NUCLEAR ENGINEERING NEWSLETTER

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VISIONS FOR THE FUTURE

Our assistant professors advance Purdue's legacy of excellence

MESSAGE FROM THE HEAD

The vibrant autumn foliage reminds us that we have been on campus, in-person, for almost an entire semester. It is a stark reminder of just how far we have come since last November, when we as a nation were amid a global pandemic and political upheaval.

The school's esteemed faculty, both newly joined and seasoned, are becoming leaders of cutting-edge research efforts across the country, including that of advanced reactor technology, nuclear security, cybersecurity, materials degradation, design of nuclear reactor core physics, and the utilization of directed energy for biomedical and defense applications. Our brilliant undergraduate and graduate students have also been hard at work, receiving many competitive academic and research awards that will not only help them fund their studies but gain invaluable hands-on experience. Likewise, I am happy to report that since last year our total student enrollment has increased from 142 to 162 and all of our graduate students are 100% financially supported.

Our school has sought out to be on the forefront of initiatives to address systemic inequities that affect the areas of policy, education, and research in nuclear engineering and science. Dr. Lefteri Tsoukalas and I represented the School at the Global Forum on Nuclear Education, Science, Technology and Policy's Advisory Group formed by the Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA). As one of a handful of universities invited to join among 13 other countries, we are proud to lead the Working Area of achieving gender equity in the nuclear engineering and technology and academic workforces.

While noting these high points, I recognize that we have all struggled in one way or another during this past year. Though, every day I see a renewed vitality and excitement among our students, staff, and faculty that I have not witnessed in some time. In the immortal words of William Butler Yeats, "Education is not the filling of a pail, but the lighting of a fire." That, more than anything, ensures me of a flourishing future for our school. I wish you a safe and enjoyable holiday!

Hail Purdue and Boiler Up!

Seungjin Kim
Capt. James F. McCarthy, Jr. and Cheryl E. McCarthy Head and Professor
School of Nuclear Engineering

TABLE OF CONTENTS

ON THE COVER

Purdue NE assistant professors: Stylianos Chatzidakis, Yunlin Xu, and Yi Xie (from left to right) stand in front of NE's new home, the Gateway Complex.

Photo by Vincent Walter.

TO MAKE A GIFT TO THE SCHOOL OF NUCLEAR ENGINEERING

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NEW FACULTY MEMBER:

STYLIANOS CHATZIDAKIS

Stylianos Chatzidakis joined the School of Nuclear Engineering faculty as assistant professor in January 2021.

As an alumnus, he earned his Ph.D. in nuclear engineering from Purdue in 2016. He holds a Dipl. Eng. in mechanical engineering (2006) from the National Technical University of Athens, Greece, and an MSc. in energy physics (2007) from the Grenoble Institute of Technology, France.

Stylianos' research interests focus on the development of next-generation radiation imaging and nuclear sensing technologies to address challenges associated with nuclear nonproliferation, digital instrumentation and control, advanced reactor monitoring, and the long-term safety and security of the nation's spent nuclear fuel.

Asst. Prof. Stylianos Chatzidakis

"My goal is to exploit recent advances in quantum computing, 3D printing, and scientific machine learning. This will improve our fundamental understanding on particle-matter interactions and develop tunable radiation sources and radiation-resistant sensors to accelerate safe deployment of advanced nuclear reactors, and at the same time, secure nuclear materials from unauthorized use that may pose a threat to national security," Chatzidakis said.

He is finishing up his work at Oak Ridge National Laboratory (ORNL), where he has been an R&D staff member and Weinberg Distinguished Fellow since 2016. While there, he contributed to several research projects and provided R&D support to Department of Energy (DoE) spent fuel management programs.

Stylianos is looking forward to beginning his higher education teaching career "and having the unique opportunity to work together with exceptional Purdue students and internationally renowned faculty and staff on high-risk/high-reward research projects on nuclear energy and beyond."

Source:
https://bit.ly/3pT1xIF

Note: SNE welcomed Chatzidakis in January 2021. He has since finished his work at ORNL.The original article has been edited to reflect present updates.

FEATURED FACULTY PROFILE:

YI XIE

Yi Xie, assistant professor at the School of Nuclear Engineering (SNE), wants to be recognized as the faculty member students can approach if they are interested in the study of nuclear materials. She believes that it is a research area that has great, innovative potential.

This belief complements her enduring research vision: She wants to make nuclear applications safer and more sustainable, and reduce the costs of manufacturing through her mapped research objectives.

Asst. Prof. Yi Xie

Xie earned her bachelor's degree in nuclear engineering from the University of Science and Technology of China and later her Ph.D. at The Ohio State University in nuclear engineering. Before joining Purdue University in June 2020, she had several research appointments at Idaho National Laboratory (INL) where she was a research staff and the inaugural Glenn T. Seaborg Distinguished Postdoctoral Research Associate, and at Virginia Tech where she was a postdoctoral research associate.

There, she participated in multiple projects which eventually helped her develop the three areas that she considers now to be her primary expertise: the manufacturing of novel materials in extreme environment applications, high-throughput screen technologies to accelerate materials discovery, and the fundamental understanding of materials degradation.

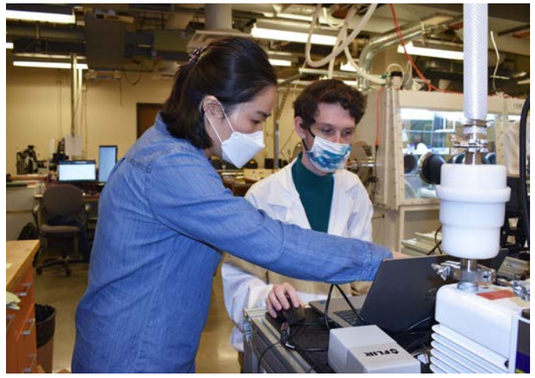
Finding these topics endlessly fascinating, Xie feels fortunate that she is able to expand her research in these areas as a recently-joined professor. The school has "a free and friendly environment that allows us to explore innovative ideas and translate them into conceptual progress and industrial applications," she says. This was her initial motivation to join the department.

Her research lab, called Materials Innovation in Nuclear Energy (MINE), is home to a research team made up of both undergraduate and graduate students.

Xie's lab has a 2000 sq. ft space for crucial research components such as materials synthesis and processing, ultrafast sintering, infrared camera, a Raise3D printer, an 8-glove glovebox, an electrochemical testing station, a metallurgical preparation station, and a creep- testing system, which is currently in development. Here, her team is developing molten salt and molten metal loops, and a directed-energy deposition technique in collaboration with SNE colleagues.

Xie's research is mainly project-based, and she seeks to apply experimental mechanisms. She says, "There's always an open question: Is there any better material that has not been created or can we modify the current materials through processing, additives, and coating?"

To achieve this feat, she explains that her team needs to develop the right manufacturing technology using advanced manufacturing techniques. In truth, her team is one step closer to this.



Xie works with grad. student Logan Joyce during a MINE lab meeting

Xie's team has designed and developed a high-temperature ultra-fast (HTUF) sintering system for the manufacturing of novel alloys and ceramics, including structure materials and nuclear fuels. HTUF is a cutting-edge sintering technique incorporating a unique configuration for extraordinary heating parameters and minimal surface contamination.

This configuration makes the sintering efficiency much higher than that of conventional ones, indeed this type of rapid sintering process ensures the minimal surface contamination by the die, which retains the integrity and function of materials particularly for multi-layered and coating materials.

