UNIVERSITY OF DELAWARE

ENGINEERING

ELECTRICAL AND COMPUTER ENGINEERING

SUMMER 2023

ADDRESSING GLOBAL CHALLENGES

INSIDE

IN MEMORIAM: CHASE COTTON

CYBERSECURITY DEGREE OF THE FUTURE

FOSTERING COMMUNITY

GROWING OUR

IMPACT

The College of Engineering is a growing and diverse community of scholars who are driven by discovery and devoted to education, research and socially responsible innovation.

INNOVATION

UD Engineering's faculty, research staff and students form a community of problem-solvers who are conducting research on sustainability, energy and health that has local, regional and global impacts.

EXCELLENCE

UD's "Hengineers" are career-ready thanks to our world-class academic programs, including 4+1 accelerated and dual degree programs, as well as internships, research and study abroad opportunities.

$119M

FY21 RESEARCH EXPENDITURES

Top 3%

AMONG U.S. UNIVERSITIES IN RESEARCH AND INNOVATION

28% Female

FALL 2022 ENROLLMENT

97%

OF OUR GRADUATES ARE EMPLOYED OR PURSUING FURTHER EDUCATION

UNIVERSITY OF DELAWARE

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SPRING 2023

Electrical & Computer Engineering News

Electrical and Computer Engineering News is published for the alumni, friends and peers of the department.

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UNIVERSITY OF DELAWARE

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UD Experts in Business and Engineering Explore Potential Changes in Stock

JAMIE PHILLIPS

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DEAR FRIENDS AND COLLEAGUES,

We are pleased to share some highlights of our Electrical and Computer Engineering Department over the past year as we strive toward our vision *To innovate across the spectrum of physical and digital systems to enrich society and address global challenges.*

As a department, we developed a strategic plan where the fundamental discoveries of our research and our students will lead the way to change the world to create a healthier, happier, and more just society.

Some recent examples include advances in climate and sustainability research through new information retrieval techniques, use of artificial intelligence and acoustics to explore the underwater environment, and advances in solar cell technologies and grid integration of solar power (and marking the 50th Anniversary of our Institute for Energy Conversion!). Our faculty have led breakthroughs ranging from the nanoscale to realize photonic integrated circuits that will advance key initiatives central to the CHIPS and Science Act, to the exploration of dark energy and dark matter in space.

We were deeply saddened by the loss of Dr. Chase Cotton, our faculty member that led the development of our cybersecurity programs. We are pleased to introduce a new Bachelor's program in Cybersecurity Engineering, one of the first of its kind that will support the workforce of the future. Our cybersecurity activities have had a broad impact that include advancing financial technologies, and we're pleased to be expanding these efforts in the new FinTech Building on STAR Campus this summer.

We hope you enjoy hearing about our recent student, staff, and faculty honors and achievements and we welcome you to stay connected with us on our social media channels on LinkedIn, Facebook, and Twitter. If you are in the area, we encourage you to contact us to say hello and engage with our ECE Community!

All the Best,

Jamie Phillips

Chair
Electrical and Computer Engineering

FACULTY HONORS

GONZALO ARCE

Fellow | National Academy of Inventors

AUSTIN BROCKMEIER

COE Faculty Award | Excellence in Service and Community Engagement

HUI FANG

COE Award | Diversity and Inclusion

ANDY NOVOCIN

COE Faculty Award | Excellence in Mentoring and Advising

DENNIS PRATHER

2022 Class of Military Sensing Symposia (MSS) Fellows
MSS Fellows are selected and recognized for outstanding contributions to the military sensing profession, including members from industry, government, and academia.

SWATI SINGH

COE Faculty Award | Outstanding Early Career Faculty Award

GRADUATE STUDENT AWARDS AND FELLOWSHIPS

LARS FOLKERTS

COE Graduate Student Award | Excellence in Teaching

ANDRES RAMIREZ-JAIME

George W. Laird Fellow

ANISHKUMAR SOMAN

COE Graduate Student Award | Excellence in Research

THUNCHANOK (TASHA) KAEWNUKULTORN

Westerman Fellowship Award
The Westerman Family Graduate Research Fund Fellowship was established in 2020 by Wayne Westerman '99PhD to provide support for graduate students, and the faculty leading them, who are conducting research in the areas of climate change or renewable energy.

CLAUDIO CESAR CLAROS OLIVARES

Bendett Fellowship Award
Established by Mark P. Bendett '81M '85PhD, the Bendett Fellowship Fund provides support for ECE graduate students entering the first year of their PhD program.

IMPROVING ALGORITHMS, FOSTERING COMMUNITY

With innovative research and inclusivity, Hui Fang exemplifies UD's collaboration culture

Whether it's looking up directions to a nearby restaurant or checking the score of the baseball game, search engines are a helpful tool for navigating everyday life. But for certain tasks, datasets or platforms, different algorithms from the ones that power internet search engines are needed.

Pioneering fundamental research in this field is professor Hui Fang. Her group is working on new ways to help researchers find what they need in their data while developing approaches to ensure that search results are fair and unbiased. Fang is also a champion of community building and exemplifies what it means to be part of UD's "collaboration culture."

Hui Fang, professor in the Department of Electrical and Computer Engineering is conducting fundamental research to improve search engine technologies. She is also a champion of DEI initiatives by helping to establish the Women in ECE student organization.

"Professor Fang is a leading scientist in the area of information retrieval and data sciences with a true gift for using these powerful techniques to address major challenges facing society such as climate change and sustainability," said department chair Jamie Phillips. "More broadly, she has had a transformative impact on mentoring and building an enthusiastic cohort of women engineers."

MAKING SENSE OF MASSIVE AMOUNTS OF INFORMATION

While search engines like Google are powerful tools for scouring the internet, users' information needs often go far beyond finding relevant web pages, explained Fang.

"Many information-seeking tasks, such as writing a literature survey about an emerging research topic, require users to synthesize relevant information from multiple documents and analyze the content for knowledge discovery or decision making," said Fang. "Because one strategy won't work for all information tasks, we are studying how to develop technologies to help users combat the information overload problems encountered in different disciplines."

To this end, Fang's research group regularly works with collaborators in other disciplines, creating customized search platforms and information management tools, including using smartphones to monitor clinical depression, analyzing political behavior on mobile devices, and an app to address opioid use disorders.

One of Fang's collaborators is the Disaster Research Center (DRC). Her team developed a new information retrieval system that allows researchers to more easily manage both digital and physical data. It also links together different data types, such as news articles and tweets, so that information is easier to parse through during an ongoing disaster.

Kuang Lu, a key developer of the system, earned his doctorate in 2019 and is now a research scientist at Meta. "With this project, I created a tool that people use and that's helping the DRC do their research in a more effective, efficient way, and that's the most rewarding part of this work," Lu said.

Fang's research can also be applied for problems related to data mining, a process where users find interesting patterns in their data without needing a specific search query. To this end, Fang is working with Professor Dionisios Vlachos, both are part of the Center for Plastics Innovation, to mine the chemical scientific literature. Their goal is to identify existing research gaps and potentially discover new ways to upcycle plastics.

Yue Zhang, a doctoral student working with Fang, is developing a platform to help researchers more easily search through existing journal articles to find chemicals of interest and reaction parameters for further study and is building a "chemicals search engine" for catalysts, which are a key component of process optimization. "Dr. Fang gives me a lot of freedom and encourages me to try new things," Zhang said.

Fang is also interested in ensuring that search results are unbiased, relevant, and provide a balanced perspective of the viable information that's available. But while the potential benefits of algorithmic fairness are wide-reaching, defining fairness in this context is complicated.

To come up with a better assessment of fairness, Fumian Chen, a doctoral student in the Financial Services Analytics (FSAN) program, is working on a Wikipedia search project that aims to provide a more balanced exposure to different groups and cover more perspectives within search results.

