824, RENSSELAER HAS BEEN AT THE FOREFRONT OF ADVANCING HUMAN PROGRESS.

Across the United States and around the globe, Rensselaer graduates constructed the canals, roads, bridges, skyscrapers, and basic infrastructure which helped to form the basis for 20th-century society.

They also were instrumental in building the world’s early digital infrastructure, and made or drove breakthroughs in numerous other areas of science and technology, and business, and continue to do so. Today at Rensselaer, we remain at the forefront of research and innovation.

We prepared Rensselaer for leadership in areas of research that are of fundamental significance in the 21st century by focusing on five “signature thrusts” — crucial areas of multidisciplinary research based on the growing interface of the basic sciences and engineering. Such a focus provides the basis for innovative solutions to today’s global challenges, including:

- Prevention and mitigation of disease
- Providing clean food and water
- Developing new sources of clean and renewable energy
- Establishing a sustainable and resilient national and international infrastructure
- Enhancing national and global security

The first of these signature research thrusts is in Biotechnology and the Life Sciences, where, at the nexus of the life sciences with engineering, the physical and computational sciences, we are, among many outcomes, creating new routes to drug discovery and development, and understanding the fundamental mechanisms of disease, from Alzheimer’s and diabetes to cancer.

Our second signature research thrust is in Computational Science and Engineering, where our focus — on high-performance computing, neuromorphic and quantum computing, big data, data analytics, and artificial intelligence — is supporting research and innovation across a broad spectrum of disciplines.

Our third signature research thrust focuses on Energy, the Environment, and Smart Systems, where we are exploring renewable technologies, energy efficiency, and the understanding of global environmental change to preserve the biodiversity of the planet.
Our fourth signature research thrust is in Media, the Arts, Science, and Technology, where we are facilitating new approaches to networking, advanced simulation, sensor design, haptics, and multiscale modeling simulations.

Our fifth signature research thrust is in Nanotechnology and Advanced Materials, where we are developing robust, affordable, and sustainable methods for manufacturing new functional hybrid materials, and the hierarchical systems and products based upon them.

To advance such crucial areas of research, we have assembled a world-class faculty, which today includes members of the National Academy of Engineering, the National Academy of Sciences, and the National Academy of Inventors, several professors who serve on key national and international panels and committees, hundreds of fellows of technical and professional societies, dozens of U.S. government early CAREER award recipients, and numerous winners of national and international awards.

To ensure that our faculty (and students) would have the resources they need for groundbreaking work, we invested $800 million in new construction, renovation of facilities, and technology upgrades for research, teaching, and student life.

With the right people, programs, and platforms in place, our partnerships have grown substantially. Our researchers are working alongside other talented scientists and engineers from the Icahn School of Medicine at Mount Sinai and from IBM, among many others.

At Rensselaer, we ask, why not change the world? In the following pages, you will read about some of our most recent transformational research projects and initiatives that are tackling today’s most pressing global challenges. I hope you enjoy this report.

Shirley Ann Jackson, Ph.D.
PRESIDENT, RENSSELAER POLYTECHNIC INSTITUTE
Researchers value the promptings of curiosity. Often, the best way to make sense of unexpected observations and anomalies comes from another discipline. In *Smarter Faster Better*, author Charles Duhigg cites the power of innovation brokers. These are people who bring the models, processes, and knowledge from one discipline into a different one. For two centuries, Rensselaer has approached exploration, including efforts in research and development, with who we are as individuals and who we are in community. Both tool-making and the pursuit of knowledge are fully human endeavors. The result: **Something new and valuable.**
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How do you observe a process that takes more than one trillion times longer than the age of the universe? The XENON Collaboration research team did it with an instrument built to find the most elusive particle in the universe — dark matter. In a paper published in the journal Nature, researchers announced that they have observed the radioactive decay of xenon-124, which has a half-life of 18 sextillion years.

“We actually saw this decay happen. It’s the longest, slowest process that has ever been directly observed, and our dark matter detector was sensitive enough to measure it,” says Ethan Brown, assistant professor of physics and co-author of the study.
The XENON Collaboration runs XENON1T, a 1,300-kilogram vat of super-pure liquid xenon shielded from cosmic rays in a cryostat submerged in deep water 1,500 meters beneath the Gran Sasso mountains of Italy. The researchers search for dark matter (which is five times more abundant than ordinary matter, but seldom interacts with ordinary matter) by recording tiny flashes of light created when particles interact with xenon inside the detector. And while XENON1T was built to capture the interaction between a dark matter particle and the nucleus of a xenon atom, the detector actually picks up signals from any interactions with the xenon.