The rapid sintering process also minimizes the loss of volatiles, which is beneficial for elements of high vapor pressure. In fact, the work temperature profile is tunable and can work from room temperature to 3000 K, and the system can produce multiple samples at a time. The HTUF technique exhibits the fascinating potential of overcoming processing limitations and producing advanced materials.

Xie's team will continue to explore its post-process capabilities on additively manufactured alloys and heat-treatment capabilities on solid oxide fuel cells through a promising joint effort with INL, among other integral partners.

Essentially, her research hinges on materials. Xie explains, "In the nuclear engineering field, we're always seeking advanced materials used in different scenarios, because the working environments are always harsh and varied depending on the components and reactor types." She continues, "We need materials that are very reliable, corrosion-resistant, radiation-resistant, and that have excellent thermal-mechanical properties." This is the ideal material for such nuclear applications.

Her additional research activities include the characterization of corrosion resistance of nuclear materials through electrochemical techniques and microstructural characterization (SEM, TEM, and XRD). These projects revolve around the corrosion and degradation of materials in nuclear applications, specifically concerning the waste containment and disposal, which impacts the safe storage of used nuclear fuels.

Xie also uses electrochemical techniques to study the corrosion of additively manufactured alloys and investigates how they behave in solutions and molten salt and molten metal environments.

She remains curious about the design and development of experiment infrastructures; she desires to simulate the reactor coolant environment to make the material endure corrosion and stress corrosion cracking. She remains curious about the design and development of experiment infrastructures; she desires to simulate the reactor coolant environment to make the material endure corrosion and stress corrosion cracking.

As an expert in these nuclear engineering areas and one of the few faculty members specializing in these research topics, she desires to lead a team organized by her "smart graduate and undergraduate students" to gradually become world-renowned for this expertise. Xie wants them to be "recognized as the team doing nuclear materials research" and for them to have substantial capabilities in research topics from "manufacturing to material behavior testing."

Grad. student Brian Bettes works on his research in the MINE lab

To reach this goal, she outlines ongoing projects that will help her and her team reach those goals. Her MINE lab is growing – she wants to continue to recruit more graduate students and hopes that there are more opportunities for this.

She aspires to attract more students in SNE who are interested in her engineering applications and technology expertise, and are motivated to do the related research. Xie hopes to offer them the vital experience of discovering what research truly is and the invaluable means to conduct experiments and simulations.

Part of her research vision is also to increase the recruitment of female students, in particular. As the only female faculty member at SNE, Xie says, "I highly encourage our female students, including graduate students and undergraduates, to join the academic field of nuclear materials. There are a lot of good opportunities – a brighter future." During her first year at SNE, she has had three female undergraduate students, one of which has already graduated.

Xie's ambitions are an integral part of her overarching plan to help students recognize the importance of these research areas and provide them with another opportunity of study within this vast field.

For more info about Xie's research, visit here: https://bit.ly/2XTFidg

FEATURED FACULTY PROFILE:

YUNLIN XU

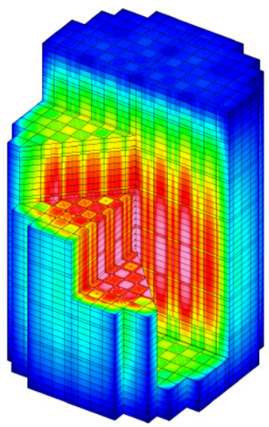
An expert in nuclear reactor core physics simulation and design, Yunlin Xu, assistant professor at the School of Nuclear Engineering (SNE), will complete three years as a faculty member at Purdue, this fall. Since joining, his research vision has expanded; with the use of PUR-1, he aims to “translate his theoretical reactor research into advance reactor simulator,” he says.

Asst. Prof. Yunlin Xu

Prior to Purdue, Xu’s research was largely focused on developing simulation methods, and applying simulation codes for reactor design and safety analysis.

Indeed, his background with nuclear reactors is extensive. He was an Adjunct Professor at the University of Michigan, Ann Arbor, and Research Staff at Argonne National Laboratory. Xu is also a former Assistant Professor of Tsinghua University and Beijing, China and the Paul Scherrer Institut in Villigen, Switzerland. In all of these roles, he developed his expertise in reactor design and safety analysis.

Xu has designed several nuclear reactors from the ground up throughout his career as a seasoned nuclear engineer. One of the reactors he has designed, the 10MW high temperature gas-cooled pebble bed reactor (HTR-10), which is one of Generation IV reactor, has been operating for more than 20 years



Power distribution from a high fidelity simulation

In addition, Xu was involved in the creation of some of the most advance reactor simulation codes such as MPACT code which was developed by the U.S. Department of Energy (DOE), as well as US Nuclear Regulatory Commission (US NRC) system codes TRACE and RELAP. The purpose of these codes is to predict reactor core behavior under regular operation as well as accident conditions. At NE, Xu is a major developer of the Purdue Advance Reactor Core Simulator (PARCS) code which is adapted by US Nuclear Regulatory Commission (NRC). This regulation code has been used by more than 30 countries.

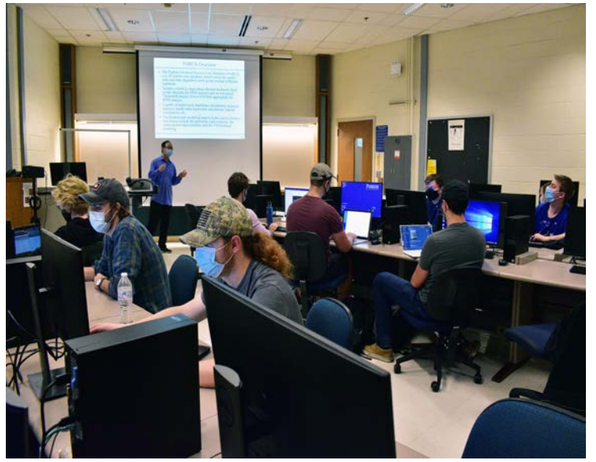
Xu has a framework for nuclear reactor core physics simulations, which engages research, at his Nuclear Reactor Design & Simulation Laboratory, in collaboration with his graduate students and partnerships with external organizations.

He also has distinct research goals, which align with this framework. They include improving the accuracy and efficiency of nuclear reactor simulation codes and to develop a new code which can be used for new types of nuclear reactor design and analysis with greater accuracy.

His team is made up of graduate and undergraduate students including True Miller, Shunjiang Tao, Oscar Lastres, and Rizki Oktavian. They are currently working on new code developments and applications. Xu enjoys working with students. He says, “The kids are full of energy, plenty of ideas and eager to try them out. It is a real pleasure to see young students grow from beginners to experts themselves with help of my guidance.”

He explains, “Since I joined Purdue, I have started my research group, working on several codes and method development. I am keeping in collaboration with the US NRC for PARCS code maintenance and new capability developments, such as development of fast reactor simulation capability with PARCS.” He continues, “I also had collaborations with national laboratories and industrial companies as well as international collaborations to get me to my research goals.”

Crucial to his research is the use of PUR-1, which Xu plans to incorporate more. For example, he recently supervised one of his graduate students in the study of the production of the radioactive isotope, Lutetium-177, which requires both simulations and experiments to verify predictions. Further, he has designed and led the experiment of calibrating PUR-1 power levels with electrical heats. This experiment together with numerical simulations provide a reliable method for small experimental reactor power calibration and will have great impact on safety of experimental reactors.



Xu teaches NUCL 497: Simulation of Nuclear Reactor Physics using Nuclear Codes

For more info about Xu’s research, visit here: https://bit.ly/3CkDitz

Xu plans to convert his recent theory developments into practical tools that can be used in advance nuclear reactors design and simulation, and have a great impact on existing reactor operations and new reactor developments.