"Estimating fairness is very challenging, and even choosing what fairness measures you use to evaluate your algorithms is also a challenge," he said. "In this project, we try to bring more flexibility and interpretability to this fairness using advanced machine learning methods."

COMMUNITY BUILDING, COLLABORATION CULTURE

Fang is also a champion of diversity, equity and inclusion efforts and during the pandemic helped assemble a group of students to lead Women in Electrical and Computer Engineering (WECE).

"We started with what we wanted to achieve with the group, and because we were remote it forced us to focus on our goal and our mission, which was to build a community," said Susan Arnopolin, a 2022 graduate who served as the WECE co-president in 2021-2022 and is now working at the Johns Hopkins Applied Physics Laboratory near Baltimore. "Dr. Fang was really crucial in the process, because she really brought us all together."

"We stepped out as a fully formed group in a way that a lot of clubs or organizations really don't get a chance to do," said Ellie Rosin, former WECE co-president who also graduated in 2022 and is now working at Northrop Grumman. "Dr. Fang was pivotal to the planning, she had ideas and enthusiasm, and key was confidence that people would want to be there."

Fang said she was initially attracted to UD's ECE department because of its collegial environment and "collaboration culture," which is an essential component of her group's research that regularly reaches across disciplines and fields.

"The most challenging part of the work is to understand the terminology and language of another discipline," she said. "But, thankfully, I have great collaborators who work with us to understand new concepts, and great students who work with me to learn new disciplines."

To learn more about Hui's research, read the full version of this article on UDaily.

A SUPPORTIVE COMMUNITY FOR WOMEN IN COMPUTER AND ELECTRICAL ENGINEERING

The mission of UD's Women in Electrical and Computer Engineering (WECE) student group is to provide a supportive community and encouraging environment for women in the ECE department. Founding student members of WECE include Susan Arnopolin, Ellie Rosin, Karelia Pena, Lianna Joseph, Parinaz Barakhshan, Jeanae Clark, Hannah West, Ellen Gupta and Nafisa Maryam.

WECE hit the ground running with virtual events in Spring 2021 and in-person activities starting Fall 2021. This past academic year, WECE continued several of their popular events such as WECE lunch and Women in Industry panels. They also ran admission events during Blue and Golden Open House and Decision Days, study breaks and game nights, and marked Women's history month with a display in the iSuite. At the end of the academic year, the group hosted their second annual celebration of graduating seniors.

Maryam, WECE co-president for the 2022-2023 academic year, said that one of the biggest benefits of WECE is its ability to provide a sense of community. "Not only can you get to know everyone really well, it's also a mix of graduate and undergrad students, which makes our group supportive about anything related to courses, jobs, or mentorship," she said.

"As female students go through their college experience, they might realize that they are the only woman in some of their classes, and that can be a little frightening sometimes," added co-president Clark. "WECE provides a safe space for women in ECE: We're able to build each other up, encourage each other, and give advice."

UD'S INSTITUTE OF ENERGY CONVERSION MARKS 50 YEARS OF SOLAR ADVANCES

UD celebrated IEC's 50th year with a special event, including the 2022 Karl Böer awards, on Tuesday, May 3, 2022, at the Audion on UD's Science, Technology and Advanced Research (STAR) campus.

In 1972, University of Delaware physicist Karl Böer founded the Institute of Energy Conversion, and by November that year it had broken ground on its proof-of-concept — Solar One — the first house to be powered and heated by the converted energy of the sun.

Solar One, dedicated in 1973, was a two-bedroom house built just off S. Chapel Street in Newark, Delaware. The small, unassuming building, which still stands today, attracted more than 100,000 visitors in its first year, due to its international popularity and timely build during a global energy crisis.

Now, as IEC looks toward the future, finding ways to expand access to renewable energy — especially solar — has become a matter of urgency worldwide because of continued environmental damage, increased demand for energy, and anxiety-driven pressure from international conflicts.

IEC brings a legacy of significant contributions to the task. It is the oldest solar research facility in the world and one of only two recognized as a Center of Excellence for Photovoltaic Research and Education by the U.S. Department of Energy.

"What excites me about the future of IEC, and solar research in general, is the very strong and clear awareness of the need for renewable carbon-free energy," said Steven Hegedus, senior scientist at IEC and a professor of electrical and computer engineering.

"It's not like we have to convince people anymore. Everybody has homes in their communities that have solar on them," Hegedus continued. "There are billions and billions of dollars going into clean technology and solar is one of the biggest beneficiaries of that. The question is, can we get this all to happen quick enough to offset the worst effects of climate change that we're headed toward?"

Hegedus was also the first resident of Newark, Delaware, to install solar panels on his home, which is registered with the state as Solar Two, a name chosen in homage to Solar One.

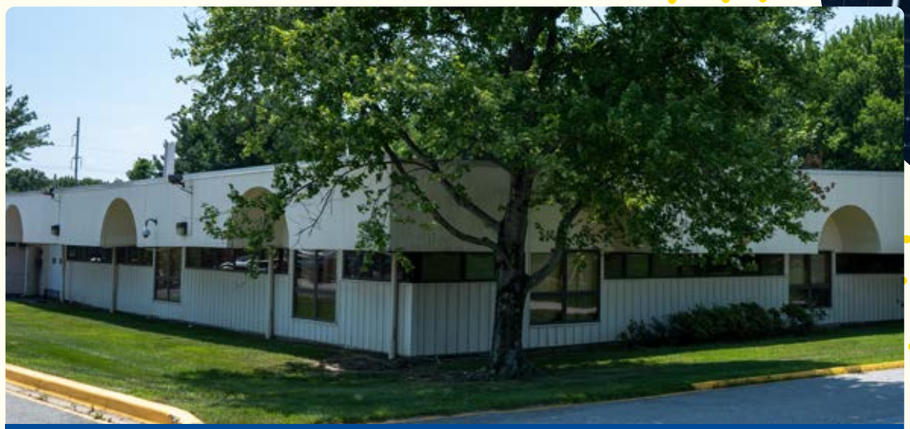
"People had to build and design things by hand," said Hegedus, who has been at IEC for about 40 years. "Even the switches in the house were different from conventional switches. So they designed a house that was intended to be totally powered by the sun and that meant not just the electricity coming from the solar modules on the roof, which — by the way — were made by graduate students here at IEC because there were no commercially available modules at that time. But they also had to store heat in the form of passive heating as well as active heating. They had fluid running through a different type of solar collector on the roof and they would store that heat in big tubs of salt that were in the basement so that the heat could be used at night to heat the building. It also could store cooling during the day and release that cooling at night."

Both Hegedus and Ujjwal Das, associate professor of ECE, are leading efforts to continue the legacy of the IEC. In 2021, the University's first research solar array was installed in a project Hegedus directs. It includes an energy hub and will be important in research related to integrating solar energy into the electricity grid in new ways. Other areas of research include Das' focus on ways to make silicon solar cells better by incorporating thin films to improve performance and reliability with lower cost than conventional manufacturing.

"It's not enough to just focus on the solar module, which had been the focus for maybe the first 35 or 40 years of this," Hegedus said. "We have to look at how we are going to integrate vastly more renewable energy onto the grid, deploying a lot of solar modules and wind power. But how do you do that when we're working with last century's grid?

"Now we have local users who are generating electricity. So you've got a grid where power is flowing in different directions than it used to, generated by people who are not utilities — by homeowners, by business owners, by farmers. And that introduces a whole set of both technology challenges and regulatory and policy challenges. Trying to resolve all of these equitably is where we're at today."

Steven Hegedus is a senior scientist at IEC and a professor of electrical and computer engineering.



The University of Delaware's Institute of Energy Conversion is the world's longest continuously operating solar research facility. It marked its 50th in anniversary 2022.