The evidence for xenon decay was produced as a proton inside the nucleus of a xenon atom converted into a neutron. In most elements subject to decay, that happens when one electron is pulled into the nucleus. But two protons in a xenon atom must simultaneously absorb two electrons to convert into two neutrons, an event called “double-electron capture.” Double-electron capture only happens when two of the electrons are right next to the nucleus at just the right time, Brown says.
Ph.D. student Prottay Mondal Adhikari and Associate Professor Luigi Vanfretti

“You need to...understand the interaction of the systems and, in an integrated way, you need to optimize them together.”

LUIGI VANFRETTI

**Sustainability**

**MODELING ELECTRIC AIRCRAFT**

Electrical and systems engineers from Rensselaer will develop simulation models to help researchers at the University of Illinois develop an all-electric aircraft, a project that recently received a $6 million grant from NASA.

Although improvements have been made to increase flight efficiency over the past few decades, the continued dependency on hydrocarbon fuels makes aircraft operation costs volatile. It also means commercial aviation will continue to contribute a significant amount of greenhouse gas emissions across the national and international transportation industry.

In an effort to address these challenges, the team is looking toward more sustainable energy sources for aviation and the introduction of new electrically driven propulsion systems for commercial aircraft systems.

“A plane has multiple systems inside of it,” says Luigi Vanfretti, associate professor of electrical, computer, and systems engineering. “You need to have a way to understand the interaction of the systems and, in an integrated way, you need to optimize them together.”

Vanfretti’s ALSETLab, which stands for Analysis Laboratory for Synchrophasor and Electrical Energy Technology, specializes in complex modeling simulations of electrical systems. His focus on simulation models has led to multiple collaborations with other academic institutions, government organizations, and industry. The work his team does, Vanfretti says, helps researchers understand how systems work together and if new developments will be successful long before they’re physically tested.

This new electric aircraft initiative, led by Phillip Ansell, assistant professor in the Department of Aerospace Engineering at the University of Illinois at Urbana-Champaign, is called CHEETA — the Center for Cryogenic High-Efficiency Electrical Technologies for Aircraft.

Through his work with CHEETA, Vanfretti will support the development of a fully electric aircraft platform that uses cryogenic liquid hydrogen as an energy storage method.
AUGMENTING REALITY

On the second floor of the J. Erik Jonsson Engineering Center in the heart of the Rensselaer campus, a room has been created that has the potential to be almost anything. Students who enter could find themselves standing on the wing of an airplane, managing a failing nuclear reactor, or designing the crystalline structure of a molecule.

It is called the Rensselaer Augmented and Virtual Environment (RAVE), a new laboratory for researchers and students to experiment with different uses of virtual and augmented reality. The former immerses users in a computer-generated environment, while the latter adds a layer of computer-generated enhancements to the real world.

“Virtual and augmented reality can be used to perform experiments and provide learning experiences that were previously impossible due to scale, cost, or safety,” says Rich Radke, co-director of the RAVE and professor of electrical, computer, and systems engineering. “The RAVE presents unprecedented opportunities for how we study and incorporate this technology at Rensselaer.”

With state-of-the-art equipment and an extremely flexible physical space, the RAVE can be configured and adjusted according to the needs of whoever is using it. A materials science and engineering class might gather around large molecular structures visible to them only through smartphones and tablets. A researcher wearing a virtual reality headset might explore a distant celestial object and be able to move around it as if she were actually there. Radke and co-director Jason Hicken, associate professor of mechanical, aerospace, and nuclear engineering, hope that Rensselaer faculty members and students make use of the lab to explore new ways in which these technologies can enhance their work.

After its ribbon cutting last fall, the RAVE began its first full semester in operation in January. “We are only beginning to discover the RAVE’s potential,” says Hicken.
A wide-eyed, soft-spoken robot named Pepper motors around the Intelligent Systems Lab at Rensselaer. One of the researchers tests Pepper, making various gestures as the robot accurately describes what he’s doing. When he crosses his arms, the robot identifies from his body language that something is off.