He and his team have already developed a set of simulation codes: Purdue Advance Nuclear Design and Analysis System (PANDAS). With continued collaboration from the NRC, national laboratories and international institutes, and potential support of the DOE NEUP program, Xu is confident his goal will be achieved in a few years.

FEATURED FACULTY PROFILE:

STYLIANOS CHATZIDAKIS

As the newest member of the School of Nuclear Engineering's (SNE) faculty, assistant professor Stylianos Chatzidakis has a clear vision for the future of his research group: To use all of the resources that "this great university has," he says, to achieve academic excellence in nuclear security, nuclear sensors, radiation imaging, and cybersecurity. He is confident that this vision can become a reality.

Asst. Prof. Stylianos Chatzidakis

Chatzidakis received his MSc in energy physics from the Institut National Polytechnique de Grenoble (INPG) in France, and his diploma in mechanical engineering from the National Technical University of Athens in Greece. He later attended Purdue University, receiving his Ph.D. in nuclear engineering. Transitioning from a graduate student to a faculty member has been "surreal" for him, he says.

He joined the department as a faculty member in January 2021. In addition to his faculty status, he is currently the Associate Reactor Director of PUR-1 and the Director of the Nuclear Engineering Radiation Lab. Before coming to Purdue, he was R&D Staff and a Weinberg Distinguished Fellow within the Reactor and Nuclear Systems Division at Oak Ridge National Laboratory (ORNL). There, he was awarded research funding to develop remote remediation and non-destructive assay technologies to address challenges associated with the safety and security of the country's spent nuclear fuel. Naturally, his varied professional background has strengthened his current research areas.

Chatzidakis' research laboratory is called RADIaNS, which stands for Radiation Imaging and Nuclear Sensing. His ten-person team is made up of graduate and undergraduate students. The students are conducting research using state-of-the-art equipment and performing numerous hands-on experiments and simulations. For Chatzidakis, working with students is one of his favorite parts of his role as a professor. He says, "That's the exciting part, right, working with the students. You know, you get all of this energy from the students, their excitement. They have great ideas. That's what I like most."

Chatzidakis is not short of energy, either. He and his team of students are currently tackling several research projects, working in collaboration with well-known entities in the field such as the Electric Power Research Institute, ORNL, Pacific Northwest National Lab, Idaho National Lab, the Nuclear Naval Lab, the University of Manchester in the United Kingdom, and McMaster University in Canada.

One of these collaborations include that of imaging and muon tomography, topics that are vital to the nuclear security field.

Chatzidakis explains that a muon is a particle that comes naturally from the sky; they have extremely high energy levels. His team is trying to use these particles, formally referred to as cosmic ray muons, in the same manner as x-rays. Essentially, in cases when x-rays cannot be used, particularly when trying to see through very dense objects, they would use muon tomography.

The practical application of this technology is crucial to nuclear security. For example, in cases of national security, if individuals are trying to smuggle nuclear materials like uranium, plutonium, or nuclear fuel in cargo containers, they would be able to use cosmic ray muon particles to scan for these materials. This technology can also be used for scanning spent fuel canisters, pyramids to identify hidden chambers, or magma density in volcanoes.

Chatzidakis says that his team is working in this research area by developing tomographic reconstruction algorithms and muon spectrometers, which would help them in accelerating the use of this very promising technology in the field.

They are also working on developing new x-ray sources and radiation sources, and improving what already exists, including tunable x-rays, or x-rays that contain energy that can be tuned depending on the real-life applications, such as nuclear nonproliferation and medical diagnosis. "Currently it's not that easy to tune x-rays," he says, because you have to use expensive facilities and accelerators to do so. The team hopes to utilize nanotechnology and radiation transport-simulations, jointly with the Purdue Birck Nanotechnology Center, in this effort.

Chatzidakis, grad. student Junghyun Bae help a student in NUCL 305: Nuclear Undergrad. Lab II

As Associate Reactor Director of PUR-1 and Director of the NE Radiation Laboratory, Chatzidakis facilitates education, research, and industry use of the reactor, with assistance from True Miller, Reactor Supervisor and Nuclear Engineering Radiation Laboratory Coordinator. This accommodates external companies that want to see how their industrial equipment behaves under radiation. These types of partnerships are essential to the school because they provide opportunities for growth and exposure, two facets that Chatzidakis hopes to expand within the next year.

Along with his work at PUR-1, his research continues to advance. Earlier this year, Chatzidakis received a competitive research award from the Nuclear Energy University Program (NEUP) through the U.S. Department of Energy (DOE). Given by the Office of Nuclear Energy, these competitively awarded grants support groundbreaking, innovative nuclear research being conducted at U.S. universities. This involves research and development (R&D), infrastructure enhancement, and the aid of student education.

This joint effort will enable access to unique technical expertise and resources including prototypic quantum equipment and the experts who built it. Chatzidakis explains, “Through our unique combination of expertise and facilities, our team will, for the first time, apply quantum technology to the critical application space of advanced nuclear systems to seal up the vulnerabilities currently provided to attackers.”

With this award, Chatzidakis also hopes to develop the next generation of nuclear engineers, and support a minimum of three Ph.D. dissertations. He intends for participating doctoral students to be an integral part of his team. As a part of this project, he and his team are building a cybersecurity testbed. In effect, they are trying to simulate microreactor operations. Microreactors are expected to be installed in remote areas around the world and controlled remotely and semi-autonomously. This may bring unique cybersecurity challenges. Using PUR-1, which has a digital I&C, or instrumentation and control, the cybersecurity testbed will simulate microreactor operations and test for potential cybersecurity issues.

Chatzidakis’ final research undertaking, presently, concerns the development of nuclear sensors. At his research lab at Purdue’s AA Potter Engineering Center, he and his team are creating compact sensors that can withstand higher levels of radiation. With these sensors, they will be able to monitor various types of critical parameters, including temperature, pressure, and radiation. Nuclear sensors like these would be ideal for remote monitoring of nuclear fuel cycle processes and would help track key materials.

Undoubtedly, Chatzidakis and his team are on a thriving path towards his research vision, and it is his hindsight as an alumnus that helps him stay focused on his overall goal. He explains, “I wasn’t expecting that I’d be faculty at Purdue where I graduated. When I was a student, I had a lot of respect for the university and the professors. I definitely had the best time here. I learned a lot of things during my Ph.D.” He continues, “It’s like a dream come true. It’s amazing, it’s amazing to me that I’m a part of this team. I’m working with the professors that once used to teach me.” Within a year, Chatzidakis wants to make strides toward the DOE NEUP cybersecurity testbed – he would like to start getting simulation results, publish his findings, and interact with their sponsors. He also aims to build a muon tomography detector and a compact tunable x-ray source, which he hopes will make a positive impact and receive more funding when he and his team present it to their sponsors.

The reactor is also at the forefront of his goals, as he desires to initiate more student training, industry usage, and research. Towards this, he and Miller are in the process of getting their reactor operating licenses. “It’s still early on,” he says and continues, “It’s only been ten months. But, we have made a lot of progress and we have a good plan. We have a good team with very bright students and Dr. Kim, the department head, and the department’s professors have been very supportive. And I’m really happy with the way things are going. I’m really excited.”

For more info about Chatzidakis’ research, visit here: https://bit.ly/3bg4my1

Graphic: https://bit.ly/3ku3ZF1

FACULTY RESEARCH SPOTLIGHT:

ALLEN GARNER ELECTED TO REPRESENT NAVAL SURFACE TECHNOLOGY INNOVATION CONSORTIUM

Allen Garner, Associate Professor at the School of Nuclear Engineering (NE), was elected as the Academic Representative for the Naval Surface Technology Innovation Consortium (NSTIC) Executive Committee. He will serve for a three-year term from October 1, 2021 to September 30, 2024.