Solar One was a two-bedroom, 1,300 sq ft house built to demonstrate solar energy's ability to provide both power and heat for a residence and to provide data for further research. Many components – including the solar modules – were built by hand because they were not commercially available in 1973.

William Shafarman is the IEC director and professor of materials science and engineering at UD.

NEW METHODS FOR DETECTING ASTROPHYSICAL SIGNALS

UD's Swati Singh receives National Science Foundation CAREER award to study dark sector

The University of Delaware's Swati Singh was a curious child. If you polled her parents, they probably would recount the numerous times she took apart her toys while trying to understand how they worked. She broke a lot of things for the same reason.

In middle school, Singh realized that she could leverage this inquisitiveness as a scientist, after a pivotal conversation with her dad. She had asked her father how a lightbulb worked. The answer, she said, came down to electrons.

"He said, 'But have you ever seen an electron?' I told him no and he said, 'You just believe it,'" she said of the conversation. "I still haven't seen an electron, but there are reasons that I believe it exists."

Singh, now a UD assistant professor of electrical and computer engineering, is still searching for answers about the unknown. These days she is focused on understanding dark matter and dark energy, the mysterious substances that make up over 95% of the universe but can't be measured using existing devices. Together dark matter and dark energy are known as the dark sector.

It's a fitting field for the curious little girl who became a well-respected quantum physicist and electrical engineer. In her work, Singh has carved a niche for herself by investigating ways to repurpose existing tabletop sensors for dark matter detection.

Now, the National Science Foundation has awarded Singh a five-year, $400,000 Faculty Early Career Development Award (NSF CAREER) to explore new methods for studying the dark sector using additional mechanical devices operating in the classical and quantum realm.

Singh hopes this groundwork will lead to new precision measurement systems to detect astrophysical signals.

STUDYING THE DARK SECTOR

So, a quick primer: ordinary matter includes all things that emit light, such as gas, dust, stars, planets and us. Dark matter comprises everything else — it doesn't emit light, but researchers know it exists by its gravitational effects. Dark energy, meanwhile, is an unknown form of energy/matter present throughout the universe that is responsible for the universe's accelerated expansion.

When normal matter is coupled with dark matter or dark energy, it can manifest in a mechanical effect, such as strains, recoil kicks or accelerations. "Accurately monitoring mechanical motion could give scientists unprecedented access to these minuscule signals," said Singh. She wants to incorporate new results from quantum physics, where recent work is providing interesting possible ways to look for very weak signals.

To begin, Singh plans to address some fundamental questions about the nature of dark matter itself. For instance, instead of swimming in a sea of dark matter as her research had assumed, what if there is a wave of dark matter that passes through at specific times? According to Singh, this would change the resulting signal.

She also plans to use a fiber-based broadband detector to search for dark matter in the infrasonic range, which sits below 20 hertz, the threshold for human hearing. Things that produce sound in this frequency range include earthquakes or volcanoes.

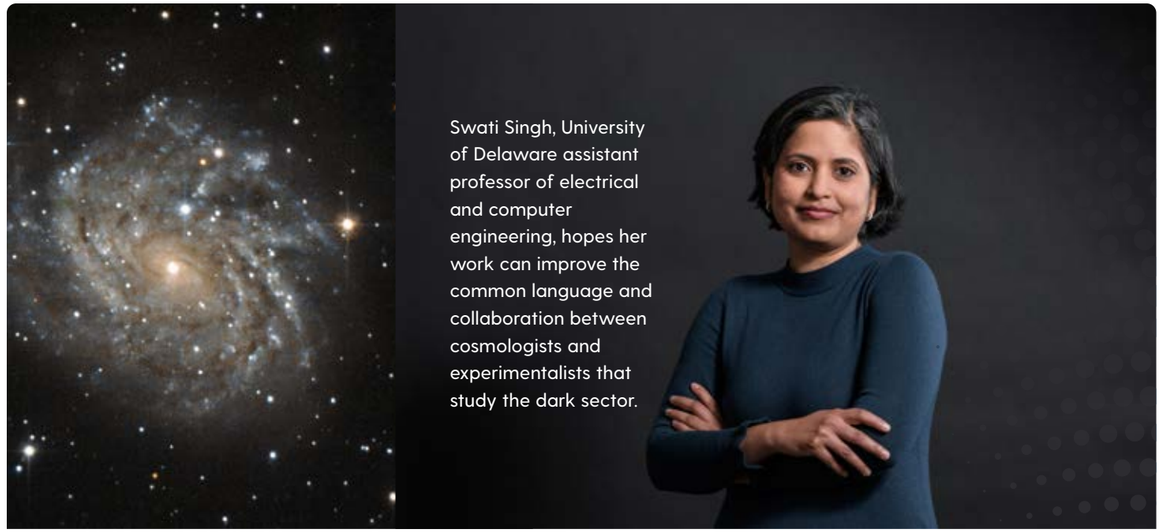
"We plan to take some of the best fiber optic cables, put them in a low-noise environment and use them as a ruler to try and measure small corrections to the length that would occur if dark matter were present," said Singh.

In addition to the dark matter research in her group, she is teaming up with an experimental group in Alberta, Canada, that is building a superfluid helium-based detector for dark matter. The collaborative effort builds off Singh's early work using helium-based detectors to sense gravitational waves. She and doctoral student Jack Manley spent time at the University of Alberta as visiting scholars to learn and contribute to this detection effort through an innovation award from the American Physical Society, funded by the Gordon and Betty Moore Foundation to address pressing problems in fundamental physics.

In another arc of her work, Singh wants to know more about what dark energy could be and why it has no effect on human-made devices.

She explained that the mass of normal matter and dark matter both bend the fabric of spacetime, which we call gravity, similar to the way a stone placed on a piece of cloth would bow the material. In the cosmos, however, the universe is also expanding at the same time. And, observations have shown the fabric of spacetime is doing more than just stretching, it's stretching faster than it has in the past. So, something is hitting the gas.

Singh plans to use spherical microparticles made of silica and membrane-based detectors as sensors to probe what dark energy might be. She said that when scientists look carefully at the force between the sun and Earth, the Earth and moon or two balls in a laboratory, they only see Newton's law of gravity at work pulling these masses together. Meanwhile, research tells us that galaxies are simultaneously expanding away from each other.



Swati Singh, University of Delaware assistant professor of electrical and computer engineering, hopes her work can improve the common language and collaboration between cosmologists and experimentalists that study the dark sector.

This cosmic acceleration is attributed to dark energy. So, why are scientists only able to detect gravity?

One possible explanation, Singh said, is that in the absence of matter, cosmic acceleration dominates. But when matter is present from a galaxy, the solar system or earthly objects such as balls in a laboratory, this acceleration effect is "screened" or masked.

Whether an object's density plays a role in this effect is an open question. For example, what if interstellar dust, which is lightweight, exhibits less of a screening effect than a piece of lead on Earth that has greater density? If correct, this could help explain why researchers would observe cosmic acceleration on the largest scales, but closer to home, where objects from pebbles to planets are denser, this acceleration is screened, leaving only gravity detectable.

INSPIRING CURRENT AND FUTURE PEERS

By helping to put experimental bounds on various connections between the dark sector and normal matter, Singh aspires to stimulate high-energy theory research into new models of dark matter and dark energy. She also hopes the work can inspire improved collaboration and a common language across multiple fields involved in studying the dark sector. To foster this type of collaboration, Singh regularly involves cosmologists and experimentalists in developing ideas that her students are working on.

Additionally, Singh wants to motivate the next generation of scientists, particularly women, to stay curious.

"I don't want to be one of the few people working in this area, so I feel the need to open the door for everyone else, as my mentors did for me," she said.

Singh recently had the rare opportunity to learn about her own influence when former students from disparate areas of her academic life got together to celebrate her NSF CAREER achievement.