“Hey, be friendly to me,” Pepper says.

Pepper’s ability to pick up on nonverbal cues is a result of the enhanced “vision” the lab’s researchers are developing. Using advanced computer vision and artificial intelligence technology, the team is enhancing the ability of robots like this one to naturally interact with humans.

“What we have been doing so far is adding visual understanding capabilities to the robot, so it can perceive human action and can naturally interact with humans through these nonverbal behaviors, like body gestures, facial expressions, and body pose,” says Qiang Ji, professor of electrical, computer, and systems engineering, and the director of the Intelligent Systems Lab.

With the support of government funding over the years, researchers at Rensselaer have mapped the human face and body so that computers, with the help of cameras built into the robots and machine-learning technologies, can perceive nonverbal cues and identify human action and emotion.

Among other things, Pepper can count how many people are in a room, scan an area to look for a particular person, estimate an individual’s age, recognize facial expressions, and maintain eye contact during an interaction.

Ji sees computer vision as the next step in developing technologies that people interact with in their homes every day. Currently, most popular AI-enabled virtual assistants rely almost entirely on vocal interactions.
There’s no vision component. Basically, it’s an audio component only,” Ji says. “In the future, we think it’s going to be multimodal, with both verbal and nonverbal interaction with the robot.”

The team is working on other vision-centered developments, like technology that would be able to track eye movement. Tools like that could be applied to smartphones and tablets.

Ji says the research being done in his lab is currently being supported by the National Science Foundation and the Defense Advanced Research Projects Agency. In addition, the Intelligent Systems Lab has received funding over the years from public and private sources including the U.S. Department of Defense, the U.S. Department of Transportation, and Honda.

The Artificial Intelligence Research Collaboration (AIRC) is a multiyear, joint effort between Rensselaer and IBM that involves multiple graduate students, postdocs, research scientists, and faculty working closely with IBM researchers to push the frontiers of AI research and apply their results to some of the world’s key global challenges.

The AIRC is part of the AI Horizons Network, which brings together IBM researchers, world-class faculty, and top graduate students to collaborate on a series of advanced research projects and experiments designed to accelerate the application of artificial intelligence, machine learning, natural language processing, and related technologies.

Projects are designed to apply the technologies to some of the world’s most enduring challenges, ranging from disease and the environment, to transportation and education. The AI Horizons Network addresses the entire AI stack, from analyzing the unstructured and structured data required to train these systems, to building the new computing infrastructures needed to optimize the new data-intensive workloads of a truly digital world.

At Rensselaer, graduate students who have been selected as Artificial Intelligence Horizons Network Scholars are working on a series of projects designed to accelerate the application of artificial intelligence, machine learning, natural language processing, and related technologies.
EARTH FIRST ORIGINS PROJECT SEeks TO REPLICATE THE CRADLE OF LIFE

The evolution of planet Earth and the emergence of life during its first half-billion years are inextricably linked, with a series of planetwide transformations — formation of the ocean, evolution of the atmosphere, and the growth of crust and continents — underpinning the environmental stepping-stones to life. But how, and in what order, were the ingredients for life on Earth manufactured and assembled?

NASA’s Astrobiology Program has awarded a $9 million grant to tackle the question through the Earth First Origins project, led by Rensselaer Assistant Professor Karyn Rogers. The five-year project seeks to uncover the conditions on early Earth that gave rise to life by identifying, replicating, and exploring how prebiotic molecules and chemical pathways could have formed under realistic early Earth conditions.

“Planet Earth and the chemistry of life share the same road,” says Rogers. “Because of that co-evolution, we can use our understanding of the fundamental planetary processes that set the Earth system in motion to sketch the physical, chemical, and environmental map to life.”

Earth First Origins serves as the catalyst for launching the Rensselaer Astrobiology Research and Education (RARE) Center. The newly established RARE Center builds on the expertise established through more than three decades of astrobiology research at Rensselaer, and supersedes its predecessor, the New York Center for Astrobiology. In addition to conducting fundamental research into life’s origins and the potential for life throughout the universe, the RARE Center will support a range of education and public engagement activities.