Assoc. Prof. Allen Garner

The NSTIC advances naval surface technology innovation through a consortium that researches, develops, tests and integrates complex naval warfare systems across a broad range of technology fields and disciplines.

Garner said, “I look forward to this opportunity to represent the interests of our university members on this committee. I am also excited to provide additional insight to the NSTIC based on my experience in submarines, shipyards, ship construction and research and development throughout my career as a Naval officer.”

The consortium enables rapid research, access to innovative commercial solutions for defense requirements and innovations from industry, academia and non-traditional companies that frequently participate in federal research and development (R&D).

In addition, the NSTIC offers federally-funded research and business opportunities for companies of varying sizes and academia, particularly newer and small-scale companies that do not commonly work with government entities.

Garner’s research expertise includes biomedical applications of pulsed power and plasmas, high power microwaves and theoretical biophysics. He is the Undergraduate Program Chairman at NE, and holds Courtesy Appointments in Electrical and Computer Engineering (ECE) and Agricultural & Biological Engineering (ABE).

Source:
https://bit.ly/2Zq9YTF

FACULTY RESEARCH SPOTLIGHT:

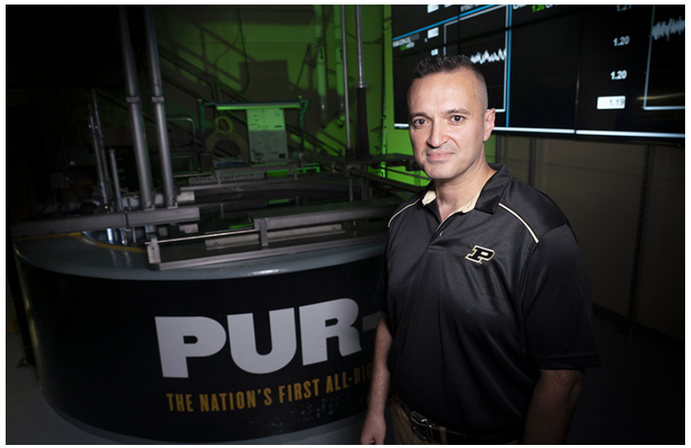
HANY ABDEL-KHALIK CREATES 'SELF-AWARE' ALGORITHM TO WARD OFF HACKING ATTEMPTS

WEST LAFAYETTE, Ind. — It sounds like a scene from a spy thriller. An attacker gets through the IT defenses of a nuclear power plant and feeds it fake, realistic data, tricking its computer systems and personnel into thinking operations are normal. The attacker then disrupts the function of key plant machinery, causing it to misperform or break down. By the time system operators realize they've been duped, it's too late, with catastrophic results.

The scenario isn't fictional; it happened in 2010, when the Stuxnet virus was used to damage nuclear centrifuges in Iran. And as ransomware and other cyberattacks around the world increase, system operators worry more about these sophisticated "false data injection" strikes.

In the wrong hands, the computer models and data analytics – based on artificial intelligence – that ensure smooth operation of today's electric grids, manufacturing facilities, and power plants could be turned against themselves.

Purdue University's Hany Abdel-Khalik has come up with a powerful response: to make the computer models that run these cyberphysical systems both self-aware and self-healing. Using the background noise within these systems' data streams, Abdel-Khalik and his students embed invisible, ever-changing, one-time-use signals that turn passive components into active watchers.



Assoc. Prof. Hany Abdel-Khalik (Purdue University photo/Vincent Walter)

Even if an attacker is armed with a perfect duplicate of a system's model, any attempt to introduce falsified data will be immediately detected and rejected by the system itself, requiring no human response.

"We call it covert cognizance," said Abdel-Khalik, an associate professor of nuclear engineering and researcher with Purdue's Center for Education and Research in Information Assurance and Security (CERIAS).

"Imagine having a bunch of bees hovering around you. Once you move a little bit, the whole network of bees responds, so it has that butterfly effect. Here, if someone sticks their finger in the data, the whole system will know that there was an intrusion, and it will be able to correct the modified data."

Trust through self-awareness

Abdel-Khalik will be the first to say that he is a nuclear engineer, not a computer scientist. But today, critical infrastructure systems in energy, water, and manufacturing all use advanced computational techniques, including machine learning, predictive analytics, and artificial intelligence. Employees use these models to monitor readings from their machinery and verify that they are within normal ranges. From studying the efficiency of reactor systems and how they respond to equipment failures and other disruptions, Abdel-Khalik grew familiar with the "digital twins" employed by these facilities: duplicate simulations of data-monitoring models that help system operators determine when true errors arise.

But gradually he became interested in intentional, rather than accidental, failures, particularly what could happen when a malicious attacker has a digital twin of their own to work with. It's not a far-fetched situation, as the simulators used to control nuclear reactors and other critical infrastructure can be easily acquired. There's also the perennial risk that someone inside a system, with access to the control model and its digital twin, could attempt a sneak attack.

"Traditionally, your defense is as good as your knowledge of the model. If they know your model pretty well, then your defense can be breached," said Yeni Li, a recent graduate from the group, whose Ph.D. research focused on the detection of such attacks using model-based methods.

Abdel-Khalik said, "Any type of system right now that is based on the control looking at information and making a decision is vulnerable to these types of attacks. If you have access to the data, and then you change the information, then whoever's making the decision is going to be basing their decision on fake data."

To thwart this strategy, Abdel-Khalik and Arvind Sundaram, a third-year graduate student in nuclear engineering, found a way to hide signals in the unobservable "noise space" of the system. Control models juggle thousands of different data variables, but only a fraction of them are actually used in the core calculations that affect the model's outputs and predictions.

By slightly altering these nonessential variables, their algorithm produces a signal so that individual components of a system can verify the authenticity of the data coming in and react accordingly.

“When you have components that are loosely coupled with each other, the system really isn’t aware of the other components or even of itself,” Sundaram said.

“It just responds to its inputs. When you’re making it self-aware, you build an anomaly detection model within itself. If something is wrong, it needs to not just detect that, but also operate in a way that doesn’t respect the malicious input that’s come in.”

For added security, these signals are generated by the random noise of the system hardware, for example, fluctuations in temperature or power consumption.

An attacker holding a digital twin of a facility’s model could not anticipate or re-create these perpetually shifting data signatures, and even someone with internal access would not be able to crack the code.

“Anytime you develop a security solution, you can trust it, but you still have to give somebody the keys,” Abdel-Khalik said. “If that person turns on you, then all bets are off. Here, we’re saying that the added perturbations are based on the noise of the system itself. So there’s no way I would know what the noise of the system is, even as an insider. It’s being recorded automatically and added to the signal.”

Though the papers published by the team members so far have focused on using their paradigm in nuclear reactors, the researchers see potential for applications across industries — any system that uses a control loop and sensors, Sundaram said. The same methods could be used also for objectives beyond cybersecurity, such as self-healing anomaly detection that could prevent costly shutdowns, and a new form of cryptography that would enable the secure sharing of data from critical systems with outside researchers.

Cyber gets physical

As nuclear engineers, Abdel-Khalik and Sundaram benefit from the expertise and resources of CERIAS to find entry points into the worlds of cybersecurity and computer science. Abdel-Khalik credits Elisa Bertino, the Samuel D. Conte Professor of Computer Science and CERIAS research director, with the original spark that led to creating the covert cognizance algorithm, and thanks the center for exposing him to new partnerships and opportunities.