"These weren't students in my research lab, they were people I had taught over the years," she said. "It was such a special moment because my research accomplishments were being celebrated by students whom I've only interacted with in a classroom setting."

It's the kind of momentum that Singh wants to keep going. To that end, she regularly interacts with students involved with engineering organizations on campus, such the Society of Women Engineers and Women in Electrical and Computer Engineering, and she plans to collaborate with the College of Engineering's K-12 program on ways to share dark matter and dark energy research with middle- and high-school students as part of her CAREER award. Singh developed a course to help UD students understand quantum computing by developing computer games, too.

"Science is not done in isolation. Instead, advances are often inspired by scientists working at the interface of different fields," Singh said.

UNDERWATER ELECTRICAL ENGINEERING

UD engineers harness the power of artificial intelligence and acoustic engineering to explore underwater worlds

About 125 miles off the New England coast, a small group of researchers from the University of Delaware's College of Engineering are harnessing the power of underwater acoustics, big data and machine learning, to better understand what lies deep beneath the surface.

Just like bottle-nose dolphins and other marine mammals use echolocation to emit pulses of sound to detect objects underwater, so too are these researchers relying on the phenomenon of sound waves and how they reverberate to understand what they cannot see. By using acoustic technologies that can transmit signals and information in a complex aquatic environment, engineers can study the ocean at a much larger scale and finer details than currently possible.

"This remote sensing is similar to using ultrasound for exploring the inside of the human body, except here we use different sound frequencies and we aim to study inside the ocean environment," said Mohsen Badiey, an acoustic oceanographer and electrical engineering professor. "The research we're doing is remote sensing of the properties of the environment from within the water column."

The team, led by Department of Electrical and Computer Engineering's Badiey and Lin Wan, an assistant professor, is measuring underwater sound in order to determine the composition and the physical properties of the ocean environment.

"By emitting sound between two locations and processing the received acoustic signals, while also using artificial intelligence and machine learning algorithms for data analysis, we can determine the properties of the ocean environment remotely," Badiey said.

The data they're collecting can be used to develop machine learning algorithms to show how underwater sounds change over time and across distances, which could in turn help researchers, aided by artificial intelligence, accomplish many objectives such as mapping sediments beneath the ocean floor, long-term monitoring of climate change and assessing the aquatic environments.

They've already extracted valuable information from similar studies in the Arctic, where UD researchers have been capturing the sounds of bearded seals, the largest species of Arctic seals. By analyzing the many different calls of these 600-to-800-pound animals, they have learned that these seals can actually tell us when the Arctic sea ice starts breaking — because they all go completely silent.

"Acoustics can be used to estimate ocean properties," Wan said. "That means people don't have to go to the ocean's deep seabed to collect samples. With acoustics, we'll be able to estimate the number and structure of layers there are, as well as the water column temperature or the sea surface wave roughness."

During the summer of 2022, Badiey, Wan and doctoral students Christian Escobar-Amado and Jhon Castro-Correa went to sea on the Woods Hole Oceanographic Institution's Neil Armstrong research vessel. Their mission was to deploy custom-made devices that capture acoustic data through high-tech arrays designed and fabricated with electronic components from different companies. These devices were placed in water reaching depths of 80 meters (just over 260 feet) along the New England continental shelf. A yellow subsurface buoy in the water was connected to a stringy skeleton of white fabric covered with arrays and connected to underwater sound recorders, called hydrophones, to passively capture sound at different depths. The arrays also include environmental sensors to capture additional information, such as temperature and conductivity of the water.

Escobar-Amado said the opportunity to work on a research vessel provided him a new perspective he didn't expect.

"As an engineer focused on signal processing and machine learning, it was a great experience to go into the field," he said. "I had the chance to experience firsthand how challenging yet rewarding it is to obtain data in such a harsh and large environment as the ocean. With this project, I feel we are making an impactful and meaningful contribution to science."

Meanwhile, undergraduate students involved with this research are learning about the technology of acoustics waves, sensors, environmental measurements and the ocean, while Kenneth Barner, Charles Black Evans Professor of Electrical Engineering, assists with the machine-learning aspects of the work.

"It's really timely to use these kinds of tools along with innovative analysis techniques, like machine learning, to address such complex problems," Barner said. "This is a real collaboration between researchers in physics, engineering, oceanography and applied signal processing. There's a significant interest in achieving a better understanding of how sound propagation in water can be utilized to gain knowledge about our fast-changing environment."

The team from UD was just one among a multi-institutional research group funded by the Office of Naval Research that also includes researchers from six other major universities, the commercial sector and national labs. Observers from other universities also attended this multi-institutional experiment.

"The ocean acoustics team led by professors Badiey and Wan will have a transformative impact in areas such as climate change studies and defense through major breakthroughs in sensing the highly complex ocean environment," said Jamie Phillips, chair of the Department of Electrical and Computer Engineering at UD. "Their work brings together advanced mathematical techniques and sensing systems at the forefront of electrical engineering that result in a major leap in ocean sensing. A unique aspect of this team is that they truly take their work to the next level with real-world experiments at sea, where very few others have the capabilities and expertise."

With the majority of the planet's land mass underwater, Badiey said there is a vast amount of resources and possibilities that have yet to be explored — from food production to extraction of minerals, navigation in shipping, underwater communication and energy.

"We need to develop ways to first learn what is out there, and, second, to explore trying to get them," Badiey said. "Underwater acoustic research can help in various ways to get to both of these."

Their work can also help scientists and decision-makers better understand climate change through remote sensing and how its impact on increasing ocean temperatures will affect future human needs.

For example, over the last decade, technological advances have led to an explosion of engineers developing sensors and networks, similar to those used by cell phones on land.

"Things are quite different down there," Wan said. "In order to develop networks in aquatic environments, we need to know how acoustic waves interact with the ocean, as electromagnetic waves have higher attenuation in the ocean than in air and they cannot propagate as far as acoustic waves in sea water. Ocean acoustic research, including at-sea experimental measurements, state-of-the-art signal processing and machine learning techniques, as well as high-performance-computing based numerical modelings, will promote our knowledge of ocean environments."

Christian Escobar-Amado (left) and Jhon Castro-Correa, doctoral electrical and computer engineering students at the University of Delaware, recover equipment at the end of an experiment off the coast of New England. They collected data to develop machine learning techniques to produce algorithms showing how underwater sounds change over time and across distances.

Acoustic-based measurements have been done for many years, but Badiey, Wan and their team are trying to advance and modernize the field by developing advanced signal processing such as machine learning to complement the existing physics-based techniques to handle faster processing and analysis.

Badiey, a professor of applied marine physics and ocean engineering, brought his background in acoustical oceanography from his time at the University's College of Ocean, Earth and Environment to the College of Engineering, where he's shown how electrical and computer engineering truly can have wide-ranging, real-world applications through the Ocean Acoustics and Engineering Lab.

When Castro-Correa, one of the graduate students working on the project, decided to pursue a doctoral degree in the College of Engineering, he never imagined working on a project at sea.

"This is pretty exciting," he said. "We're able to do several things at the same time: signal processing, machine learning, studying environmental properties affecting our world, biology, design and development of innovative equipment. We're putting those things together and doing great things."

OPTICAL INNOVATIONS

UD Engineering's Tingyi Gu, fellow researchers are creating state-of-the-art computing devices

On the third floor of the University of Delaware's Du Pont Hall, electrical engineers analyze delicate, centimeter-sized computer chips on a large optical table surrounded by oscilloscopes, lenses and lasers. Researchers are busy collecting data on how well these chips can convert light waves into electrical signals. And after that, they'll figure out how to make the next batch of chips even faster, more energy efficient or with increased computing capabilities.

It's here in the lab of Tingyi Gu, an associate professor in the Department of Electrical and Computer Engineering, where researchers are pushing the limits of the field of integrated photonic devices. Gu's research group has made progress in developing new chip designs and applying unique materials for a wide range of optical communication, sensing and computing applications.

