RENSSELAER **STRONG**

RENSSELAER POLYTECHNIC INSTITUTE **PRESIDENT'S REPORT 2020**

We have a history of taking on the most demanding issues, requiring knowledge, understanding, analysis, discernment, and experience, and reaching beyond the Institute to the larger world.

The challenge of something as widespread, dynamic, and serious as the COVID-19 pandemic calls for responses that are both timely and thoughtful. Because Rensselaer has experts, technologies, frameworks, and perspectives that meet this moment, we have been able to fulfill our promises and contribute to solving this challenge.

We have a history of taking on the most demanding issues, requiring knowledge, understanding, analysis, discernment, and experience, and reaching beyond the Institute to the larger world. Some endeavors, like the space program, presented new opportunities to tackle problems as wide-ranging as aerospace engineering and human health. Others, like the transcontinental railroad, suggested unimaginable opportunities that could provide better lives and be impactful.

Responding to a worldwide disaster tests us in different ways. There is an urgency because the stakes include health, social stability, economic welfare, and life itself. Decisions made early can lead to large consequences later on. And this is not a crisis that can be put aside. It is unremitting and requires new solutions every day.

Across our campus, we have the technological capabilities needed to meet the challenges of the pandemic. Certainly, our Center for Biotechnology and Interdisciplinary Studies stands out as a center for assessment, testing, and molecular modeling. Contributions range from providing the reagents and equipment to detect infections to searching for vulnerabilities in the virus.

But this is a crisis that intertwines science and technological answers with social factors. Its complexity requires comprehensive planning. This includes making modifications aimed at reducing density, such as reducing the total number of students in residence halls, in dining halls, in classes, and on campus as a whole. It involves adjusting schedules to reduce travel, such as closing the campus from Thanksgiving to late January. In addition, options like remote learning provide means to reduce face-to-face contact.

Masks, social distancing, and hygiene also are included in our plan. But using simulation, available data, and the advice of our experts, the heart of our plan became what we call T3SQ/I^{sm} (Testing, Tracing, Tracking, Surveillance, and Quarantine/Isolation). We created a program for meeting our own testing needs, with a schedule and process for turnarounds adequate to create margins of safety for our community. We developed the skills and structure to do our own contact tracing, so that we could take action quickly when tests returned positive results, squelching any spread.

We remain cognizant of the global community, which has faced scarcities. At our Manufacturing Innovation Learning Laboratory, we adapted our manufacturing capability to provide much-needed personal protective equipment. Our taking responsibility for testing and tracing kept our community safer, helped us to understand ongoing risks, and opened up the availability of outside resources to those beyond our campus.

We have taken advantage of our expertise in information technology to create the Daily Interactions and Activities Log (DIAL) app. This application provides vital tracking information when infection is detected. We also have been able to use smart phone location information to detect and analyze information that is key to understanding social distancing, including identifying congestion points on campus that might threaten safety.

Led by our deans, we have reshaped the Rensselaer curriculum to minimize risk for our community and to reduce on-site density through distance learning and adapting The Arch. Reworking that program allowed our juniors to continue their studies off campus for a semester. In keeping with the Institute mission to prepare the next generation of world-changing leaders, students learned how a range of disciplines might respond to the most pressing global health challenge of the modern era.

The COVID-19 pandemic has challenged the world and the Rensselaer community is no exception. Students, faculty, and staff have adapted to an ever-changing landscape, which has allowed us to continue to provide a safe and high-quality in-person living and learning experience for our students.

We may not have welcomed this moment, but we were prepared for it. Before emergency rooms were overwhelmed and prior to the deep bite of economic dislocation, Rensselaer was already looking aggressively for solutions.

We continue to lead in research that builds understanding and knowledge of COVID-19 and the epidemiological factors that are essential to meeting the challenges it presents. Our comprehensive plan builds on our deep subject matter expertise, our skills in collaborating across disciplines, and our leadership in research, testing, modeling, and manufacturing.

We have leveraged that expertise to keep the campus community safe, to continue to provide a world-class education, and to provide solutions to the challenges presented by COVID-19.

SHIRLEY ANN JACKSON, PH.D.

PRESIDENT, RENSSELAER POLYTECHNIC INSTITUTE

Leadership is tested by the unexpected. In the case of the COVID-19 pandemic, the Rensselaer community has risen to the challenges presented by the constant evolution of knowledge of transmission, disease etiology, testing needs, and data analysis — and has led the way in creating solutions.

Consistent with our legacy of technological expertise, Rensselaer faculty and students developed a powerful algorithm that determined the optimal regimen for keeping the infection rate on campus safely below 1% for any two-week period. That algorithm is now publicly available as COVID Back-to-School.

Our research — which is focused on addressing the world's most pressing challenges — pivoted to focus on developing therapeutics, creating computational modeling, understanding supply chain and manufacturing recovery, and manufacturing and improving personal protective equipment.

With careful planning and agile pivoting, our faculty provided students with a robust academic experience throughout the pandemic — and even found ways to strengthen the curriculum moving forward.

In short, we were responsible for each other, using data and judgment to confront the situation with a combination of clarity and compassion.

Rensselaer Provides Supercomputing Capabilities to Battle COVID-19

As the pandemic began, Rensselaer offered the research community access to AiMOS, one of the most powerful supercomputers in the world, which became part of the White House's COVID-19 High Performance Computing Consortium, to both support and rapidly advance scientific research related to the coronavirus disease.

"In order to combat the devastating effects of this pandemic, we must be able to fully grasp the complexities and interconnectedness of biological systems and epidemiological data, as researchers work to develop therapeutic interventions and address gaps in our knowledge," said President Shirley Ann Jackson. "This effort requires expertise, collaboration, and the ability to process incredible amounts of data, and Rensselaer is offering all three at this critical time. In particular, the ability to model at very large scales requires the unique capabilities of AiMOS."

AiMOS, short for Artificial Intelligence Multiprocessing Optimized System, is able to perform eight quadrillion calculations per second. A collaboration between Rensselaer, IBM, and New York State, AiMOS debuted in the November 2019 Top500 ranking of supercomputers as the 24th most powerful supercomputer in the world and the third-most energy efficient. It also ranked as the most powerful supercomputer housed at a private university.

In addition to the platform, Rensselaer offered access to the expertise of world-class faculty in data, artificial intelligence, networking, therapeutic interventions, materials, public health, and other areas necessary to understand and address the threat of COVID-19.

"This effort requires expertise, collaboration, and the ability to process incredible amounts of data, and Rensselaer is offering all three at this critical time."

PRESIDENT SHIRLEY ANN JACKSON

PRESIDENT JOINS NEW YORK FORWARD REOPENING ADVISORY BOARD

President Shirley Ann Jackson was appointed by Governor Andrew Cuomo to the New York Forward Reopening Advisory Board. The advisory board, tasked with guiding the state's reopening strategy, includes business, community, and civic leaders from across the state. "At Rensselaer, we believe in an interdisciplinary approach to developing scientifically sound solutions to pressing global challenges," President Jackson said. "The diversity of perspectives on Governor Cuomo's advisory board, combined with a collaborative spirit, will ensure that New York moves forward in a smart and strategic manner."

Workplace Disparities Contribute to Rates of Both COVID-19 and Lead Exposure

The manner in which the COVID-19 pandemic has exposed systemic inequalities in the United States has parallels with other environmental health threats, such as lead exposure, according to an essay written for the online magazine *Toxic News* by two researchers from Rensselaer.

In the essay, Abby Kinchy, professor, and Dan Walls, postdoctoral research associate, both in the Department of Science and Technology Studies, specifically compare the American government response to lead-contaminated environments with its reaction to the novel coronavirus crisis.

The authors present startling similarities between uneven access to tests for both lead poisoning and COVID-19, both of which have a disproportionate impact on people of color. They also observed disparities in the workplace environments where people are likely to be exposed to lead or COVID-19 and then spread either in their home environment.

"Throughout this unsettling experience, we have reflected on how this pandemic, and the United States government's response to it, creates a new lens through which we see the dangerous exposures that are more familiar to us, such as toxic pollution," Kinchy said.

Kinchy, a sociologist, has long studied the relationship between science and democracy. Her recent research focuses on the politics of public participation in scientific research. Kinchy is currently working on a project supported by the National Science Foundation that explores how citizen science could help urban communities identify heavy metal contamination in soil and advocate for solutions. She is the author of *Science by the People: Participation, Power, and the Politics of Environmental Knowledge*, co-authored with Aya H. Kimura. Kinchy is also a co-organizer of STS Underground, a research network that advances social science research on the technoscientific dimensions of mining, burial, and other forms of subterranean exploration.

Demonstrating Rensselaer Resilience

As the COVID-19 pandemic overtook the world in 2020, the Rensselaer community confronted it head-on with courage, determination, and ingenuity.

Researchers across the campus sprang into action, shifting their focus to devise solutions to the challenges brought on by the pandemic. The Institute's supercomputer, AiMOS — short for Artificial Intelligence Multiprocessing Optimized System — has been key in national efforts to fight the pandemic as part of the COVID-19 High Performance Computing Consortium.