Founded in 1998, CERIAS is one of the oldest and largest research centers in the world concentrating on cybersecurity. Its mission, says managing director Joel Rasmus, has always been interdisciplinary, and today the center works with researchers from 18 departments and eight colleges at Purdue. Abdel-Khalik’s research is a perfect example of this diverse network.

“When most people think about cybersecurity, they only think about computer science,” Rasmus said.

“Here’s a nuclear engineering faculty member who’s doing unbelievably great cyber and cyberphysical security work. We’ve been able to link him with computer scientists at Purdue who understand this problem, but yet don’t understand anything about nuclear engineering or the power grid, so they’re able to collaborate with him.”

Abdel-Khalik and Sundaram have begun to explore the commercial possibilities of covert cognizance through a startup company. That startup, Covert Defenses LLC, has recently engaged with Entanglement Inc., an early-stage deep tech company, to develop a go-to-market strategy.

In parallel, the team will be working to develop a software toolkit that can be integrated with the cyberphysical test beds at CERIAS and the Pacific Northwest National Laboratory, where sensors and actuators coupled to software provide a simulation of large-scale industrial systems.

“We can provide additional applications for the technologies that he’s developing, since this is an idea that can help nearly every cyberphysical domain, such as advanced manufacturing or transportation,” Rasmus said. “We want to make sure that the research that we’re doing actually helps move the world forward, that it helps solve actual real-world problems.”

Cybersecurity is a critical topic under Purdue’s Next Moves, the ongoing strategic initiatives that will advance the university’s competitive advantage. Purdue’s cybersecurity research and educational initiatives are centered under CERIAS, which includes 135 affiliated faculty members.

Assoc. Prof. Hany Abdel-Khalik (center), Arvind Sundaram (left), third-year nuclear engineering Ph.D. student, and Yeni Li (right), nuclear engineering postdoctoral associate (Purdue University/Vincent Walter photo)

Source: https://bit.ly/3jqjjC0

Graphic: https://www.cerias.purdue.edu

Note: This story was originally published by Purdue University College of Engineering News on October 7, 2021.

NE NEWS

SNE TO LEAD NEW COLLEGE CENTER: THE CENTER FOR INTELLIGENT ENERGY SYSTEMS (CiENS)

The Purdue School of Nuclear Engineering (SNE) will lead an exciting new initiative to establish a Purdue College of Engineering-wide center called the Center for Intelligent Energy Systems (CiENS).

Led by Lefteri Tsoukalas, professor of nuclear engineering, the interdisciplinary center of excellence will provide research, educational programs, and facilities to develop and deploy advanced concepts, techniques, and methodologies for large energy systems at various scales. These methodologies include artificial intelligence, neural networks, learning systems, and fuzzy knowledge-based systems. Tsoukalas will be the center's director.

Prof. Lefteri Tsoukalas

For decades, the physical sciences and technology have dominated our approach to all problems. However, it has become gradually clear that each new technology, taken in isolation, often creates its own set of new problems. Only recently have we come to recognize the role of artificial intelligence (AI) in managing sophisticated technologies such as the operation of power generating plants, high performance aircrafts, spacecrafts, chemical and refining facilities, and various manufacturing processes.

"SMART ENERGY FOR A SMARTER WORLD"

Automation on a small scale with limited objectives, such as check processing in banks, holographic grocery store checkout stations, and automatic pilots in commercial aircraft, has been eminently successful. In these processes, several questions arise, such as: How do we assure the safe and efficient operation of a power plant going live this year that has 1,450 programmable digital controllers in a distributed control array? How do we develop a highly-automated automotive assembly plant, with its control monitoring, diagnostic, and prognostic systems, to be competitive?

And how do we ensure cyber-security for nuclear reactors when connectivity may open the door for undesirable entry? In the future, answers to these questions may be formulated and implemented in terms of basic research findings, methodologies, and paradigms developed by the forthcoming center.

The science and technology required to address such problems come from many disciplines and must include the humanities and social sciences.

The team behind CiENS recognizes that neither a single department nor a single college in a traditional public university setting has the diversity of disciplines to solve such problems.

Therefore, CiENS seeks to mobilize a dedicated, innovative community of researchers from a wide range of fields to critically examine, develop, and integrate emerging and future research into a coherent theoretical framework that will be applicable to AI and machine learning in areas like power and chemical plants, refineries, avionics, semiconductor manufacturing, transportation systems, specialty steel production, and other manufacturing industries.

The center will operate on four primary pillars: a focused theme, innovative research, cross-disciplinary education, and extensive outreach. The long-term goal of CiENS is to enhance the global economic competitiveness and national security of the United States by developing intelligent tools for the increasingly critical problems of monitoring, diagnosing, and controlling our energy infrastructure.

Through the center, Tsoukalas hopes to potentially collaborate with various academic units across campus, including but not limited to the Elmore Family School of Electrical and Computer Engineering (ECE), the School of Mechanical Engineering (ME), the Davidson School of Chemical Engineering (ChemE), The Center for Education and Research in Information Assurance and Security (CERIAS), the Department of Health Sciences, and the Department of English.

The trailblazing center will launch on November 30, with the 1st CiENS Intelligent Energy Symposium where experts from multidisciplinary topics will gather virtually to celebrate and connect further on these vital topics.

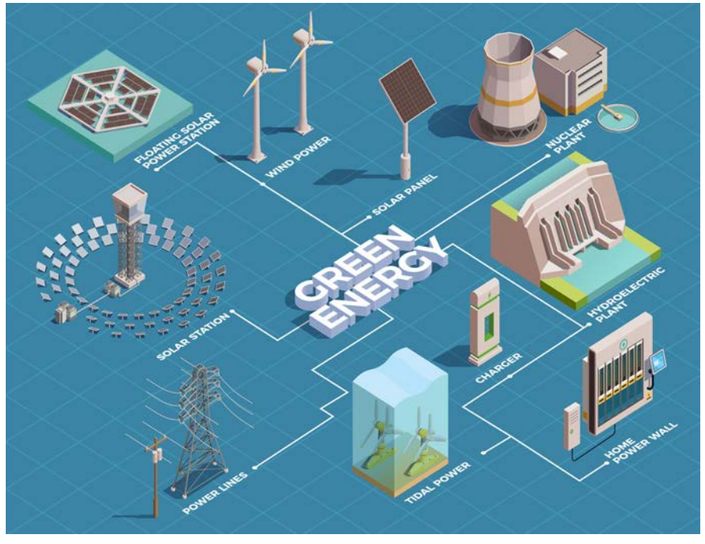


Illustration of green energy production

Graphic: Freepik.com

NE NEWS (CONT.)

KIM, TSOUKALAS ATTEND INAUGURAL FORUM FOR GLOBAL OUTREACH

Purdue's School of Nuclear Engineering was invited to be an inaugural member of the Global Forum on Nuclear Education, Science, Technology and Policy's Advisory Group

This international initiative was formed by the Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) as a platform for cooperation among leading academic institutions around the world involved in nuclear science and technology education, policy development and research.

Seungjin Kim, the Capt. James F. McCarthy Jr. and Cheryl E. McCarthy Head of the School of Nuclear Engineering, and Lefteri Tsoukalas, professor in the School of Nuclear Engineering, represented Purdue during the virtual kickoff meeting on April 23, 2021.

The inaugural advisory council was comprised of 23 universities from 13 countries. The other U.S. institutions invited were MIT, Texas A&M, University of California Berkeley, and the University of Wisconsin.

The advisory group was composed of experts from the nuclear science and technology academic community with a demonstrated record of scientific excellence, while assuring geographical and gender balance, explained William D. Magwood IV, director-general of the OECD/NEA, in his invitation letter.