LIGHT CONTROL

Photonic devices are ones that can create, control or detect light, and photonic integrated circuits are able to use light for even more complex functions such as data analysis. Gu, who began working in this field as a graduate student, is focused on improving photonic integrated circuits, with a focus on developing new chip designs and studying how materials from other applications could be incorporated into photonic devices.

"For me and my students, we're less likely to read a paper and modify something to show a slightly better advantage. Instead, we try to find something that can be more revolutionary by trying to fundamentally change the way we're doing it," said Gu about her group's research strategy. "This is a higher risk approach, but it's more fun to explore rather than try to repeat what others have done or make some incremental progress."

Two examples of how Gu's research strategy has led to progress in the field of photonics can be found in two of her group's papers from 2022, one published in Nature Communications and the other in Advanced Materials.

SCALING UP

In 2019, Gu and graduate student Zi Wang developed an on-chip transformative optics design principle for robust wavefront control on an integrated photonic platform, which can be used for complicated processes related to other areas such as quantum optics.

Now, the group's latest Nature Communications paper demonstrates how advanced computing capabilities can be integrated directly onto these photonic chips. "In 2019, our device had very simple components, like Fourier transformation. Now, with nearly a thousand pre-programmed elements, the integrated metasystem can handle uncertainties across the spectral domains, which is a milestone of integrated photonic processors to its electronic counterpart," said Gu.

Wang, who is now a postdoc at the National Institute of Standards and Technology (NIST), said that scaling up their original design, which would also make it compatible with manufacturing processes, was the most challenging part of this recent paper. "The structure was designed with a gradient back-propagation method, which cost a lot of time and computing resources in our original design," said Wang. "But I found that our structure has a particular symmetry, and by using the symmetry in mathematical calculation, the computation became much easier."

Thanks to this insight, the researchers discovered that they could use light diffraction to perform complex computations and data analyses. "And because each of the programmable components is much smaller than the conventional chips, you can pack many more in the same chip area," said Gu.

Gu added that this paper is an example of how new design approaches can help researchers use existing fabrication methods to create chips that are more powerful than current state-of-the-art technologies.

MAKING NEW (OPTICAL) MEMORIES

A second paper, published in Advanced Materials, demonstrates how Gu's lab takes inspiration from materials in other applications to evaluate if they could be used for photonic memory, which rely on light instead of magnetism to store information.

Known as optical memristive devices, these platforms for rewritable memory storage have the potential to reduce overall energy consumption but currently rely on a slow process related to changes in the material's phase, or the physical state of the material (the most common being solid, liquid and gas). Phase shifting is how optical devices store memory, but here the phase shifting process requires a transition between an amorphous phase (one that doesn't have much structure, like a pile of sand grains) and a crystalline phase (one that is highly structured, like a close-up of a snowflake).

Creating a phase shifter for photonic integrated circuits that is both compact and controllable has remained a challenge because the materials currently available for optical devices only change phases very slowly and at extremely high temperatures.

In this paper, the group studied indium selenide (In2Se3), a material commonly used in electronic devices but that has not been widely incorporated in optical applications, to see if they could create optical memory by shifting between different crystalline phases instead of between crystalline and amorphous phases.

In this study, lead author Tiantian Li, a former UD postdoc who is now an associate professor at Xi'an University of Posts and Telecommunications, first discovered that the phase transition mechanism for indium selenide was different than originally theorized based on simulated results. The researchers then used these theoretical insights to phase shift between different crystalline states, creating optical memories using short, nanosecond light pulses.

"Optical phase change materials have attracted a lot of interest because of the promising application in optical computing," said Li about the impacts of this work. "The high-power consumption of the phase change material influences the computing speed of the neural network, and our material promises to break this bottleneck."

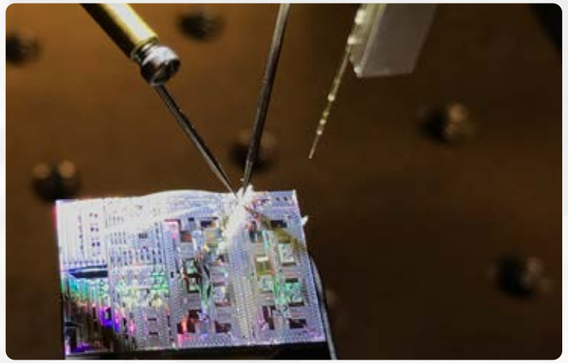
Beyond their applications for the field of photonics, these two papers also showcase the importance of creativity and unique sources of inspiration in this field. "We try to leverage other resources and combine knowledge from different areas," said Gu.

THE FUTURE OF PHOTONICS

Current members of the Gu lab are busy continuing the progress of these and other projects, all with a focus on improving the current state-of-the-art for photonic devices.

This innovative work entails three key yet challenging phases: Simulation, where different chip designs are evaluated using computer software; fabrication, where the actual chips are made at UD's Nanofabrication Facility; and testing, where they bring the chips back to the lab to see how well they perform compared to what was predicted by the simulation.

For Yahui Xiao, a doctoral student working on photonic crystals, doing this type of research, which requires knowledge that stretches from fundamental physics to manufacturing, has provided her with a meaningful graduate school experience, especially since she looks forward to a career doing this type of "hybrid" research in optical engineering and nanophotonics.



Doctoral student Dun Mao, who is working on the indium selenide project, says that while research in this field can be challenging, it's encouraging when they are able to make breakthroughs and get good results. "The most exciting part is when we observe some interesting phenomenon from our experiments that can make a device faster or more efficient," he said.

Gu added that while there are many unanswered research questions in the field of photonics that their group could address, the work in her lab is always driven by her student's interests and passions. "We try to take higher risk approaches in the lab, and sometimes it's good, sometimes it's not as good, but I think students learn a lot," said Gu.

Both Mao and Xiao said that Gu's support has been instrumental to their success in graduate school thus far, and Xiao added that having Gu as a woman mentor in a field that is typically male dominated has been additionally inspiring for her.

The complete list of co-authors on the Nature Communications paper includes UD's Zi Wang, Lorry Chang, Feifan Wang, Tiantian Li (now an associate professor at Xi'an University of Posts and Telecommunications) and Tingyi Gu.

The complete list of co-authors on the Advanced Materials paper includes Chris J. Benmore and Ganesh Sivaraman from Argonne National Laboratory and UD's Tiantian Li (now an associate professor at Xi'an University of Posts and Telecommunications), Yong Wang, Wei Li, Dun Mao, Igor Evangelista, Huadan Xing, Qiu Li, Feifan Wang, Anderson Janotti, Stephanie Law and Tingyi Gu.

IN MEMORIAM
CHASE COTTON

Engineering professor remembered for his unique research perspective, student advocacy and mentoring

Chase Cotton speaking at the ECE senior design lunch in 2016. As the lead instructor of senior design in the department, Dr. Cotton was renowned for his ability to remember and share stories about projects and students from years past.

Chase Cotton, a knowledgeable and passionate researcher, educator and colleague in the University of Delaware College of Engineering's Department of Electrical and Computer Engineering, passed away on Tuesday, March 14, 2023.

After a long career in the communications industry, Dr. Cotton, who earned his Ph.D. in electrical engineering from UD in 1984, joined the ECE department in 2008 as a visiting scholar before becoming a senior scientist and later a professor of practice.

Dr. Cotton was known for his unique perspective on research thanks to his long career in industry, for always advocating in the best interests of students in the department and for being a kind and supportive role model and mentor to students and faculty alike.

"Chase Cotton was truly one of a kind. He was deeply committed to helping his students be successful and, in turn, they revered him. His collegiality, good humor and kindness won him the admiration and respect of just about everyone he met," said Levi Thompson, dean of the College of Engineering and Elizabeth Inez Kelley Professor of Chemical Engineering.