Malik Magdon-Ismail, professor of computer science, created several robust machine learning models, including COVID War Room, which analyzes reopening strategies, and COVID Back-to-School, an app designed to help schools reopen. It allows users to plug in a number of different factors to predict how many individuals could become infected with COVID-19 over time.

Researchers from all disciplines tackled the challenge from many angles, exploring the development of self-disinfecting face masks, using data analytics to track and confront the spread of the virus, and creating methods to aid in plasma therapy, vaccine delivery, and disinfection.

When Rensselaer shifted the spring semester to remote learning, leaders immediately began planning how to return safely to campus-based operations in the fall. By relying on its roots of scientific and technological prowess, the university developed a strategy to protect the health and safety of its community members and prevent the spread of COVID-19 on campus. They devised a startup plan designed to contain any potential outbreaks with the T3SQ/I^{sm} protocol: Testing, Tracing, Tracking, Surveillance, and Quarantine/Isolation.

ANTHONY SPOFFORD JR., A FIRST-YEAR FOOTBALL PLAYER MAJORING IN BUSINESS AND MANAGEMENT.

R. HELEN ZHA, ASSISTANT PROFESSOR OF CHEMICAL AND BIOLOGICAL ENGINEERING, AND HER TEAM ARE EXPLORING WAYS TO EQUIP N95 RESPIRATOR MASKS WITH ANTIVIRAL PROPERTIES.

Everyone with access to campus was required to be tested twice weekly. Rensselaer trained 12 staff members as contact tracers, and each had to undergo privacy training. To aid in rapid and effective contact tracing, Rensselaer also developed the Daily Interactions and Activity Log (DIAL) app, in addition to a health and wellness check-in form.

The faculty quickly pivoted to rethink the concept of a classroom, continuing to provide students a world-class education both remotely and on campus. Virtual environments were utilized for classes, experiments, and events of all kinds.

COVID-19 was a focus this fall in many courses. In keeping with the Institute mission to prepare the next generation of world-changing leaders, students learned how a range of disciplines might respond to the most pressing global health challenge of the modern era.

IN SENIOR LECTURER JOSHUA HURST'S *MECHATRONICS* CLASS, STUDENTS COULD ATTEND REMOTELY OR IN PERSON.

Addressing PPE Shortages as a Community

As health care workers across the world battled a highly contagious respiratory disease without the proper protection, Rensselaer students, faculty, staff, parents, and alumni came together to address the critical shortages of personal protective equipment (PPE) resulting from the COVID-19 pandemic.

In April 2020, Rensselaer was able to donate 10,000 surgical masks to hospitals in need in New York state, thanks to donations from the parents of Rensselaer international students. The donations, provided by more than 200 families from China, went to Mount Sinai in New York City, and Albany Medical Center and St. Peter's Health Partners in the Capital Region.

"We thank these incredibly generous families for their support and their ingenuity during this difficult time," said President Shirley Ann Jackson. "Rensselaer is truly a global community, and we are all committed to doing our part to change the world for the better."

As the extent of PPE shortages became more apparent, researchers at Rensselaer began looking for ways to extend hospitals' existing stock of supplies.

A team including Bob Karlicek, director of the Center for Lighting Enabled Systems and Applications (LESA); Mohammed Alnaggar, assistant professor of civil and environmental engineering; and Arunas Tuzikas, LESA senior staff engineer, designed a system using ultraviolet light to quickly disinfect large quantities of masks, which was later set up at Mount Sinai.

Engineers Helen Zha and Edmund Palermo also began exploring ways to equip N95 respirator masks with antiviral properties and the ability to withstand sterilization, with support from a Rapid Response Research grant from the National Science Foundation.

Meanwhile, Rensselaer community members located in the Troy, New York, area, and throughout the country, manufactured PPE to help combat the shortages.

A group of manufacturing faculty and staff worked in collaboration with Industrial Tool & Die, a private business based in Troy, to manufacture hundreds of face shields for Albany Medical Center. "Our work is grounded in fairly simple engineering principles, but it's going to save lives," said Robert Hull, acting vice president for research.

Additionally, the group organized a larger manufacturing effort using the plastics injection molding and laser cutting machines usually used to teach students about manufacturing. While a 3D printer takes an average of one and a half hours to produce a single face shield, the tools and machinery at the Manufacturing Innovation Learning Laboratory (MILL) were able to produce 50 face shields per hour and print a design that offers more protection for health care workers. "This is an opportunity to put into practice what we teach our students: how to go from design to reality to meet the needs of society," said Sam Chiappone, director of the MILL.

"Your contribution could not be more vital or appreciated as our team works tirelessly to care for patients, protect our community, expand access to testing, and search for treatments and a vaccine."

MOUNT SINAI

Eric Ameres, lecturer in the School of Humanities, Arts, and Social Sciences, used his own 3D printers at home to manufacture face shields and ear savers for health care professionals.

Students also pitched in to develop PPE while learning remotely. The Forge, a student-managed makerspace at Rensselaer, provided equipment to St. Peter's Health Partners, as well as through a network organized by industrial 3D printing company Stratasys. The Forge also recruited student and alumni volunteers who printed face shields in their homes, which were later provided to St. Peter's Health Partners and other hospitals along the East Coast. Guillermo Lopez-Balcells, an exchange student from Spain, used his family's business, which closed temporarily due to the pandemic, to produce and sell protective screens to essential businesses.

In true Rensselaer fashion, alumni pivoted their own businesses to help address PPE shortages. Jennifer Aspell '85, president of Bright View Technologies, and her team developed a face shield prototype and recruited unemployed workers to assemble the shields safely from home. Their efforts supplied officials in North Carolina with hundreds of thousands of face shields.

Zach Hines '09 and Ryan Doherty, cofounders of the optics company Ripclear, also shifted their business focus to manufacture PPE, and delivered millions of face shields and face masks to those in need in just months.

Responding to the COVID-19 Classroom Challenge

The COVID-19 pandemic has changed so many aspects of the way we live our lives — in the workplace, in the home, and especially in academia.

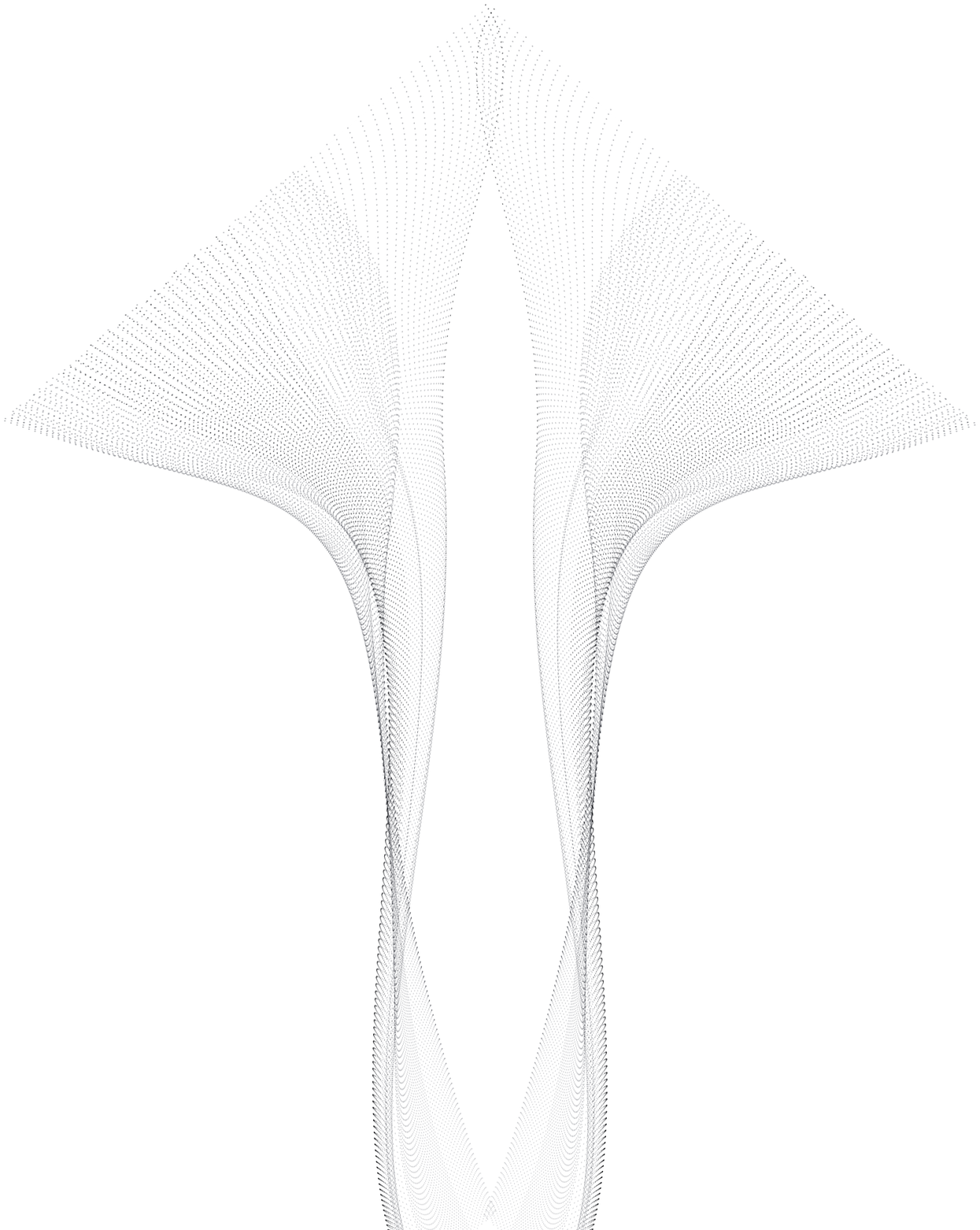
As classes began last fall, some remotely and some in person, students were exposed not only to how a range of disciplines might respond to the most pressing global health challenge of the modern era, but also to redesigned courses and labs. While some classrooms changed physically, with redesigned work space and protective barriers, others changed virtually. One of the more challenging aspects of teaching virtually was redesigning the hands-on aspect of working in a lab. Computer-based simulation models and tools allowed remote students to have similar interactivity as those on campus.