Earth First Origins and the RARE Center unite a diverse team of experts in planetary evolution, early Earth geochemistry, prebiotic and experimental astrobiology, and analytical chemistry. Complemented by a team of molecular biologists, geochemical modelers, and data and visualization experts, the research team brings a wealth of experience poised to launch a new research paradigm for studying life’s origins.
STUDY PROVIDES NEW INSIGHT INTO TRAUMATIC BRAIN INJURIES

Understanding how the brain reacts to acceleration is essential to designing more effective protective equipment and strategies for preventing traumatic brain injury, or TBI.

Data and analysis that illuminates how a healthy brain acts under rotational movement was recently published by a multidisciplinary team that includes first author Deva Chan, assistant professor of biomedical engineering, in the Journal of Biomechanical Engineering. The quality and impact of the work was recognized by the American Society of Mechanical Engineers, which recently awarded the team the 2018 Richard Skalak Award for best paper.

Most TBI models and simulation studies are based on data from cadavers, Chan says, but there is a disconnect between what researchers can learn from donated tissues and what actually happens in a living human where tissues are interacting and blood is actively flowing. That’s why this study was so impactful.

“On the experimental end, it really helps us to understand the healthy brain and how it reacts,” says Chan.

Chan, along with a team of researchers from the Henry M. Jackson Foundation for the Advancement of Military Medicine, Washington University in St. Louis, and the National Institutes of Health Clinical Center, looked at the brains of 34 healthy adult volunteers using noninvasive imaging as they went through controlled, rotational movement under low acceleration — approximately a tenth of what someone would experience heading a soccer ball.

“We were able to see how the brain moves after the head has stopped moving,” Chan says. “A lot of the injuries that occur are the skull stopping and then the brain hitting parts of the skull and also moving around within the skull. These are things we can’t see on the outside.”

Chan continued to work with the collaborative team and analyzed the image data she and others collected. She says it will provide critical information to experts who create computational models to study the brain and TBI.

Chan says this information could be used to design better helmets for soldiers or safer restraint systems for cars — ones that are created with a living brain in mind.

“You need models based on experimental data measured in living humans in order to be able to really predict what might happen.”

DEVA CHAN
The National Institute on Aging of the National Institutes of Health has awarded a five-year grant totaling more than $4 million to the Rensselaer Lighting Research Center (LRC) to support research that could benefit the more than 5.7 million Americans living with Alzheimer’s disease.

Mariana Figueiro, LRC director, will serve as the principal investigator and will work with the Icahn School of Medicine at Mount Sinai to study whether a novel tailored lighting intervention designed to promote circadian entrainment can reduce metabolic impairment in Alzheimer’s and mild cognitive impairment (MCI) patients.

Alzheimer’s disease and Type 2 diabetes are closely linked, yet the relationship between these two diseases is poorly understood. Insulin resistance, a hallmark of Type 2 diabetes, appears to develop in the brains of individuals with Alzheimer’s and may account for the epidemiological link between the two diseases. Studies show that circadian disruption impairs metabolic control and increases the risk for diabetes and obesity. Conversely, disrupted sleep and depression are linked with impaired metabolic control and increased diabetes risk.

Notably, Alzheimer’s is associated with circadian disruption, which may be amplified by exposure to irregular light-dark patterns or constant dim light. To what extent circadian disruption contributes to increased metabolic risk in Alzheimer’s remains unclear. This will be the first study to investigate whether a lighting intervention designed to re-entrain circadian rhythms can improve metabolic control in Alzheimer’s and MCI patients.

The Mount Sinai team will focus on individuals with MCI to ascertain how long-term use of light therapy can reduce metabolic disorder and delay transition to Alzheimer’s disease, while the LRC will evaluate the impact of light in those who are already at the later stages of Alzheimer’s disease.
Researchers envision a future in which airplanes in flight share sensor data across an “internet of airplanes” to improve safety and efficiency. But when nodes in the network move at the speed of flight, realizing that vision requires a data sharing framework adapted to the challenges and needs of the environment.

With a three-year $325,000 grant from the National Science Foundation, Rensselaer computer scientists Stacy Patterson and Carlos Varela have teamed up to develop a prototype framework, the “Virtual Sky” platform, to fuse and analyze flight sensor data correctly, reliably, and quickly. Virtual Sky would serve as a model extension of the Federal Aviation Administration’s Next Generation Air Transportation System, a sweeping modernization of the National Airspace System that includes greater use of computer and satellite systems in air traffic elements like communication, navigation, weather, information management, and tracking.