IMPACTFUL RESEARCHER, ENGAGED EDUCATOR

In the mid-1980s, Dr. Cotton began his career at Bellcore (now iconectiv), where he was involved in developing new algorithms and computational methods for telecommunication applications. He worked with carriers worldwide to set up ISPs and was involved with the first large scale commercial DSL deployment for consumer broadband services. While working for Sprint in the 2000s, Dr. Cotton led a team that twice set the Internet 2 Land Speed World Record on a commercial production network.

Dr. Cotton brought his unique perspective to UD in 2008, where his initial focus on networking architecture evolved into a research program that combined cybersecurity and machine learning. Not only did Dr. Cotton broaden the ECE department's expertise in the field of cybersecurity, explained Kenneth Barner, Charles Black Evans Professor of Electrical Engineering, he also expanded the department's educational and training opportunities in the field.

"He was the first true cybersecurity expert we had," said Barner. "His focus on networking, and the security of those networks, grew into what we now consider the field of cybersecurity."

Dr. Cotton was the driver behind the ECE department's first program offerings in cybersecurity and served as the director of the cybersecurity minor and master's programs. He also developed a cybersecurity certificate training program for engineers and scientists at Aberdeen Proving Ground and hosted summer cybersecurity boot camps. Dr. Cotton was also instrumental in developing the Cyber Range, a safe environment for cyber warfare training located in the Evans Hall iSuite.

After joining UD, Dr. Cotton also revitalized ECE's senior design program by consolidating the previous program into a single two-semester course.

"Chase had a tremendous impact on shaping the professional lives of engineers over many decades," said Jamie Phillips, chair of the ECE department. "His vast experience in teaching and industry—and the fact that he was pretty much an expert in almost anything and everything—made him an ideal fit for our senior capstone design course sequence. He was so vested in helping our students succeed in these projects that he could point to prototypes in his office from years ago and talk in great detail about the project, the student team, and the great things they went on to do after graduation."

In 2016, when a team of seniors had the opportunity to send their project to space through the NASA's RockSat-C program, Dr. Cotton traveled with the team. "For him, it was all about supporting our students," said Cyndi McLaughlin, who was previously ECE's business administrator and is now associate director for business operations in UD's Office of Communications and Marketing. "He could easily tell stories about students and their projects, and he always remembered his students by name. He was always there for them."

'MY MENTOR FOR LIFE'

As a teacher, mentor and adviser, Dr. Cotton was known for how much he cared for and believed in his students. To read more from Dr. Cotton's students and colleagues about his impact on their lives and careers, or to share your own remembrance, visit the ECE's in memoriam website.

"Everyone knows Dr. Cotton as a successful researcher, but his students know him as a kind and incredibly compassionate human being," said Ishaani Priyadarshini, who came to UD for the cybersecurity master's program and, after working with Dr. Cotton for her thesis project, decided to stay in his lab for her doctorate. She is now a lecturer at the University of California, Berkeley and credits Dr. Cotton's support as instrumental in achieving her goal of working in academia. "He knew what we were capable of, and he never stopped encouraging us," she added.

Arshiya Khan also came to UD for a master's in cybersecurity and through a shared interest in topics around artificial intelligence and machine learning began working on her Ph.D. with Dr. Cotton. "He wasn't just my Ph.D. adviser—he was my mentor for life," said Khan.

Doctoral candidate Saleh Makkawy said that Dr. Cotton was always welcoming, helpful and generous with his time. "Whenever you would go and talk to him when you were feeling down about something, he would always encourage you," said Makkawy. "He was always there to support and encourage you and he would help you work to achieve your goals. I learned a lot from him."

Michael De Lucia, who works for the U.S. Army Research Laboratory (ARL) at Aberdeen Proving Ground, met Dr. Cotton in 2014 and decided to come to UD for his doctorate, after which he co-taught the Topics in Cybersecurity course with Dr. Cotton on network security applied machine learning. De Lucia said that Dr. Cotton was always a supportive mentor, both as an academic adviser and later as a co-instructor.

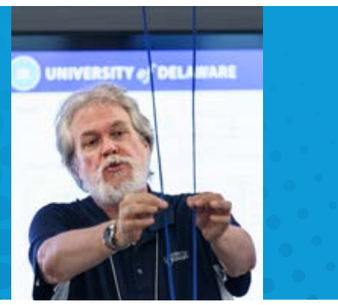
"For my dissertation, he was always someone I could bounce ideas off of and who reinforced that my ideas were good. And while we were teaching together, he showed me different teaching styles, how to make the content interesting, and was also a mentor for me in the classroom," said De Lucia.

A LASTING LEGACY

From the outpouring of stories and memories shared by students, faculty and colleagues since his passing, it's apparent that Dr. Cotton's impact on the UD community is one that will be felt for years to come.

"He was one of the smartest people I knew, but he never made you feel less than," said McLaughlin. "If you wanted to learn, he was happy to teach. That's just who he was, and it's what made him such a great mentor and teacher."

Priyadarshini shared that because Dr. Cotton was such a visionary, some of his students have wondered who would ever be able to continue his incredible legacy. "But a person's legacy can be so many different things," she said. "Dr. Cotton used to say that everyone is smart in academia, and that you should distinguish yourself by being kind. We can all take that from him and keep him alive in our hearts by imparting his lessons into our everyday lives."



ENCOURAGING EQUITY IN FINTECH

Partnership to expand Mobile ID use in banking illustrates innovations underway at the FinTech Innovation Hub

Mobile devices, online banking and payment apps such as Apple Pay or CashApp have decreased the use of paper currency, but what if technology could also help safely and securely verify identities to bring services to the underserved?

That's exactly what the engineering, business and financial technology (also known as fintech) experts at the University of Delaware and the new FinTech Innovation Hub at the University's Science, Technology and Advanced Research (STAR) Campus are hoping to achieve. One of the first examples of the effort is a project now underway to develop a new application for using mobile identification in banking and notary services.

Led by UD's Nektarios Georgios Tsoutsos, an assistant professor in the Department of Electrical and Computer Engineering, the project is a partnership with IDEMIA, the developer of the Delaware Mobile ID app, and supported by funding provided by Discover Bank to The Venture Center, an Arkansas-based entrepreneur support organization. The team aims to utilize about $250,000 in funding to pilot a project with a Wilmington-based credit union to develop a secure way to virtually open a bank account with mobile identification.

"The challenges surrounding financial health are complex, and it will take diverse approaches and talent to have impact," UD Provost Laura Carlson said. "The IDEMIA collaboration brings UD student and faculty expertise to these challenges and represents an incredible model of partnership for the FinTech Innovation Hub and its mission."

In the First State, the Delaware Division of Motor Vehicles is the only entity currently using Mobile ID services, which allow people to use an electronic version of a driver's license through a phone app instead of having a hard copy on hand. Tsoutsos said that by expanding Mobile ID uses to local banking services — such as simply opening up a new bank account beyond normal business hours — they can also expand access and safely simplify the banking process for those who may not otherwise be able to access these resources due to working hours or transportation barriers.

"This type of technology can help provide access to banking for people who may not have had it before and help with notarizing a document for those with limited transportation means or time to travel," said Matthew Parks, vice president for CRA and retail banking at Discover Bank. "That is why we provided funding for the project as well as worked to connect companies in the area in order to work through test cases."

Tsoutsos said while it's possible to open a bank account today from a phone or computer, there are potential security problems. Banks don't always trust the credit report-driven questions and answers — like the prompts that ask a person to pick an address they lived at previously or the make and model of a car they once owned. But they do trust the Division of Motor Vehicles.