Some first-year engineering students received portable labs, which are almost small enough to fit inside a pocket, to help them visualize the fundamental relationships between current, voltage, and impedance.

Professors also redesigned many courses to teach students how to better use course material to understand the effects of the pandemic. Students were asked to consider the challenges COVID-19 patients face and how new medical systems or applications could contribute to solutions.

In other areas, students studied the impact of COVID-19 on businesses and consumer behavior, and the research gained will be used in a number of projects. By incorporating innovative teaching methods that enable students throughout the Institute to consider the problems posed by the COVID-19 pandemic from a range of perspectives and disciplines, Rensselaer created a cohort of problem solvers prepared to thrive in a changing world. This campuswide effort highlights the power of The New Polytechnic, the interdisciplinary model that drives teaching and research at Rensselaer.

"Rensselaer faculty lead by example when it comes to preparing students to address global challenges," said Provost Prabhat Hajela. "By design, our curriculum emphasizes real-world applications and meaningful engagement with the outside world. The global pandemic has presented new and unique challenges. Addressing them in our instruction and research will help prepare the next generation of talent that will be on the frontline of developing solutions and leading new discoveries."



Rensselaer has a legacy of groundbreaking research focused on global challenges. As the COVID-19 pandemic overspread our world, members of our research community leapt into action to devise solutions and offer hope.

By launching new research projects and applying existing knowledge to a range of problems related to COVID-19, our faculty, students, and staff have made meaningful contributions to the understanding of — and response to — this complex crisis.

As a member of the COVID-19 High Performance Computing Consortium, Rensselaer provided pandemic researchers around the globe with access to our supercomputer, AiMOS, the Artificial Intelligence Multiprocessing Optimized System, in support of research related to the disease.

In a way, these times have presented the very challenges our researchers have been preparing for from the founding of the Institute. The solutions they've devised are novel, complex, and significant. When society is called to follow science, Rensselaer takes the lead.

Engineers Develop Unique System for Sterilizing Masks in Bulk

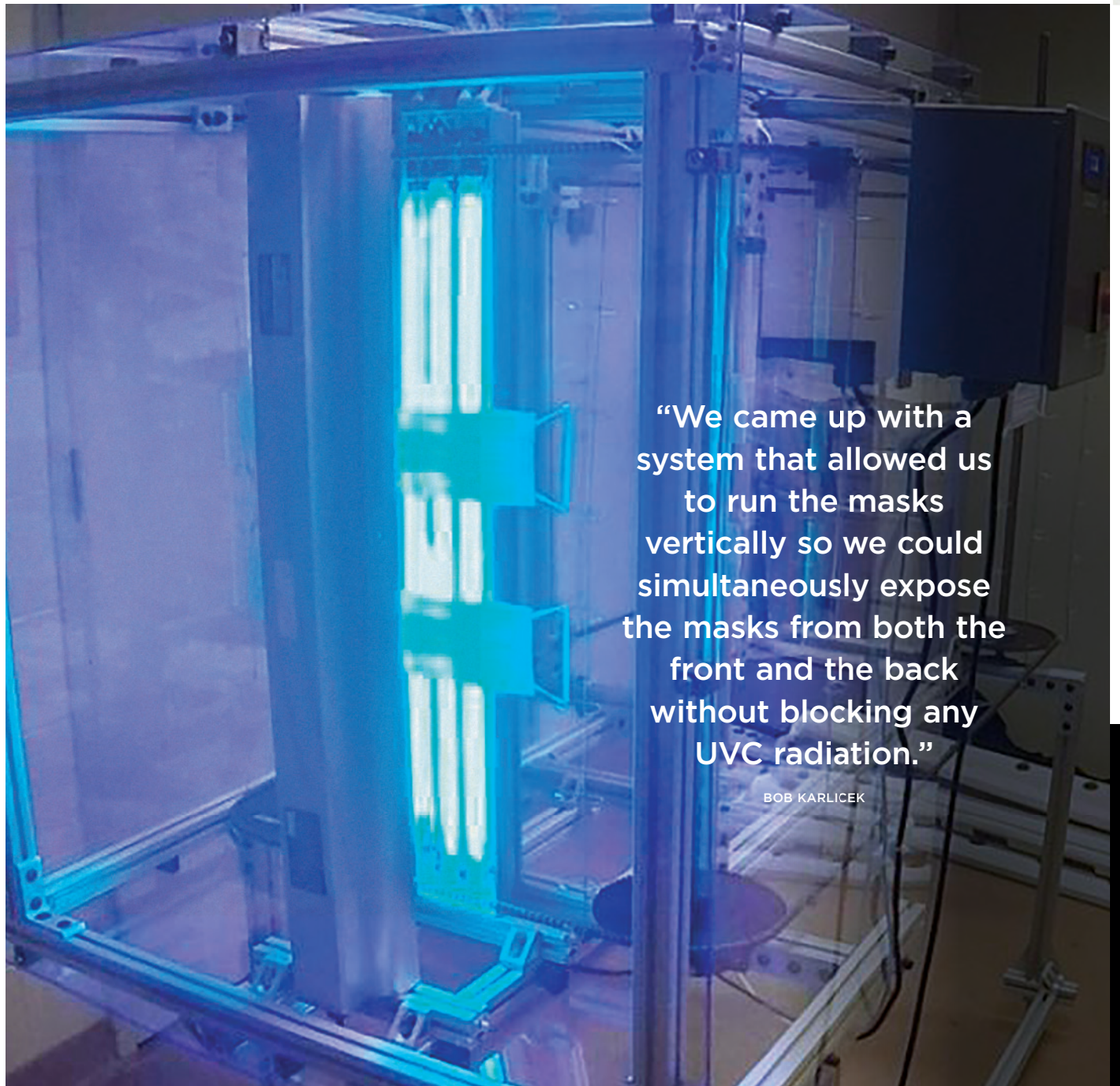
The shortage of critical personal protective equipment (PPE) has been a persistent problem for medical and other frontline workers as they battle the COVID-19 pandemic at close range day after day. A team of researchers at Rensselaer has developed a potential solution: a machine that uses ultraviolet (UVC) light to sterilize thousands of protective masks each day, rendering them safe for reuse.

The project was a collaboration between Rensselaer and longtime research partner Mount Sinai. As the pandemic worsened in New York City, and the shortage of PPE deepened, Mount Sinai reached out to Rensselaer to develop a way to make critical resources last longer without losing their effectiveness.

The UVC sterilization system, developed by a multidisciplinary team of engineers at Rensselaer, stands about 8 feet tall and about 8 feet long. Two UVC lamp fixtures, each containing two UVC tubes, are attached vertically across from one another so that masks — hung on a series of hooks that are part of a motorized belt system — can pass in between the two UVC sources. The speed of that belt determines the dose of radiation that the masks receive.

According to Bob Karlicek, director of the Center for Lighting Enabled Systems and Applications (LESA), the system is unique because of its vertical setup, which allows light to disinfect the masks from both sides.

"Since UVC radiation is a line-of-sight disinfection process, if there's any shadow from the mask or any material blocking the access of UVC radiation to the mask, you're not going to disinfect that part," Karlicek said. "We elected to come up with a system that allowed us to run the masks vertically so we could simultaneously expose the masks from both the front and the back without blocking any UVC radiation."



Data Visualization Tool Examines Community Factors Underlying COVID-19 Outcomes

A new data visualization tool examines how and why COVID-19 impacts regions differently. Using daily updated data, COVIDMinder compares community risks, mediation tools, and outcomes related to COVID-19 by state across the United States, and by county within New York state.