“We see Virtual Sky as an infrastructure, and like the infrastructure of the internet, it will have basic protocols, and basic ways to transmit data, on top of which applications will be built,” Varela says.

Although some elements of air traffic have already transitioned to “NextGen” systems, a surprising amount of the information shared between airplanes depends on radio transmissions between pilots, and pilot observations, leaving much room for improvement.

The challenge, Patterson says, is that an “internet of airplanes” is a dynamic environment, with airplanes moving in multiple dimensions, directions, and speeds, and with varying connectivity. The project builds on the combined experience of the researchers. Varela, associate professor of computer science, is a licensed pilot and a middleware architecture expert with extensive domain knowledge researching computer systems that monitor and detect faulty aircraft sensor readings. A system he developed in 2014 detects and corrects faulty airspeed readings, such as those that contributed to the 2009 crash of Air France flight 447. Patterson, associate professor of computer science, is an expert in distributed algorithms, sensor networks, and the Internet of Things and has also been developing automobile sensor networks.

Ultimately, say Varela and Patterson, Virtual Sky is about giving pilots better information to make better decisions.

“In commercial aviation, humans will ultimately make the decision. But a computer can give a much faster and more accurate assessment of the current conditions, and that can help the humans in the situation make better decisions,” Varela says.
AS CLIMATE CHANGES, SMALL INCREASES IN RAINFALL MAY CAUSE WIDESPREAD ROAD OUTAGES

As more rain falls on a warming planet, a new computer model shows that it may not take a downpour to cause widespread disruption of road networks. The model combined data on road networks with the hills and valleys of topography to reveal “tipping points” at which even small localized increases in rain cause widespread road outages.

The findings, which were tested using data from the impact of Hurricane Harvey on the Houston area, were published in *Nature Communications*.

“To prepare for climate change, we have to know where flooding leads to the biggest disruptions in transportation routes. Network science typically points to the biggest interactions, or the most heavily traveled routes. That’s not what we see here,” says Jianxi Gao, assistant professor of computer science at Rensselaer and lead author of the study. “A little bit of flood-induced damage can cause abrupt widespread failures.”

Gao, a network scientist, worked with environmental scientists at Beijing Normal University and a physicist at Boston University to reconcile traditional network science models that predict how specific disruptions impact a road network with environmental science models that predict how topography influences flooding. Traditional network science predicts continuous levels of damage, in which case knocking out minor roads or intersections would cause only minor damage to the network. But because of how water flows over land, adding topographical information yields a more accurate prediction.

In Florida, an increase from 30 mm to 35 mm of rainfall knocked out 50% of the road network. And in New York, Gao found that runoff greater than 45 mm isolated the northeastern part of the state from the interior of the United States.

In the Hunan province of China, an increase from 25 mm to 30 mm of rainfall knocked out 42% of the provincial road network. In the Sichuan province, an increase from 95 mm to 100 mm in rainfall knocked out 48.7% of the provincial road network.

The researchers validated their model by comparing predicted results with observed road outages in Houston and South East Texas caused by Hurricane Harvey. Their model predicted 90.6% of reported road closures and 94.1% of reported flooded streets.

“We cracked the data. Hurricane Harvey caused some of the most extensive road outages in U.S. history, and our model predicted that damage,” Gao says. “Adding 3D information causes more unusual failure patterns than we expected, but now we have developed the mathematical equations to predict those patterns.”
Steve Jane, a graduate student in biological sciences, has been awarded a prestigious Fulbright U.S. Student Program Fellowship for the 2019-2020 academic year from the U.S. Department of State and the J. William Fulbright Foreign Scholarship Board. Jane will spend his Fulbright tenure researching freshwater ecological responses to changes in climate and land use at Uppsala University in Sweden.

Carbon Capture Research Receives $3 Million from U.S. Department of Energy

The United States Department of Energy (DOE) has announced that a research project at Rensselaer is one of eight in the nation selected to receive federal funding geared toward the development of “novel and enabling carbon capture transformational technologies.”

Miao Yu, an associate professor of chemical and biological engineering, will receive DOE funding of $3 million to support his work on a new, scalable approach to capturing carbon dioxide before it leaves coal power plants and enters the atmosphere.