"We are proud of the fact that Delaware was one of the first states to pilot and launch Mobile ID," said Jana Simpler, director of the Delaware Division of Motor Vehicles. "We look forward to seeing many positive results from IDEMIA's partnership with the University of Delaware's College of Engineering as they develop a prototype demo web application continuing to expand relying party integrations and provide additional ways for Delaware residents to protect their identity during online transactions."

Tsoutsos, with the help of three doctoral students and one master's student, is building the web application, which would most likely be used on a mobile device but could also be used on a desktop or laptop. The application is complex, he explained, because it must include a lot of cybersecurity and advanced cryptography to ensure the driver's license data is totally safe.

"Everything will have multiple layers of encryption," he said. "Not even us on the server will be able to access this information online."

The application could also be useful in digital exchanges of legal documents, like those used by mobile notary services, Tsoutsos said.

"This project is a great convergence of IDEMIA's industry leading work in digital identity and our work on behalf of financial institutions and payment processors," said Hal Wiediger, senior vice president of client success at IDEMIA Identity & Security. "Delaware should be proud to be an early adopter of this technology while working to improve the customer experience through the development of this prototype. Having use cases that prioritize security and convenience go a long way in growing adoption of [Mobile ID], and we are proud to work alongside the University of Delaware on this exciting project."

The project is also an opportunity to showcase ways that businesses can work with UD to develop various financial technologies, Parks and others said.

"This project is a perfect model of what we're trying to do," said Mike Bowman with the Delaware Technology Park on the STAR Campus. He described the FinTech Innovation Hub as a "trifecta" that is taking the academic excellence in engineering and business from UD faculty and students and applying it to a financial equity problem while engaging corporate partners.

The University, in collaboration with its stakeholders, aims to create a "national center of excellence" focused on financial equity, explained Tracy Shickel, UD's associate vice president of corporate engagement. That means having representatives from industry, government and academia collaboratively working together to seek solutions for complex fintech problems.

"This will be the first of many, many opportunities, particularly between UD faculty and external supporters," she said. "We're trying to move the needle on the nation's financial health crisis, and we've got the talent to do it."

EMERGING FINANCIAL TECHNOLOGY

UD experts in business and engineering explore potential changes in stock market operations

Imagine a world where NFTs are more than an overpriced novelty and the TikTok filters that allow artificial intelligence to generate artsy and colorful backgrounds symbolizing someone's name or birthday are actually key components of future online markets. It might sound hard to believe, but back in the 1990s, an online world of commerce seemed out of reach, too.

Exploring the future potential of high-tech applications such as these are at the heart of a forward-looking journal article co-authored by the University of Delaware's Alfred Lerner College of Business and Economics Dean Bruce Weber and Associate Professor Andy Novocin with the College of Engineering's Department of Electrical and Computer Engineering. The article was recently published in the Journal of Portfolio Management (JPM). The article explores what the future of "disruptive tech" may mean for all corners of business and industry, particularly in the financial realm. This is an example of the interdisciplinary research happening at UD in Fintech on the new technology that seeks to improve and automate the use and delivery of financial services.

The article is titled, **"Emerging Technologies and the Transformation of Exchange Trading Platforms."**

To read the article, visit: www.udel.edu/0010768

DEGREE OF THE FUTURE

Cybersecurity engineering undergraduate program launched at UD in Fall 2022

With digital devices infiltrating nearly every corner of our lives, from the way we communicate to how we bank to how we cast our ballots, making sure those systems are safe and secure has become more important than ever.

In recent years, Americans have witnessed first-hand what happens when safeguards on these digital devices fail. In 2021, hackers side-lined the nation's largest fuel pipeline, bringing a vital supply chain to its knees and highlighting the real threat of cyberattacks.

Cybersecurity, once a niche focus for tech-focused minds, is now a critical part of our everyday lives. Earning cybersecurity certificates or studying the field as a minor will no longer cut it in today's digital age.

To help fill that gap, the University of Delaware's College of Engineering is among the leading academic institutions in the nation to offer a unique cybersecurity engineering degree that started in Fall 2022. The undergraduate degree will help train a much needed workforce that is in high demand now, and is expected to grow in the coming years.

"We are extremely excited to offer the new cybersecurity engineering degree, with a program that is designed to meet a major market and societal need, particularly in Delaware and the region in the financial and defense sectors," said Jamie Phillips, professor and chair of the Department of Electrical and Computer Engineering where the new program will be housed.

A key strength of the program, Phillips said, is the combination of rigorous cybersecurity fundamentals along with the design and problem-solving skills that UD engineers are known for, thanks to the department's design-infused curriculum.

"As a result, our graduates will not only have the important modern-day cyber skills, but also the expertise and mindset to analyze, design and build secure devices and systems," he said.

In October 2021, the White House even emphasized the need for a "whole-of-nation effort to confront cyber threats."

"Cyber threats can affect every American, every business regardless of size, and every community," President Joe Biden, a UD alum, said in a statement issued by the White House. "The Federal government needs the partnership of every American and every American company in these efforts. We must lock our digital doors — by encrypting our data and using multi-factor authentication, for example — and we must build technology securely by design, enabling consumers to understand the risks in the technologies they buy. Because people — from those who build technology to those to deploy technology — are at the heart of our success."

UD's College of Engineering has anticipated this need for years and now is expanding its offerings with this specialized degree offering.

"We're a leader in the game," said Kenneth Barner, Charles Black Evans Professor of Electrical Engineering who, along with Department of Electrical and Computer Engineering Assistant Professor Nektarios Tsoutsos, was a driving force behind the new degree program. While at least two dozen other institutions, such as Purdue University, the University of Texas at Austin and the U.S. Naval Academy, offer cybersecurity degrees, UD will be among the earliest in the nation to offer a cybersecurity engineering program.

"To have a dedicated degree makes the graduates much more well-prepared to hit the ground running with an employer or pursue graduate studies," said Kenneth Barner, Charles Black Evans Professor of Electrical Engineering. "This is not just a fad. These are the kind of skills that employers want and need."

"We've been doing this kind of work for a very long time, and we already have a huge portfolio of programs that add to our expertise in this area," said Tsoutsos. "The cybersecurity threats are real and we need to defend. Before you could do that and get away with an electrical engineering degree and a minor in cybersecurity. Now that doesn't work anymore, and we were among the first to notice that."

Just as computer engineering was a new field in itself only a few decades ago, the new cybersecurity engineering degree will provide a strong foundation that bridges math and science with a design-infused curriculum. Within the Department of Electrical and Computer Engineering as well as the Department of Computer and Information Sciences, students already can pursue a minor in cybersecurity, a master's in cybersecurity or pursue professional certifications. More competitive students can then use their skills to participate year-round in hackathons and cyber games, even at a national level, in large part thanks to the resources available at the on-campus Innovation Suite (iSuite).

"To have a dedicated degree makes the graduates much more well-prepared to hit the ground running with an employer or pursue graduate studies," Barner said. "This is not just a fad. These are the kind of skills that employers want and need."

The engineering focus of this unique program means students will not just tackle theoretical coding challenges. They'll be gaining hands-on skills that are desperately needed in today's industry.

"Cybersecurity is one of the hottest areas in science, technology, engineering and math," said Tsoutsos. "It's not going to die out, and there is a major shortage of skilled labor in this area."

Tsoutsos said that the cybersecurity field is growing by 7% annually, offering stable job security for anyone willing to tackle the problems of the digital age. The United States is a leader in the field, and future students will have an opportunity to be on the forefront of future innovations in cybersecurity.

"I believe that the new cybersecurity engineering program will be wildly successful in attracting a diverse student population, and will meet an ever growing demand for talented professionals in Delaware, the region and beyond," said Phillips.

To learn more or to enroll in this new program, visit: www.udel.edu/0010769.

BLUE HENS CAPTURE THE FLAG

International competitors face cybersecurity challenges in competition designed by UD students

Cybersecurity was front-and-center at the University of Delaware throughout October, culminating with a Capture the Flag (CTF) competition that attracted more than 3,000 participants from at least 17 countries around the world.