"Your community directly affects your health outcomes, and we're seeing that play out in the COVID-19 pandemic," said Kristin Bennett, project director and associate director of the Institute for Data Exploration and Applications (IDEA).

The web-based tool was developed by the Rensselaer team of faculty and undergraduate and graduate students behind the award-winning MortalityMinder, a similar tool that identifies social and economic factors contributing to declining life expectancy at the community level.

Bennett said that worsening social and economic determinants of mortality have already driven up rates of premature mortality since the Great Recession of 2008. The COVID-19 pandemic is further deteriorating those social and economic determinants, while simultaneously crowding out health care access for consumers with non-COVID-19-related problems.

As the developers worked on the tool, the changing visualizations gave them an inside view of how the preparation for the spread of the disease differed throughout the country. "Powerful graphical tools, such as COVIDMinder, allow both policymakers and the general public direct access to clear and interpretable information showing the geographic distribution of risk factors and response capabilities to the COVID-19 pandemic," said Curt Breneman, dean of the School of Science.

DESIGNER PEPTIDES SHOW POTENTIAL FOR BLOCKING VIRUSES

Chemically engineered peptides, designed and developed by a team of researchers at Rensselaer, could prove valuable in the battle against some of the most persistent human health challenges.

The team's findings demonstrate how researchers can engineer peptides capable of selectively binding to polysialic acid (PSA) — a unique carbohydrate that is present on critical human cells and plays a key role in neurological development and disease progression.

This foundational research lays the groundwork for further study into the ability of these peptides to provide an effective vehicle for therapeutics in the treatment of diseases such as Alzheimer's, Parkinson's, and cancer. The team's findings suggest the peptides may also prove valuable in providing a barrier between cells and viruses, such as the one that causes COVID-19.

JOSÉ HOLGUÍN-VERAS

Consumer Behavior Has Shifted Significantly During the Pandemic

An increase in telework and online commerce, and a significant decrease in personal trips, has been brought on by the COVID-19 pandemic. Understanding the effects of these rapid changes on the economy, supply chains, and the environment will be essential, as some of these behaviors will continue even after the pandemic has ended.

Researchers from Rensselaer presented the results of two sets of surveys they conducted in an effort to quantify and understand these unprecedented shifts. One survey was collected from respondents in more than 20 countries, and the other was collected from respondents within the United States.

In a series of three webinars, José Holguín-Veras, the William Howard Hart Professor of Civil and Environmental Engineering at Rensselaer, and Cara Wang, associate professor of civil and environmental engineering, led a team of researchers in presenting their findings on how the pandemic has affected in-person trips to places like school, work, and the store; teleactivities, such as shopping, education, and work; and purchasing behaviors, including e-commerce, and precautionary and opportunistic buying.

"What is clear from this research is these disaster-related buying behaviors create tremendous problems," Holguín-Veras said. "It increases demand, removes critical supplies from the markets, and makes supplies unavailable to emergency responders. It is impossible for the supply chain to deliver these sharp increases in demand."

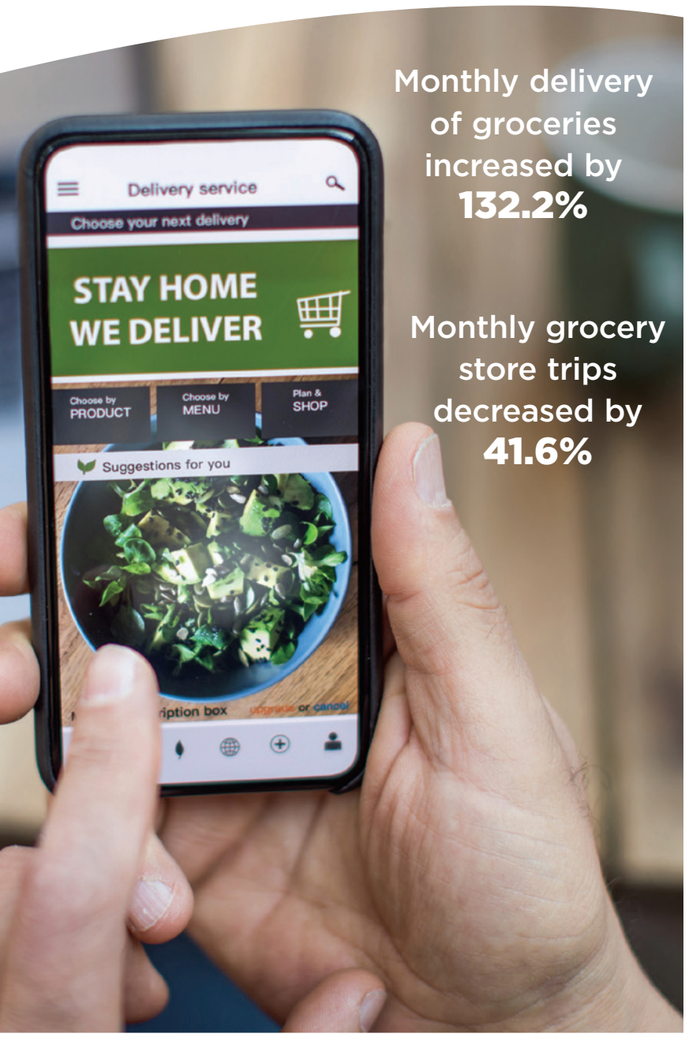
The survey revealed that 53% of respondents in the U.S. bought an increased quantity of products during the pandemic, 20% purchased products more frequently, and 30% switched from shopping within a store to shopping online.

When the team looked at equity in terms of access to critical supplies, the surveys revealed that those from lower income households were less able to stock up on supplies and therefore reported precautionary buying more frequently than higher income households.

Monthly grocery store trips decreased by 41.6% when the pandemic happened, with some people shopping less frequently and others shifting to grocery purchases online.

Monthly delivery of groceries increased by 132.2% during the pandemic, a trend that may not disappear once the pandemic is over. Respondents expect that post-pandemic, their monthly grocery deliveries will still be 63.8% higher than before COVID-19.

"The pandemic has caused short-term change, for sure, and part of the change will remain after the pandemic. These changes are also likely to continue to develop in the long term," Wang said.



Heparin May Effectively Neutralize Virus That Causes COVID-19

A common drug, already approved by the Food and Drug Administration (FDA), may also be a powerful tool in fighting COVID-19.

SARS-CoV-2, the virus that causes COVID-19, uses a surface spike protein to latch onto human cells and initiate infection. But heparin, a blood thinner also available in non-anticoagulant varieties, binds tightly with the surface spike protein, potentially blocking the infection from happening. This makes it a decoy, which might be introduced into the body using a nasal spray or nebulizer, to run interference to lower the odds of infection. Similar decoy strategies have already shown promise in curbing other viruses, including influenza A, Zika, and dengue.

"We see this as part of a larger antiviral strategy," said Robert Linhardt, lead author and the Ann and John H. Broadbent Jr. '59 Senior Contellation Professor of Biocatalysis and Metabolic Engineering. "There are many ways to combat a virus, and as we've seen with HIV, with the right combination of therapies, we can control the disease."

To infect a cell, a virus must first latch onto a specific target on the cell surface, slice through the cell membrane, and insert its own genetic instructions, hijacking the cellular machinery within to produce replicas of the virus. But the virus could just as easily be persuaded to lock onto a decoy molecule, provided that molecule offers the same fit as the cellular target. Once bound to a decoy, the virus would be neutralized, unable to infect a cell or free itself, and would eventually degrade.

"This isn't the only virus we're going to confront in a pandemic," said Jonathan Dordick, the Howard P. Isermann '42 Professor of Chemical and Biological Engineering, who is collaborating with Linhardt to develop the decoy strategy. "This is a pathway forward. We need to be in a position where we understand how things like heparin and related compounds can block virus entry."

"There are many ways to combat a virus, and as we've seen with HIV, with the right combination of therapies we can control the disease."