Yu and his team are developing a sorbent capable of trapping carbon dioxide in its pores as flue gas — exhaust produced by coal power plants — passes through it. The sorbent is a surface modified solid powder-like material made of zeolites, which are minerals with very small pores.

The research team plans to create a water-resistant and molecular-sieving coating that will be applied to the zeolite in a way that can be carefully adjusted to control the size of the pores. That will make it possible for the sorbent to capture carbon dioxide while rejecting similarly sized molecules like nitrogen.

“The combination of this concept with the zeolite material is unique,” Yu says. “No other group in the world is working on this.”
The Kessler Syndrome, a theory presented by NASA scientist Donald Kessler in 1978, proposes that, if there is a large enough concentration of objects orbiting in space, these objects can generate a flood of collisions resulting in an exponential growth in the number of pieces of debris. The amount of space debris ultimately becomes so great that large regions of space become saturated with fast-moving junk, rendering these regions effectively unusable.

To help prevent this scenario, Anderson and his students are developing OSCaR, a small device that will be able to inexpensively be sent into space aboard larger vehicles and then released to nearly autonomously seek out, capture, and then de-orbit space debris.

OSCaR is a three-unit member of a class of very small satellites known as CubeSats. Each unit is a small and light 10 cm x 10 cm x 10 cm cube. One of those CubeSat units will house the “brains” of OSCaR including GPS, data storage, and communication, as well as the power and thermal management systems. Another will hold propellant and the system’s propulsion module to drive OSCaR forward. The third unit will contain four gun barrels, nets, and tethers to physically capture debris, one piece at a time.

This capture module will also have optical, thermal, and radar imaging sensors to help OSCaR locate debris in the vastness of its surrounding space.

After it is done collecting debris, OSCaR will be programmed to de-orbit itself within five years, destroying itself and the debris it caught.

Anderson foresees a future in which OSCaRs, which make for easy cargo, could be routinely carried aboard space-bound craft as part of an ongoing cleanup effort. His team of researchers is currently in the process of perfecting the team’s algorithms. They hope to test the device on the ground sometime this year, and will then look to test it in space.

“There’s an informal agreement that’s been in place for a few years that people who put space objects up there should be practicing good citizenship,” Anderson says. “We envision a day where we could send up an entire flock; or squadron, of OSCaRs to work jointly going after large collections of debris.”
TWEAKING FREIGHT DELIVERY PATTERNS MAY HAVE ENVIRONMENTAL BENEFITS

As online commerce drives up the number of deliveries being made each day throughout the country, relatively small changes in the timing and frequency of freight deliveries — such as switching the standard delivery window from day to night — may have significant environmental and economic benefits, according to experts at Rensselaer.

To further examine how changing the behavior of supply chains could reduce energy consumption, a Rensselaer research team — with the support of a $2 million grant awarded by the U.S. Department of Energy in 2017 — will soon start collecting data from trucks making deliveries in, around, and between Albany and New York City. The researchers are interested in examining transport in congested areas as well as long-distance travel, including the use of barges and ships.

“The goal is to use a public and private collaborative approach to induce increases in the performance of supply chains — in essence trying to make delivery faster, more efficient, and result in a smaller amount of negative externalities like pollution and congestion,” says José Holguín-Veras, professor of civil and environmental engineering.

Holguín-Veras’ previous research has shown that implementing behavior changes can reduce transportation and delivery costs, as well as emissions. A key example is the Off-Hour Delivery program designed by Holguín-Veras and his team, which was implemented in New York City.

Data his team collected and analyzed showed a significant benefit to commuters, businesses, and the environment when deliveries were made between the hours of 7 p.m. and 6 a.m.

This shift in scheduling is effective because trucks that are traveling on less congested roadways can take more direct routes, cutting down on miles traveled and time on the road. The trucks’ engines operate more efficiently, emitting less pollution, because the vehicles can move more quickly and aren’t constantly stopping and going.

“For every receiver that switched deliveries to the off-hours, we estimated that the total amount of travel saved for the commuters in the city was 10 days,” says Holguín-Veras.