The challenges, presented virtually were designed by College of Engineering students and faculty. More than 590 teams, including high school and college students as well as professionals from the United States, the United Kingdom, Germany, India, Singapore and South Korea, tested their skills in detecting and defending against cyberattacks in a variety of digital challenges. Categories for the competition included binary exploitation, cryptography, forensics, reverse engineering, web and Minecraft, for a total of 50 unique challenges that cybersecurity professionals might face.

"CTF is teaching students a cybersecurity mindset and teaching them how to use tools," said Nektarios Georgios Tsoutsos, an assistant professor in the Department of Electrical and Computer Engineering and associate director of the Center for Cybersecurity, Assurance and Privacy. "It's showing them realistic scenarios of what will happen in industry as they become analysts or cybersecurity engineers."

Tsoutsos said the CTF challenges also serve as an aptitude test, highlighting skills or knowledge gaps during the contests.

"Students receive valuable real-world experience through CTF challenges," said Kenneth Barner, UD's Charles Black Evans Professor of Electrical Engineering. "The UD CTF has drawn strong support from our partners and sponsors, and we have participating teams across the globe."

Electrical and computer engineering doctoral student Charles Gouert said the goal of the competition is "to encourage academic students and researchers to explore and develop a passion for cybersecurity as well as allow them to demonstrate and further hone their proficiency in a variety of cybersecurity disciplines, such as cryptography and reverse engineering" at all skill levels.

"At the end of the day, we want everyone who participates to have a great time and develop or hone key cybersecurity skills that will be instrumental in their success in the industry as well as in academia," he said.

Senior computer science Honors student Tyler Werman, who is pursuing a minor and concentration in cybersecurity, joined the Blue Hens CTF student organization his sophomore year and now serves as co-president of the organization. With about two dozen other participating students, he has played a key role in developing and testing some of the challenges on display this year.

When most people hear of capture the flag, they think of the more physical game than the coding contests that are open to all ages and abilities. Being one of the students and faculty designing those contests has given him a different sense of accomplishment than simply participating in the problem-solving competition, he said.

"It's like you step up from being a student to being able to teach the topic," he said. "There's a different level of knowledge that goes into the background of actually creating a problem."

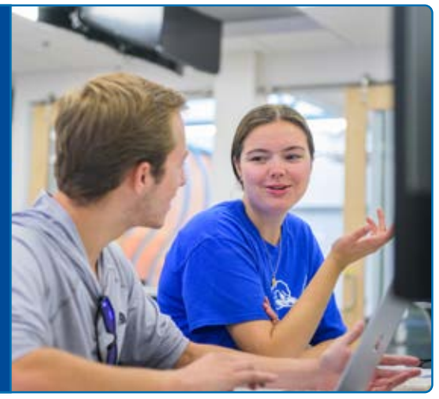
Only U.S.-based teams were eligible for the $500 top prize, which went to team "View Source" from Salem High School. The final team rankings are available at ctftime.org/event/1738/.

"CTFs are by far the best way to train students in the creative problem solving that cyber professionals need," Novocin said. "A cyber incident always feels a bit like an escape room and you have to pull on the thread of curiosity to find out what is really going on."

The event was supported by Diamond-level sponsors JP Morgan Chase & Co. and LabWare and Gold-level sponsor Tech Impact.

"Cybersecurity is strong in Delaware," Tsoutsos said. "Our security is a national priority, and we want to educate our students and the public on how important it is to learn and raise awareness for cybersecurity."

Another way UD aimed to do just that was through a cybersecurity-focused ECE Wednesday Tech Forum, or "WTF!," panel featuring speakers from the Edison Electric Institute, the Krebs Stamos Group, the national blast and Scythe. WTF!, which continued through November, is supported by the Department of Electrical and Computer Engineering and the Center for Cybersecurity, Assurance and Privacy.



Students from the University of Delaware's College of Engineering played a role in designing some of the 50 challenges featured in the second annual Capture the Flag competition.

WEDNESDAY TECH FORUM

WTF! The ECE department's Wednesday Tech Forum (WTF!) are an opportunity for students to grab lunch, network with colleagues and have a chance to hear from alumni and faculty about research, educational and career opportunities. The event takes place on Wednesdays during the fall and spring semesters in the iSuite.
This past academic year, WTF! hosted representatives from Horn, WL Gore, Accenture, APG, Johns Hopkins Applied Physics Lab, Sean's House, AmeriGas Propane, Kickd, Vertically Integrated Projects (VIP), and Futurewei Technologies. Students also learned about ECE clubs, cybersecurity engineering and summer scholars research opportunities.

OUTSTANDING ENGINEER

First-year grad student Andres Ramirez-Jaime earns prestigious Laird Fellowship

Andres Ramirez-Jaime is pursuing a doctorate from the UD's Department of Electrical and Computer Engineering and has earned the 2022 George W. Laird Merit Fellowship.

This versatile graduate student has already accomplished more than many people hope to achieve in their entire careers, and is now eyeing his next grand challenge: helping the National Aeronautics and Space Administration (NASA) better understand the global changes impacting the world's forests.

Ramirez-Jaime, who began his pursuit of a doctorate from the Department of Electrical and Computer Engineering at the beginning of 2022, recently earned the George W. Laird Merit Fellowship, which has recognized outstanding and well-rounded first-year graduate students in the College of Engineering since 1978. The award comes with $25,000 in tuition funding.

Visit UDaily to read the full version of this article.

"Andres embodies the diverse mix of talent, intellect, interests and passion that is needed to address today's technological challenges," said College of Engineering Dean Levi Thompson. "His accomplishments in Colombia and his performance in research and development here at the University of Delaware — plus his extraordinary talents outside of the classroom and lab — give me hope that this upcoming generation of engineers and computer scientists will change the world for the better."

Order of the Engineer Ring Ceremony

The Order of the Engineer ceremony promotes high standards of ethics among engineers. This event provides an opportunity for engineers to publicly accept the noble charge to consider honesty and integrity, always, as you endeavor to contribute technically to the welfare of society.

Held in the historic Mitchell Hall in February 2022, the Order of the Engineer event included representatives from six departments in the College of Engineering and inducted over 100 undergraduate and graduate students. Students receive a stainless steel ring that is traditionally worn on the "working hand" as a sign of their commitment to the profession.

Eta Kappa Nu Honor Society Induction

The Eta Kappa Nu honor society induction dinner was held March 20, 2022 in Perkins Student Center.

IEEE-Eta Kappa Nu (IEEE-HKN), the honor society of IEEE, promotes excellence in the profession and in education with ideals of Scholarship, Character and Attitude.

Founded on October 28, 1904, HKN promotes professional accomplishment, service to others, and leadership development for students and professionals in electrical engineering, computer engineering, and other IEEE fields of interest. With its merger in 2010 with IEEE, the honor society now has over 200,000+ members in more than 250 Chapters around the globe.

PHD DISSERTATIONS

YIKUN BAI
Advisor: Wu
Optimal Transport Meets Information Science: From Measure Concentration, to Information Theory, to Machine Learning

WILLIAM BEARDELL
Advisor: Prather
Spatial-Spectral Imaging with Microwave Photonic Arrays

RUI BIAN
Advisor: Cotton and Wang
Using Stand-Off Observation and Measurement to Understand Aspects of the Global Internet

MARIANO BURICH
Advisor: Garcia-Frias
Non-Linear Mappings for Graph-Based Random Error Correction

VICTORIA CAREY
Advisor: Prather
High Power Photodiodes in Millimeter Wave Photonic Systems

QI CHENG
Advisor: Zeng
Modeling and Simulation of Nano-Scale Transistor

JUAN FLOREZ OSPINA
Advisor: Arce
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