ROBERT LINHARDT

MALIK MAGDON-ISMAIL

Machine Learning Models Predict COVID-19 Impact in Smaller Cities

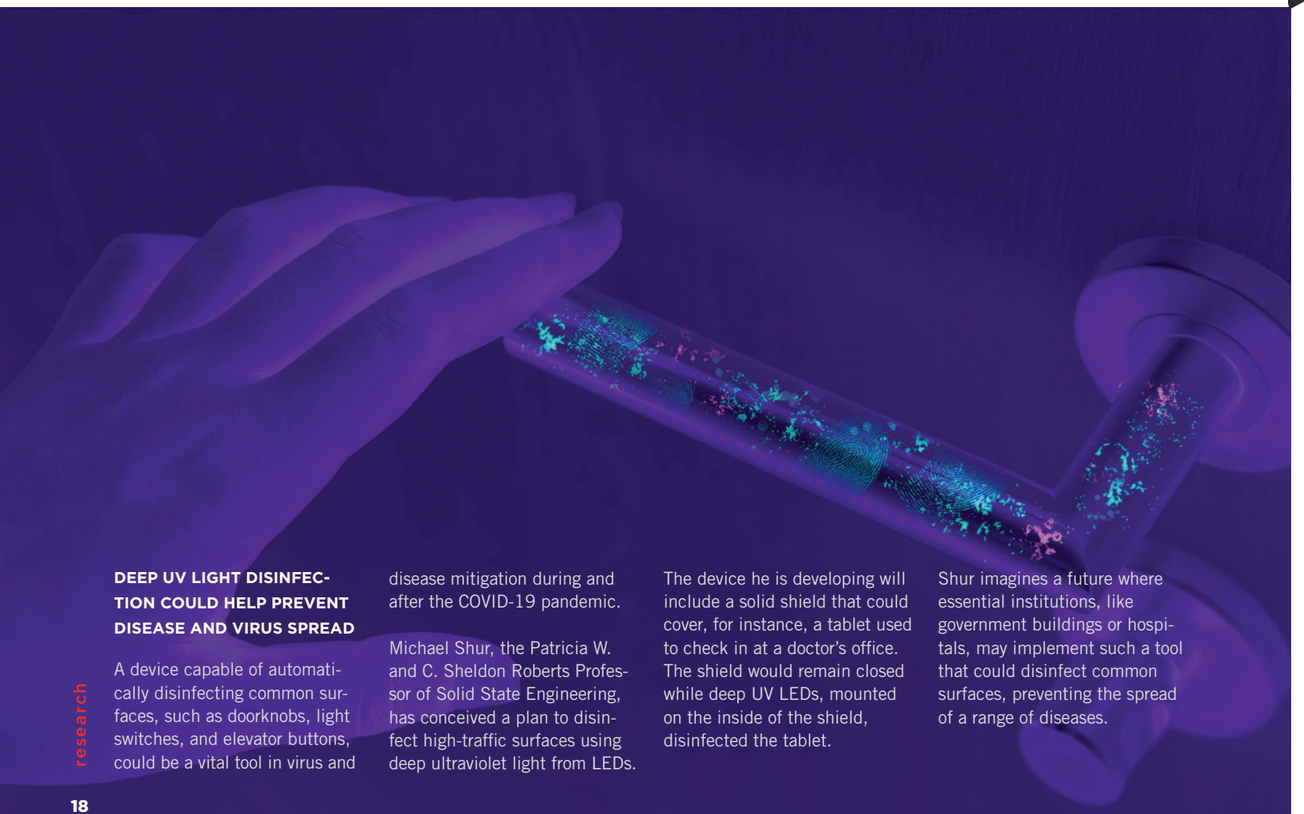
Using county data available through the New York State Department of Health and Mental Hygiene, researcher Malik Magdon-Ismail has developed models that can predict local aspects of the pandemic, such as the rate of infections over time, the infectious force of the pandemic, the rate at which mild infections become serious, and estimates for asymptomatic infections.

"There are no simple, robust, general tools that, for example, officials in Albany could use to make projections," said Magdon-Ismail, professor of computer science and expert in machine learning, data mining, and pattern recognition. "These models show that the projections vary enormously from one city to another. This knowledge could relieve some of the uncertainty in developing policy."

Modeling smaller cities with machine learning is a challenge in that few data points are available and data is updated less frequently than the picture of the nation as a whole or an epicenter like New York City. Generic machine learning models operating on such data would likely produce inaccurate predictions. To compensate, Magdon-Ismail focused on simple models and used "robust" algorithms that incorporate solutions beyond that of the mathematical ideal.

"The machine gives you the model that best fits the data, but it turns out the best is usually a very fragile principle. There are lots of different models and explanations that are essentially as good," Magdon-Ismail said. "To make the output robust, we consider the collection of models that have near-optimal levels of consistency with the data. I find a variety of models that fit the data, and then I use all of those models together to predict."

Magdon-Ismail said producing similar models for other small cities in New York state would be as easy as "running the numbers."

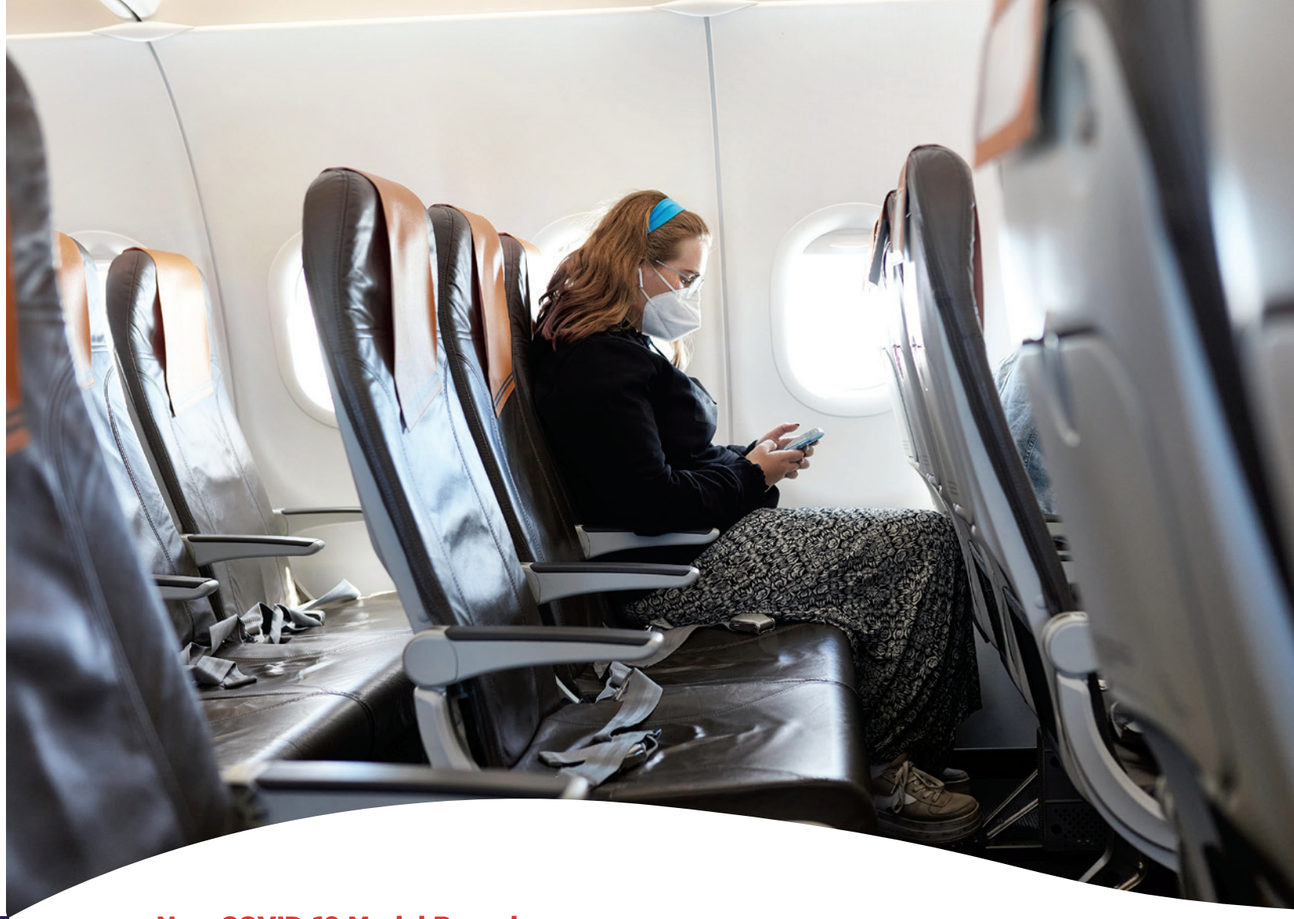


DEEP UV LIGHT DISINFECTION COULD HELP PREVENT DISEASE AND VIRUS SPREAD

A device capable of automatically disinfecting common surfaces, such as doorknobs, light switches, and elevator buttons, could be a vital tool in virus and disease mitigation during and after the COVID-19 pandemic.

Michael Shur, the Patricia W. and C. Sheldon Roberts Professor of Solid State Engineering, has conceived a plan to disinfect high-traffic surfaces using deep ultraviolet light from LEDs. The device he is developing will include a solid shield that could cover, for instance, a tablet used to check in at a doctor's office. The shield would remain closed while deep UV LEDs, mounted on the inside of the shield, disinfected the tablet.

Shur imagines a future where essential institutions, like government buildings or hospitals, may implement such a tool that could disinfect common surfaces, preventing the spread of a range of diseases.



New COVID-19 Model Reveals Need for Better Travel Restriction Implementation

More strategic and coordinated travel restrictions could have reduced the spread of COVID-19 in the early stages of the pandemic, data confirms. The conclusion stems from new modeling conducted by a multidisciplinary team of scientists and engineers at Rensselaer.

The researchers evaluated the distance between countries in terms of air travel, a more complex measurement than simply mapping physical distance. For instance, while China and Thailand may be geographically more proximate to one another, if there are significantly more flights between China and the United States, the chance of disease spread may be higher.