“The number of freight trips in New York City is larger than the number of deliveries when New York City was a manufacturing powerhouse in the 1960s,” Holguín-Veras says. “Because of the gravity of climate change, we need to use collaborative approaches involving the public and private sectors and researchers to find solutions not only to benefit the environment, but also to increase economic productivity.”
Signature Research Thrusts

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.

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

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.

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.

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

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.
Recent Faculty Achievements

MICHAEL “MIKI” AMITAY, James L. Decker ’45 Endowed Chair in Aerospace Engineering, has been elected a fellow of the American Institute of Aeronautics and Astronautics. Amitay is an internationally recognized expert for his research on active and passive flow control techniques and how that can be applied to airplanes, wind turbines, building, and many other engineering systems. He serves as the director of the Center for Flow Physics and Control at Rensselaer.

PETER FOX, data scientist and Tetherless World Constellation Chair, was elected a fellow of the American Association for the Advancement of Science, in recognition of his “distinguished, innovative, and sustained fundamental contributions in Earth and space science informatics and data science research, education, and service.”

RICHARD GROSS, biocatalysis expert and Constellation Chair, was awarded the 2019 ACS Award for Affordable Green Chemistry by the American Chemical Society for outstanding scientific discoveries or chemistries that lay the foundation for cost-effective environmentally friendly products or manufacturing processes that are less expensive than existing alternatives.

JAMES HENDLER, the Tetherless World Professor of Computer, Web, and Cognitive Sciences, was selected by the National Academy of Public Administration for inclusion in its 2018 Class of Academy Fellows. Fellow status recognizes outstanding contributions to the field of public administration and policy.

LIPING HUANG, professor of materials science and engineering, has been accepted as a member of the 2019-2020 cohort of fellows for the Executive Leadership in Academic Technology, Engineering and Science (ELATES) at Drexel®. ELATES is a one-year, part-time fellowship aimed at advancing senior female faculty in academic engineering, computer science, and other STEM fields across the country.

XAVIER INTEZ, professor of biomedical engineering and co-director of the Biomedical Imaging Center, has been promoted to fellow of the Society by SPIE, the international society for optics and photonics. This promotion recognizes his achievements in translational biophotonics.

FRANCINE BERMAN, professor of computer science, has been elected to the American Academy of Arts and Sciences. The academy recognizes the outstanding achievements of individuals in academia, the arts, business, government, and public affairs. Founder of the Research Data Alliance, Berman is an international leader in data science whose work has focused on the stewardship, preservation, and cyberinfrastructure of the digital data on which modern research relies.

JOHN CHRISTIAN, assistant professor of mechanical, aerospace, and nuclear engineering, has been elected an associate fellow of the American Institute of Aeronautics and Astronautics. Christian focuses his research on spacecraft navigation, computer vision, astrodynamics, and space systems. He is director of the Rensselaer Sensing, Estimation, and Automation Laboratory, which is developing new spacecraft technologies that will enable scientific missions to new and unexplored destinations.

JONATHAN DORDICK, the Howard P. Isermann ’42 Professor of Chemical and Biological Engineering, received the Agilent Biochemical and Molecular Engineering Award at the ECI Conference on Biochemical and Molecular Engineering in July. The award recognizes research excellence and leadership in biomedical and molecular engineering.

MILES KIMBALL, assistant professor of mechanical, aerospace, and nuclear engineering, has won a Faculty Early Career Development Program (CAREER) award grant from the National Science Foundation (NSF) for her research on cancer cell growth. The results of her work will contribute to a fundamental understanding of tumor growth and development. The CAREER Award is given to faculty members near the beginning of their academic careers and is one of the most competitive awards given by the NSF to junior faculty.

MINORU TOMOZAWA, professor of materials science and engineering, has been elected a Distinguished Life Member of the American Ceramic Society in recognition of his contribution to the ceramics profession. No more than three such memberships are awarded each year to members of the society that includes more than 11,000 ceramic and glass professionals.

E. BRUCE WATSON, Institute Professor, was honored by the Mineralogical Society of America with its highest honor, the Roebling Medal, bestowed for scientific eminence in the broad field of mineralogical science. Watson, an expert in solid-Earth geochemistry, is an experimentalist and numerical modeler whose research characterizes how materials of Earth’s crust and upper mantle behave under high pressure-temperature conditions. The Roebling Medal commemorates Brooklyn Bridge builder and mineral collector Washington A. Roebling, Class of 1877.
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