At the meeting, the council confirmed the four Working Areas that were developed during the exploratory meetings, which included participation from Kim and Tsoukalas on behalf of Purdue Nuclear Engineering.

Working Area 1: Achieving gender equity in the nuclear engineering and technology and academic workforces

Working Area 2: Future of nuclear engineering education

Working Area 3: Rethinking the relationship between nuclear energy and society

Working Area 4: Future requirements for the competitiveness of nuclear energy

"Purdue is well positioned to make contributions in all areas," Kim said. After the meeting, NEA launched a tentative GF website under the NEA, which is to be updated with membership and other information soon.

Purdue Nuclear Engineering was invited to the first exploratory meeting in July 2019 and has been involved in subsequent meetings. "This is great international recognition for our department and for the College of Engineering," Kim said. "Purdue will be at the forefront in making global impact on nuclear energy and developing a workforce for future generations."

He and Tsoukalas agree that Purdue is an ideal partner for NEA because of its legacy and reputation of using nuclear power to produce energy.

"Purdue has a history of contributions in nuclear power engineering. We had an impactful role in the development of nuclear reactors in the 1950s and 1960s, collaborating with national labs where the machines were designed,"

Tsoukalas said. "Our school is one of the most well recognized in the history of developing nuclear reactors." But Purdue's Nuclear Engineering program has never been satisfied to rest on its laurels. In 2019, Purdue's PUR-1 became the only nuclear reactor in the United States licensed by the U.S. Nuclear Regulatory Commission for 100% digital I&C systems.

"Purdue is leading the digital age of nuclear engineering at the university level," Tsoukalas said.He added that Purdue is excited to share its experience and lessons learned that will help facilitate and catalyze improvements in the nuclear arena.

"Once you digitalize a system, you don't have to close the innovation space. It's very important to keep improving the technology," Tsoukalas said. "We have all kinds of things opening up to improve upon – big data, artificial intelligence, machine learning – and we can share our expertise."

Members of the OECD advisory group will contribute to solutions to the challenges that affect the nuclear energy sector, engage with multi-governmental bodies within the NEA framework, and provide input to the ongoing NEA activities related to human capacity building, knowledge management, and innovation.

"This important initiative launched by the NEA is quite timely in that it comes when nuclear energy will play a key role in providing the global community with a solution for one of the most important issues at hand, climate change," Kim said.

Kim and Tsoukalas do not discount the impact their students have had on Purdue's OECD invitation. Kim recounted Magwood's last visit to Purdue when he gave a talk in the Atrium to a standing-room-only group of students.

That level of interest speaks to the engagement found in the School of Nuclear Engineering and students' genuine desire to learn.

“Purdue has its own personality, its own culture,” said Tsoukalas. “Our kids are excited about things they sense and understand to have the potential to make our world a better place. It’s very rewarding to see that a lot of young people now are excited to learn.”

Source:
https://bit.ly/3miHu7g

Graphic: oecd-nea.org

NE NEWS (CONT.)

STYLIANOS CHATZIDAKIS SELECTED AS ONE OF 10 VIRTUAL LAB FACULTY FELLOWS

Virtual labs have been gaining ground in the College of Engineering. By combining mixed reality technologies with physics-based modeling and simulation and authentic machine interfaces, virtual labs are enriching learning. To expand the reach of this innovative instructional approach, the College has launched the Virtual Labs Faculty Fellows program, and has selected and engaged the first cohort of fellows.

CIE | CENTER FOR INSTRUCTIONAL EXCELLENCE

The 10 inaugural fellows have embarked on a six-week virtual lab development program this summer. Weekly workshops focus on evidence-based practices and activities to design, develop and implement virtual labs content.

Each fellow has received $10,000 in discretionary funding. College experts are teaching the workshops, supported by specialists from Purdue’s Envision Center, which will produce the virtual labs, and Center for Instructional Excellence (CIE). The new virtual labs, each of which will complement or replace one or two weeks of lab activities in a course, are expected to be deployed by the 2022-2023 academic year.

“We are excited about the continued growth and adoption of virtual labs within the Purdue Engineering curriculum,” said Michael D. Sangid, Elmer F. Bruhn Associate Professor of Aeronautics and Astronautics, Professor of Materials Engineering, and Dean’s Fellow for Virtual Labs. “The faculty are exploring endless possibilities for the delivery of educational material through virtual labs, which provide opportunities to transcend the constraints of physical labs.” Sangid initiated and is leading the virtual lab summer development program.

Sangid added: “Purdue already is at the cutting edge of virtual labs. We created the Faculty Fellows program to help us attain our vision of becoming the international leader in virtual labs for education, and are the first university to widely adopt and deploy virtual labs across its entire engineering curriculum.”

“Improvements and standardization of web-deployed 3D content and related production tools over the last decade have allowed the Envision Center to take educational and research content into much broader and accessible platforms,” said George Takahashi, lead visualization scientist at the Envision Center, who is leading development and production aspects of virtual labs.

“These experiential learning platforms supplement or even enhance traditional labs through advanced visualization, computation, and intuitive interaction. Making this content available online enables students to learn at their own pace while alleviating logistical constraints with physical spaces and equipment.”

“Engaging with virtual labs allows students to develop skills, including procedural and visualization skills, critical thinking, and metacognition, at scale without restrictions on time, space and materials,” said Erica Lott, senior instructional developer for the CIE, who is leading educational aspects. “Faculty can use virtual labs in and outside of the classroom to convey tangible and abstract concepts, identify and address alternate conceptions, and work on discipline-specific skill development in order to provide students the opportunity to develop a deeper understanding of the content and its application.”

Summer 2021 Virtual Labs Faculty Fellows and Their Virtual Lab Plans

Stylianos Chatzidakis

Assistant Professor, Nuclear Engineering

Course: NUCL 305: Nuclear Engineering Undergraduate Lab II (Radiation Detection Lab)

In this virtual lab, students will detect and measure fast and thermal neutrons emitted from various radioactive sources. They will learn to set up and operate equipment commonly used to detect neutrons; measure and plot the count rate versus voltage curves for different neutron detectors; determine the optimal operating voltage from the curve plateau, and identify and observe differences in neutron spectra.

Source:
https://bit.ly/3vUJshp

Note: This story was originally published by Purdue University College of Engineering News. The article includes details regarding the other 9 Virtual Lab Faculty Fellows, however it was parsed for brevity and relevancy to SNE.

Graphic: https://www.purdue.edu/cie/

NE NEWS (CONT.)

ANDREW FAIRBANKS, PH.D. STUDENT, RECOGNIZED FOR DIRECTED ENERGY RESEARCH

WEST LAFAYETTE, Ind. – An invention from Purdue University innovators may provide a new option to use directed energy for biomedical and defense applications.

Biomedical and defense applications depiction

The Purdue invention uses composite based nonlinear transmission lines (NLTLs) for a complete high-power microwave system, eliminating the need for multiple auxiliary systems. The interest in NLTLs has increased in the past few decades because they offer an effective solid-state alternative to conventional vacuum-based, high-power microwave generators that require large and expensive external systems, such as cryogenic electromagnets and high-voltage nanosecond pulse generators.

NLTLs have proven effective for applications in the defense and biomedical fields. They create directed high-power microwaves that can be used to disrupt or destroy adversary electronic equipment at a distance. The same technology also can be used for biomedical devices for sterilization and noninvasive medical treatments.

“We created a new NLTL device that reduces the bulkiness of current options and offers new opportunities to protect our country and help patients in a man-portable form factor,” said Andrew Fairbanks, a Ph.D. student and graduate research assistant in Purdue’s College of Engineering. “In engineering, we are concerned about size, weight, power and cost. Our invention helps address all of these.”