"This is considered a global problem," said Mamadou Diagne, assistant professor of mechanical, aerospace, and nuclear engineering, "so we wanted to know if coordinated action could be taken to mitigate contamination rates all across the world."

By mapping and analyzing the global mobility network through air traffic patterns, the researchers were able to determine the level of connection between various nations and develop a model that can predict which countries are closer to one another in terms of disease spread. The model was able to successfully predict when the virus arrived in the United States.

Using this approach, the team examined the effectiveness of various travel restrictions countries implemented in an effort to slow the transmission of the virus that causes COVID-19.

"For example, we found that the Chinese lockdown reduced the arrival time of the virus in uninfected countries by about 11 days," said Jianxi Gao, assistant professor of computer science. "And, it reduced the number of infections by 1 million globally."

Travel restrictions enacted by other nations also helped to reduce the global spread. However, the team found that these actions could have been significantly more effective if countries had worked together.

"According to the data we collected, about 50% of travel restrictions were ineffective," said Lu Zhong, postdoctoral researcher in mechanical, aerospace, and nuclear engineering. "Because the travel restrictions were done in an uncoordinated way, they failed to contribute to the global good."

Seaweed Extract Effectively Blocks COVID-19 Virus

In a test of antiviral effectiveness against the virus that causes COVID-19, an extract from edible seaweeds substantially outperformed remdesivir, the current standard antiviral used to combat the disease. Heparin, a common blood thinner, and a heparin variant stripped of its anticoagulant properties, performed on par with remdesivir in inhibiting SARS-CoV-2 infection in mammalian cells.

The research is the latest example of a decoy strategy researchers from the Center for Biotechnology and Interdisciplinary Studies are developing against viruses like the novel coronavirus that spawned the global health crisis.

The spike protein on the surface of SARS-CoV-2 latches onto the ACE-2 receptor, a molecule on the surface of human cells. Once secured, the virus inserts its own genetic material into the cell, hijacking the cellular machinery to produce replica viruses. But the virus could just as easily be persuaded to lock onto a decoy molecule that offers a similar fit. The neutralized virus would be trapped and eventually degrade naturally.

Previous research has shown this decoy technique works in trapping other viruses, including dengue, Zika, and influenza A. “We’re learning how to block viral infection, and that is knowledge we are going to need if we want to rapidly confront pandemics,” said Jonathan Dordick, the Howard P. Isermann ’42 Professor of Chemical and Biological Engineering and lead researcher. “To protect ourselves against future pandemics, we are going to need an arsenal of approaches that we can quickly adapt to emerging viruses.”

“What interests us is a new way of getting at infection,” said Robert Linhardt, the Ann and John H. Broadbent Jr. ’59 Senior Constellation Professor of Biocatalysis and Metabolic Engineering, who is collaborating with Dordick to develop the decoy strategy. “If you could simply treat the infection early, or even treat before you have the infection, you would have a way of blocking it before it enters the body.”

PINGKUN YAN (LEFT) IS LEADING EFFORTS TO CREATE ALGORITHMS THAT CAN INTEGRATE CRITICAL INFORMATION ABOUT A PERSON.

Creating AI Tools to Identify High-Risk COVID-19 Patients

Improved screening and treatment options for COVID-19 are critically important for high-risk patients with comorbidities, such as diabetes, pulmonary disease, and cardiovascular disease.

A new grant from the National Institutes of Health (NIH) supports the rapid development and integration of a series of artificial intelligence algorithms that will analyze multiple pieces of health data — from chest computed tomography (CT) images to vital signs — in order to help clinicians assess disease severity and predict patient outcomes. The effort is being led by Pingkun Yan, assistant professor of biomedical engineering. “Screening out the high-risk patients who may need intensive care later, and monitoring them more closely to provide early intervention, may help save their lives,” said Yan.

According to Yan, the few artificial intelligence tools that are currently available in the COVID-19 fight can only help doctors determine the severity of lung infection brought about by the disease. They fail to assess and account for comorbidities.

The research team will create a framework of algorithms that can integrate critical information about a patient, including CT scans that assess the severity of lung infection, patient demographic information, vital signs, and laboratory blood test results.

“My group has been focusing on using artificial intelligence and deep learning to analyze medical imaging data with an emphasis on translating the technology from benchside to bedside,” Yan said. “This focus built a solid foundation for us, so when the crisis emerged, with our clinical collaborator at Massachusetts General Hospital, we quickly identified the clinical needs and started working on a solution.”

Rensselaer prepares students to learn and lead in a world that demands adaptability and resilience. In 2020, this took on special meaning. When they began classes last August, our students quickly demonstrated their strengths and embraced new protocols to make it possible to live and learn alongside one another.

In keeping with the Institute's mission to prepare the next generation of world-changing leaders, COVID-19 assumed a prominent focus in the content of many courses throughout the university.

Students learned how a range of disciplines could respond to the most pressing global health challenge of the modern era.

They also contributed to creating solutions. Teams of undergraduate researchers, with guidance from graduate students, created several applications that enable us to better understand the complexities of the COVID-19 pandemic.

By empowering our students to consider the problems posed by the COVID-19 pandemic from a range of perspectives and disciplines, Rensselaer is creating a cohort of problem-solvers prepared to thrive in a changing world.

Celebrating the Class of 2020 Virtually

Rensselaer held its first virtual Commencement ceremony on May 23, 2020, to celebrate the Class of 2020. A total of 2,099 degrees were conferred during the ceremony, including 124 doctoral degrees, 407 master's degrees, and 1,568 bachelor's degrees, all to students who finished their final semester of courses remotely due to the worldwide spread of COVID-19.

The virtual ceremony was viewed more than 57,000 times. President Shirley Ann Jackson congratulated the graduates on their accomplishments and encouraged them to use their talents and creativity to help others in need, especially during the ongoing crisis.

"None of our celebrations have been as unexpected as this one, which is taking place amid the greatest disruption of daily life in the United States since World War II," said President Jackson. "This pandemic will help you discover your own strength and resilience. Remember that we all need you, and we are counting on you to carry on the great work of making the world a better place."

Families celebrated their graduates, many of whom earned multiple degrees, with lawn signs and drive-by parades. They also had the opportunity to download a custom congratulatory graphic, including the graduate's name, degree, and photo, when provided, to share with their friends and loved ones on social media.

Faculty and staff offered congratulations, well wishes, and advice through recorded videos that were shared with graduates via the Institute's social media pages.

The virtual ceremony also included two student speakers. Graduate student speaker Alexis Marie Ziemba, a recipient of a doctoral degree in biomedical engineering, praised the graduates for the sacrifices they have made for the sake of creating new knowledge.

"We have cultivated a set of skills that will help us to develop new therapeutics, improve our energy technology, make better business decisions, and so much more," she said. "I encourage you all to think about how you can use your skills to make the most impact in our world."

Sruja Machani, the Class of 2020 president, championed the future leaders earning their diplomas and beginning new journeys amid these unique circumstances.

"As we step into our futures, I hope that we can employ the lessons we've learned at Rensselaer, inside and outside the classroom, to address every new day with innovation, purpose, and aim," said Machani, who received a bachelor's degree in biochemistry and biophysics.

Commencement 2020 by the Numbers

2,099
total degrees awarded to
2,074
students (some earning multiple degrees)

124
doctoral degrees

407
master's degrees

1,568
bachelor's degrees

"This pandemic will help you discover your own strength and resilience."

PRESIDENT SHIRLEY ANN JACKSON

"When faced with obstacles, musicians find new modes of artistic communication."

MARY SIMONI

Reimagining Music Education for the COVID-19 Era

A new course was created to meet the challenges of the pandemic. It equips students on campus and off with novel strategies for pursuing and practicing music performance in an era of social distancing and remote learning.

With the COVID-19 pandemic necessitating certain public health guidelines, and the Rensselaer return-to-campus plan calling for some students to remain off campus in the fall, proceeding with the traditional music ensemble courses in the School of Humanities, Arts, and Social Sciences (HASS) was not a feasible option.

Led by Christopher Fisher-Lochhead, lecturer in HASS, the new *Fusion Ensemble* course combines the Orchestra, Concert Choir, and Chamber Music Ensembles into one class, melding the different practices together to discover provocative affinities that might not have been uncovered in the separate classes. The course is taught using inventive technical and pedagogical methods that allow students to participate in person, remotely, during a set class time, or asynchronously.

"Since we're forced to reconceive performance and collaboration because of the pandemic," Fisher-Lochhead said, "it's important to find ways we can reimagine music that aren't just reactions to the challenges of today, but are also enduring responses to this age of technological mediation and social unrest and everything that defines our current moment. This is exactly what music performance should do in a technological setting like Rensselaer."

MEMBERS OF THE FUSION ENSEMBLE REHEARSED JOHANNES BRAHMS' "PIANO QUARTET IN C MINOR, OP. 60" IN EARLY DECEMBER.

STUDENTS PLACE SECOND IN COVID-19 COMPUTATIONAL CHALLENGE

Yueyang Li '20, Feng Wang '20, Junxiong Tang '20, and Tong Chen '20 took second place in the 2020 COVID-19 Computational Challenge cohosted by the City of Los Angeles and the Global Association for Research Methods and Data Science. The COVID-19 Computational Challenge tasked participants with creating innovative solutions to determine the risk of exposure in and around the city of Los Angeles. Team RPI Solvers presented a model and dashboard for computing risk scores at given places of interest (e.g., grocery stores, restaurants, museums) by factoring in three key data sets: local infection rates, number of hourly visitors, and spatial density.

The team was mentored by Dorit Nevo, associate professor and acting associate dean of the Lally School of Management. Chen, Li, and Tang pursued a master's degree in business analytics and Wang, a master's degree in electrical engineering.

Humanities Students Use Hindsight 2020 to Exhibit Final Projects

Claudia Sanchez and her classmates had been looking forward to seeing their *Creative Seminar* work on display in the Arts Center of the Capital Region in Troy. As graduating students in the School of Humanities, Arts, and Social Sciences (HASS), this gallery show was supposed to be the culmination of four years of intense learning and hard work.

Sanchez wanted the experience of watching the public view her capstone project, a 2D animation short titled *En Mi Viejo San Juan*, a homage to the emotional struggle she felt about leaving her home in Puerto Rico to study in Troy.

Then the pandemic struck.

For students in arts-related majors, *Creative Seminar* provides a forum for the development and presentation of a senior thesis. Last spring, with the campus operating remotely and public events canceled, Sanchez and her classmates were unable to publicly showcase their individual projects as planned. But she didn't want their work to go entirely unseen, so she began leading the effort to develop an alternative exhibition.

In May, Sanchez and her classmates launched Hindsight 2020, a website designed for each student to feature their individual portfolios. "It's important for me and the other students to showcase what we've learned at Rensselaer to the community," Sanchez said.

"Art has been used as a way to communicate and to relax in moments of anxiety," Sanchez said. "My classmates and I have learned a lot during our four years at Rensselaer, and we want people to enjoy the art experience, especially during these stressful times."

MARIAM ELASSER '20, A FIRST-GENERATION MOROCCAN IMMIGRANT, CREATED A DOCUMENTARY THAT EXPLORES THE REALITIES OF CULTURAL AND PERSONAL LOSS RELATING TO THE POTTERY INDUSTRY AND TRADITIONS OF HER MOTHER'S HOMETOWN OF SAFI, MOROCCO.

Remote Research Yields Deeper, More Ingenious Approach to Findings

On a typical day, Jackie Pelham would spend most of her time in a lab coat and goggles. Working at a laboratory bench, she would examine proteins found in the body. Due to the COVID-19 pandemic, Pelham traded her lab coat for a laptop and her lab bench for a desk in her home. Rather than observing biochemical processes, she pored over previously collected data. Somewhat unexpectedly, Pelham saw this temporary trade-off as an opportunity.

For many scientists and engineers at Rensselaer, the pandemic presented a new challenge in the form of remote research. As faculty moved their instruction online last spring, they also continued to lead their labs in making discoveries.

Jennifer Hurley, assistant professor of biological sciences, said working remotely has prompted people to analyze information and write up their findings with much more focus. "We are finding really interesting data, and we are realizing that we should present that to the community," she said.

Hurley and Pelham are both circadian biologists who are interested in how the human body keeps time. In a lab setting, they spend an extensive amount of time studying the ways in which the circadian clock touches every protein, RNA, metabolite, and lipid in the body.

"That means we have these enormous data sets of exactly what is changing over the day and those data sets are computational," Hurley said. "Now, some of the lab members are crunching exactly what is controlled by the circadian clock and how that impacts biology."

Rensselaer prides itself on this type of ingenuity, as well as a particular strength and emphasis in data dexterity. As researchers lean on both, they are finding ways to make the most of this challenging time while continuing to contribute to the scientific community.

"The silver lining is that now you have time to go over the literature and actually sit down with your data and pull out things that, at least originally, you didn't think you needed," said Samuel Stephen, a National Science Foundation graduate fellow and a doctoral student in the Department of Biomedical Engineering.

Stephen works in the lab of Deepak Vashishth, director of the Center for Biotechnology and Interdisciplinary Studies, where he investigates the effect of obesity and diabetes on bone.

Remote research has encouraged Stephen to revisit the data he collected from bone samples before the pandemic. His new analysis has uncovered additional information he originally believed would require a more time-consuming and labor-intensive biochemical assay in the lab. What Stephen discovered, he said, will provide the lab another way — one that is easier, faster, and more cost-effective — to measure the effects of obesity on bone.

Class of 2024 Brings New Talents to Change the World

Members of the Class of 2024, who began their first year of higher education in the midst of a pandemic, have brought a wide range of expertise and experience to the campus. “In a world dealing with a variety of pressing challenges, it is exciting to know that exceptional young minds continue to come to Rensselaer to hone their skills, discover new talents, and prepare to change the world,” said Jonathan Wexler, vice president of enrollment management. “Rensselaer has embraced the vision of The New Polytechnic, which acknowledges that the greatest problems facing our world cannot be solved by a single person or discipline alone, and this clearly resonates with students.”

The Class of 2024 is made up of high achievers. Members of the class have summited Mount Kilimanjaro, played in Carnegie Hall, designed their own video games, and become the youngest nationally certified search personnel in the National Association for Search and Rescue.

They are inventive. Class of 2024 sudents have developed treatments for paronychia, solar-powered water desalinization backpacks for refugees, a mobile phone amplifier, technology to prevent parents from leaving kids in their cars, and even an artificial intelligence-enabled toilet for cats.

They are self-starters. One student created a nonprofit organization that holds traveling clinics to provide health care to the underserved. Another started a club at their high school that provided students a platform to give TED-style lectures. A third — a beekeeper who maintains four hives of his own — spends his summers teaching beekeeping techniques to farmers to help them optimize their crops.

These qualities will serve the Class of 2024 well as they navigate the unprecedented circumstances that mark the beginning of their collegiate career.

BEN CHANG

GAMING THE PANDEMIC

Combating the COVID-19 crisis will require researchers to tackle the problem with a range of strategies and tools — including gaming.

Faculty and students in the Games and Simulation Arts and Sciences (GSAS) program have developed a number of creative responses to the ongoing pandemic, and they encouraged others doing the same.

The development of games related to health care, education, and a combination of the two is not new territory for the GSAS program. For example, in collaboration with the Icahn School of Medicine at Mount Sinai, faculty and students are developing a video game called *Cure Quest*.

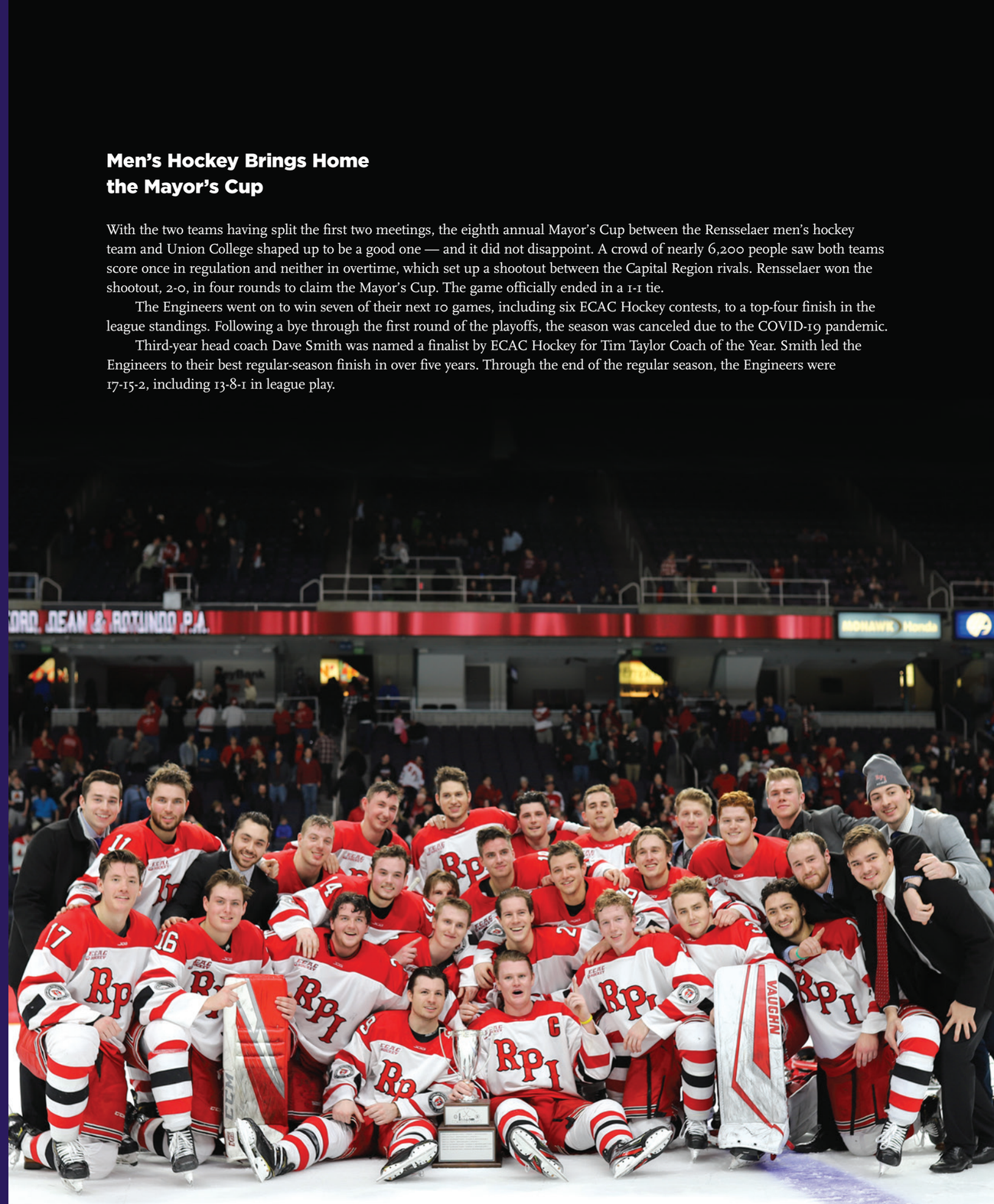
This game aims to improve the understanding of the complex process of bringing a drug or vaccine from the research bench to the bedside of a patient. According to Ben Chang, professor of arts and director of GSAS, *Cure Quest* will bridge the gap in medical school education between the clinical side of medicine and basic research. “*Cure Quest* will allow medical students to tie together the necessary steps for vaccine development in both dramatic cases, like we’re seeing right now with COVID-19, and in drugs we would use day-to-day,” Chang said.