Allen Garner, an associate professor of nuclear engineering, led the Purdue team. The researchers created a novel device using composite-based NLTLs as complete high-power microwave systems, encompassing high-voltage pulse and high-power microwave formation. The Purdue device combines the elements of traditional NLTLs into a composite-based system and eliminates typical bulky auxiliary equipment.

The system is charged using a DC high-voltage supply and discharged using a high-voltage, gas-based switch.

Andrew Fairbanks, Assoc. Prof. Allen Garner

The system eliminates the need for external pulse generation and is more rugged due to the solid-state construction.

This work was supported by the Office of Naval Research (Grant No. N00014-18-1-2341).

The innovators worked with the Purdue Research Foundation Office of Technology Commercialization to patent their technology.“It has been very beneficial to our team and our advancement of this technology to have OTC here at Purdue,” Fairbanks said.

“OTC and other resources from Purdue Research Foundation provide support to take our technology and push it out to the world through patenting and commercialization.”

The innovators and OTC are looking for partners to continue developing their technology. For more information on licensing and other opportunities, contact Matthew Halladay of OTC at mrhalladay@prf.org and mention track code 69397.

Source: https://bit.ly/3s2U4XT

Note: This story was originally published by Purdue University Research Foundation News on April 7, 2021.

NE NEWS (CONT.)

SNE WELCOMES 3 NEW STAFF MEMBERS

Ashvini Malshe

ASHVINI MALSHE

ASSOCIATE MARKETING & COMMUNICATIONS SPECIALIST

As a lifelong writer and former journalist, Malshe hails from Northwest Arkansas. She first started her career at Purdue University as a Communications Consultant for the College of Engineering, before joining Nuclear Engineering earlier this fall semester. With a passion for equity in higher education, she received her bachelor’s degree in media communication from the University of Illinois at Urbana-Champaign in 2018 and her master’s degree in journalism from the University of California, Berkeley in 2020. Malshe now calls West Lafayette home.

TRUE MILLER

REACTOR SUPERVISOR & NUCLEAR
ENGINEERING LABORATORY COORDINATOR

Originally from Indianapolis, Miller received both his bachelor's and master's degrees in nuclear engineering from Purdue University. He is currently the Reactor Supervisor and Nuclear Engineering Radiation Laboratory Coordinator of PUR-1.

True Miller

Holly Mueller

HOLLY MUELLER

ACADEMIC ADVISOR

Mueller is a world traveler and a devoted Boilermaker. After receiving her bachelor's degree in linguistics and German at Purdue University, she decided to remain with the Boilermaker family and proceed with getting a master's in higher education. Her goal is to help inspire a tenacity and a lifelong desire for learning in the students that she works with, in the same way that her Purdue education has inspired much the same in herself.

DAVID STORZ, PUR-1 ELECTRONICS TECHNICIAN, RETIRES

The School of Nuclear Engineering's (SNE) David Storz retired in October after serving seven years as the PUR-1 Electronics Technician. Storz's main role was to ensure all electrical components of the reactor controls were operating in a manner consistent with their purpose. He also assisted in evaluating and maintaining the procedures for operation of the reactor, and was instrumental in PUR-1 receiving licensing from the U.S. Nuclear Regulatory Commission (NRC). At SNE, he received various awards, including multiple Bravo Awards and a College of Engineering Award of Excellence for his work at PUR-1. Storz is a veteran of the U.S. Navy. He plans to travel globally with his wife, and will remain local.

SNE Head Seungjin Kim presents Storz with a retirement gift

ALUMNI NEWS

NE ALUMNUS ESTABLISHES ENDOWMENT FOR GRADUATE STUDENTS

Sean Barnett talks about his 30-year public service career as an engineer and attorney. Thanks to alumnus Sean Barnett (BSNE '85), future graduate students in Purdue's School of Nuclear Engineering will have an added source of financial support.

Sean Barnett

Barnett recently made a deferred estate gift to establish an endowment, named the Dr. D. Sean Barnett Fund for Nuclear Engineering. The fund's primary purpose is to provide support to academically qualified graduate students with preference given to candidates who intend to pursue a career in the public sector (federal, state, local, civilian or military).

He was inspired to designate the gift after learning that there was a particular need for graduate student funding. "I want to provide opportunities for other deserving students to be able to obtain the high quality education at Purdue that I did," Barnett said.

In addition, priority will be placed on candidates who participate in Purdue Bands & Orchestras.

"I was a musician in the marching and concert bands while at Purdue, and I thought it would be nice to help students who brought music to Purdue that everyone on campus seemed to enjoy when I was a student."

He holds Purdue and the School of Nuclear Engineering in high regard, providing "a high-quality education in an area – nuclear science and engineering – that is important to the well-being of our society."

He credits Purdue for providing the foundation that enabled him to go forward and pursue other educational and career endeavors. Barnett earned a PhD in nuclear engineering from MIT and a juris doctor degree from Georgetown University. He also cites Nuclear Engineering Professor Chan Choi as a great influence while he was an undergraduate.

"He taught the fusion engineering course that inspired me to study fusion in graduate school, and he actually encouraged me to attend MIT when I had the opportunity to do so. He was always very encouraging to me, which I appreciate very much. He helped me follow an academic and career path that ultimately worked out very well for me."

Barnett has enjoyed a fulfilling career with 30 years of experience in the fields of defense analysis, nuclear engineering, national security, energy and law. He currently is a senior engineer at the RAND Corporation, where most of his work has supported the U.S. Army and has involved military operational assessments, modernization and force structure requirements, and force management issues.

“I have recently analyzed potential major conflicts with Russia, North Korea and China. I have worked on North Korean nuclear weapon developments, Army artillery and aviation requirements, theater-level combat modeling, and the Army personnel screening system,” Barnett said.

For several years, he has been engaged in wargaming both professionally and personally. He leads and supports RAND’s wargame development efforts across multiple theaters and potential conflicts.

“I’m passionate about my work – helping the Defense and Homeland Security departments plan to protect against the threats that our nation faces. I’m passionate about my hobbies of military history and wargaming. Our military history has been important to our nation. It can have implications for policy even today, and wargaming is a way to make history come to life in a competitive and stimulating but also fun way.”

His love of history and travel led him to Normandy, France, in 2019 for the 75th anniversary of D-Day. He has written short books about wargaming scenarios centered around the World War II battles of Villers-Bocage and Operation Epsom.

Before transitioning to RAND, he worked for the Institute for Defense Analyses (IDA) from 1989 to 1997, and then from 2005 to 2015. Between stints at IDA, he practiced administrative law at the firm of Pillsbury Winthrop Shaw Pittman, where he focused on nuclear energy regulation and facility licensing matters before the Nuclear Regulatory Commission and the federal courts.

“What I’m most proud of over the course of my career has been my ability to perform insightful analyses and solve problems related to U.S. national security for the Departments of Defense, Homeland Security, and Energy,” Barnett said. “In doing that, I’ve been able to apply my natural skills and my education – including the education I received at Purdue – to the benefit of all Americans and our friends and allies in the world.

“Our country has faced – and likely will again face – significant threats that could potentially cause us great harm if not mitigated,” Barnett added. “The collective efforts of everyone who works to defend our national security serve to reduce those threats and help enable all of us to pursue our lives as safely as we can.”

He also is committed to finding ways “to bridge the issues that seem to be dividing the American people and causing so much pain these days.”

Whenever he talks about Purdue, he fondly remembers his experience.

“A Big Ten school is a great place to go to college, a great place to meet people of all backgrounds and make great friends,” he said. “Nuclear Engineering provided me a great education, and it educates students to work in an important science and engineering discipline.”