Men’s Hockey Brings Home the Mayor’s Cup

With the two teams having split the first two meetings, the eighth annual Mayor’s Cup between the Rensselaer men’s hockey team and Union College shaped up to be a good one — and it did not disappoint. A crowd of nearly 6,200 people saw both teams score once in regulation and neither in overtime, which set up a shootout between the Capital Region rivals. Rensselaer won the shootout, 2-0, in four rounds to claim the Mayor’s Cup. The game officially ended in a 1-1 tie.

The Engineers went on to win seven of their next 10 games, including six ECAC Hockey contests, to a top-four finish in the league standings. Following a bye through the first round of the playoffs, the season was canceled due to the COVID-19 pandemic.

Third-year head coach Dave Smith was named a finalist by ECAC Hockey for Tim Taylor Coach of the Year. Smith led the Engineers to their best regular-season finish in over five years. Through the end of the regular season, the Engineers were 17-15-2, including 13-8-1 in league play.



THE RPI ENGINEERS, JAN. 25, 2020, AT THE ALBANY TIMES UNION CENTER.

Faculty Distinctions

ACCOLADES AND HONORS

Francine Berman, the Edward P. Hamilton Distinguished Professor of Computer Science, was named the 2020 recipient of the Paul Evan Peters Award for "notable, lasting achievements in the creation and innovative use of network-based information resources and services that advance scholarship and intellectual productivity."

Yaron Danon, professor of mechanical, aerospace, and nuclear engineering, has been elected a fellow of the American Nuclear Society. Researchers earn the grade of fellow based on "outstanding accomplishment in any one of the areas of nuclear science and engineering."

Farhan Gandhi, the Rosalind and John J. Redfern Jr. '33 Endowed Chair in Aerospace Engineering, was elected to the Class of 2020 Fellows of the American Institute of Aeronautics and Astronautics.

Juergen Hahn, professor and head of the Department of Biomedical Engineering, was named a fellow of the American Institute of Chemical Engineers. He also accepted the position of deputy editor-in-chief of the *Journal of Process Control*.

James Hendler, director of the Institute for Data Exploration and Applications and the Tetherless World Senior Constellation Professor of Computer and Cognitive Science, has been named to the International Advisory Board of Health Data Research UK, the national institute for health data science. He was also named to the COVID-19 Rapid Response Task Force, which is a resource for federal and state legislators and other policymakers.

Liping Huang, professor of materials science and engineering, has been named a fellow of the American Ceramic Society, for "outstanding contributions to the ceramic arts or sciences."

Pawel Keblinski, professor and head of the Department of Materials Science and Engineering, was elected a fellow of the Materials Research Society for his influential contributions to "the development of computational methods leading to fundamental understanding of thermal transport in materials on nanometer-length scales."

George Makhatadze, associate department head and professor of biological sciences, was named a fellow of the American Association for the Advancement of Science for his seminal contributions to the understanding of protein thermodynamics, including temperature, pressure, and electrostatics; and the applications of this insight in biotechnology, biopharmaceutics, and diagnostics.

Vincent Meunier, department head and professor of physics, applied physics, and astronomy, was named a fellow of the American Association for the Advancement of Science for distinguished contributions advancing the fields of nanoscience and nanotechnology through the application of innovative theory and advanced computation.

Ravishankar Sundararaman, assistant professor of materials science and engineering, received the AIME Robert Lansing Hardy Award in recognition of his "seminal contributions to transmute and harness quantum electronic structure calculations for computational materials design in the diverse fields of materials research including electrochemistry and plasmonics."

Deepak Vashishth, director of the Center for Biotechnology and Interdisciplinary Studies and professor of biomedical engineering, was named a fellow of the American Bone and Mineral Society for "outstanding contributions to the field of bone and mineral science."

Ge Wang, the Clark and Crossan Endowed Chair of Biomedical Engineering and director of the Biomedical Imaging Center, was named a fellow of the National Academy of Inventors. The honor is bestowed on those who have created or facilitated inventions that have improved quality of life, economic development, and the welfare of society.

Esther Wertz, assistant professor of physics, applied physics, and astronomy, was awarded a National Science Foundation Faculty Early Career Development Program (CAREER) Award to investigate nanometer-scale metal structures that will control light at the quantum limit, one photon at a time.

Langdon Winner, the Thomas Phelan Chair of Humanities and Social Sciences, was awarded the 2020 John Desmond Bernal Prize by 4S, the Society for Social Studies of Science. The Bernal Prize is a career award for distinguished contributions to the field of social studies of science, technology, and medicine.

X. George Xu, the Edward E. Hood Endowed Chair Professor of Mechanical, Aerospace, and Nuclear Engineering, has received the 2020 Arthur Holly Compton Award in Education from the American Nuclear Society for "outstanding contributions to education in nuclear science and engineering." He was also selected by the American Association of Physicists in Medicine to receive the Edith H. Quimby Award for Lifetime Achievement in Medical Physics.

Tong Zhang, professor of electrical, computer, and systems engineering, was elevated to IEEE fellow, for his "contributions to system design and VLSI implementation for data storage."

RENSSELAER HONORS

DAVID M. DARRIN '40 COUNSELING AWARD

Jeffrey H. Braunstein '04 Ph.D., former senior lecturer of electrical, computer, and systems engineering. The income from an endowment established by the late David M. Darrin '40 is awarded annually to a member of the faculty who has made an unusual contribution in the counseling of students. Nominations are made by students and the recipient is chosen by Phalanx, the student leadership honor society.

JAMES M. TIEN '66 EARLY CAREER AWARD FOR FACULTY

Jian Shi, associate professor of materials science and engineering. The award honors productivity in both teaching and research, with outstanding achievement in one of these areas.

JEROME FISCHBACH '38 FACULTY TRAVEL GRANT

Larry D. Reid, professor of psychology and neuroscience. The award recognizes contributions faculty members have made to the education and motivation of students.

WILLIAM H. WILEY 1866 DISTINGUISHED FACULTY AWARD

John T. Wen '85 Ph.D., Russell Sage Professor of Engineering, professor and head of the Department of Electrical, Computer, and Systems Engineering. Established by Edward P. Hamilton, Class of 1907, in memory of William H. Wiley, Class of 1866, the award honors those who have won the respect of the faculty through excellence in teaching, productive research, and interest in the totality of the educational process.

CLASS OF 1951 OUTSTANDING TEACHING DEVELOPMENT GRANT

Shankar Narayanan, assistant professor of mechanical, aerospace, and nuclear engineering. The fellowship was established by the Class of 1951 to commend faculty members for their outstanding accomplishments in education.

RENSSELAER ALUMNI ASSOCIATION TEACHING AWARD

Jennifer Pazour, associate professor of industrial and systems engineering. The award was created to recognize current members of the Rensselaer faculty for their outstanding teaching techniques, contributions to the campus experience, and commitment to students.

TRUSTEES' OUTSTANDING TEACHER AWARD

Barbara M. Cutler, associate professor of computer science. The award was established in 1994 to recognize outstanding accomplishments in classroom instruction.

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