Barnett, who grew up in Carmel, Ind., resides in Annandale, Va.

Source:
https://bit.ly/3pHGsDX

ALUMNI NEWS (CONT.)

JUSTIN R. HARDY PROMOTED TO COMMANDING OFFICER OF USS ALASKA

KINGS BAY, Ga. (NNS) –The Gold crew of the Ohio-class ballistic-missile submarine USS Alaska (SSBN 732) held a change of command onboard Naval Submarine Base Kings Bay, Georgia, Oct. 29.

Cmdr. Justin Hardy relieved Cmdr. Adam Thomas as the Gold crew’s commanding officer in a ceremony held at the base chapel.

Retired Capt. Mark Davis was the guest speaker at the change of command.

Cmdr. Justin R. Hardy

“Adam, you’ve had an exceptional command tour, and I know your Dad, John, and your Stepmom, Carol, are bursting with pride today,” said Davis. “I take great pleasure in seeing your accomplishments, and I know that you will continue to serve our great submarine force. You earned your seat at the head of the table and you served with distinction.”

Thomas, a native of Ann Arbor, Michigan, graduated with honors from the University of Michigan in 2002 with a degree in nuclear engineering. He later earned a master’s degree in operations research with honors from the Naval Postgraduate School.

“Admiral Richard, the combatant commander for U.S. Strategic Command who directs all of our nuclear forces, frequently talks about the 150,000 Sailors, Airmen, Soldiers, Marines, and civil servants who comprise our nuclear deterrent and execute the most important mission in the department of defense,” said Thomas.

“We, as USS Alaska – because there are about 150 of us – make up 1/1000th of that force. I’d like to think that over the past 2.5 years, we performed way more than 1/1000th of the mission.”

Thomas praised his crew for their performance under his command.

“We, as professional war fighters, operate the most powerful warship ever created in order to execute the most important mission in the department of defense. If nothing else, I hope everyone who’s served with me remembers that for the rest of your life, and looks back on it proudly. With the help of our families and friends sitting over here, what really makes us the most powerful warship ever created is the Sailors sitting over there. They’re the ones who take a simple idea – get the submarine underway, stay underway and undetected – and use their skills and knowledge to turn that idea into a reality. And we do that every day, and Alaska will keep winning without me here.”

Under his command, Alaska executed the Department of Defense’s number one mission of nuclear deterrence, completing three strategic deterrent patrols. During this time, Alaska also conducted the first overseas crew exchange in Faslane, Scotland since the Cold War, and also executed operations in the Mediterranean with a highly visible port visit to Gibraltar. Additionally, Alaska was awarded the Squadron Twenty Battle Efficiency Award and the U.S. Strategic Command Omaha Trophy in 2019. Alaska also earned Retention Excellence Awards for developing and retaining Sailors while Thomas was in command.

The incoming commanding officer, Hardy, takes command after serving as the Director of Nuclear Power School where he oversaw a staff of 200 and the training of 3,000 future nuclear officers and enlisted Sailors annually.

Hardy directed his closing remarks to the family members of his new crew.

“The world is more dangerous today than it has ever been in my lifetime and your loved ones have been placed in a position to assure peace is maintained. I will do my part to make sure they are ready for whatever challenges are placed in our way. However, we cannot be successful without your continued support and sacrifices. Thank you for all that you have done and will continue to do in support your Sailor.”

During the ceremony, Thomas was awarded the Legion of Merit for his performance as commanding officer.

Alaska is the fourth U.S. Navy ship to bear the name of the state.

Source: https://bit.ly/2Y8huT4

Note: This story was originally published by the Defense Visual Information Distribution Service on October 29, 2021.

IN CONVERSATION WITH TIM HANLEY

INTRODUCING THE SNE ALUMNI & FRIENDS ORGANIZATION

Tim Hanley

Over 34 years, alumnus Timothy K. Hanley has remained engaged with his network of peers that he established during his time at Purdue SNE. “When I graduated from the School of Nuclear Engineering, I believe seven of my classmates all went to work for what has now become Exelon,” he says.

Hanley is currently the Chief Operating Officer for Exelon Nuclear, the nation’s leading provider of zero-carbon nuclear energy located in Chicago, Illinois.

He is responsible for the corporate functional areas that provide governance and oversight to the 21 nuclear reactors along with the day to day operations of the Exelon fleet. He received his bachelor’s degree in nuclear engineering at Purdue, and he serves on SNE’S Academic Advisory Board.

Through his strong ties with SNE, he now seeks to create the inaugural Alumni & Friends Organization so that a broader network of alumni can stay connected and provide support for the school. His long-term vision for the organization is defined by four main pillars: support, advocacy, mentorship, and comradery.

Hanley’s time at Purdue was invaluable, as the relationships he made helped further his career. He also recognizes SNE as a leading nuclear engineering school for its undeniable contributions to the field and rich history. Many of the people who have attended SNE, he says, have gone on to pursue “very prestigious roles.”

With this new alumni organization, he intends to create a dedicated space for SNE alumni to connect and give back. He also believes that stronger school engagement is vital to the more pressing issues of climate change, and nuclear energy as a carbon-free generation source.

Advocacy and exposure to this issue, for current students and newer alumni, is crucial. Hanley notes that younger generations are more aware of climate change and the impact of fossil fuels on the climate.

Through organizational mentorship of these students, and potential SNE students interested in STEM, he hopes that they will be excited by the vast potential for innovation in the nuclear field, such as fuel fabrication and emerging technologies concerning small modular reactors. “These are some of the things that this organization could really help with and brainstorm ideas of where they can make a difference,” he adds.

For recent and future alumni, Hanley believes the pillars of advocacy and networking will boost awareness of the extent of new opportunities available within the nuclear industry. He wants the organization to help make nuclear "a degree that people want to go after because of its impact on the planet, climate, and society, but also in a broader perspective," he says.

He feels that younger alumni will be vital to the organization, as they have "the pulse" for ideas on how to promote nuclear engineering as the future of clean energy.

Among his initial ideas for the organization, Hanley's current goal is to reach out to SNE's large alumni network to try and understand their expectations. He aims for it to be self-directed, and to use his four outlined cornerstones as a way to lead this early effort. Eventually, he would like to develop a charter so that people interested in joining later on will understand the purpose of the group.

Due to the COVID-19 pandemic, plans for an introductory in-person gathering are on hold. Switching to an online forum in the interim is a potential route. In collaboration with SNE Head Dr. Seungjin Kim, Hanley is looking to plan a remote gathering for fall 2022.

He says, "It's something for people that are interested in and have a love for the School of Nuclear Engineering and Purdue to see what they can do to further its goals."

For more information about the SNE Alumni & Friends Organization, please contact Tim Hanley at HanleyPUNE@mediacombb.net or SNE Head Dr. Seungjin Kim at seungjin@purdue.edu.

ALUMNI: SHARE YOUR UPDATES WITH US!

Do you have news to share since graduating from SNE? Go to engineering.purdue.edu/NE/foryou/alums/update-your-information to send us any updates. This can include your address, place of work, and/or personal life notes. Please don't hesitate to reach out.

FACULTY AWARDS

REVANKAR SELECTED FOR SPECIAL COVID-19 INSTRUCTIONAL AWARD

Prof. Shripad Revankar

Shripad Revankar, professor in the School of Nuclear Engineering, has been selected by the Purdue Teaching Academy and Office of Provost as a recipient of the Award for Exceptional Teaching and Instructional Support during the COVID-19 pandemic.

The special award was developed as a way to honor the extraordinary efforts by professors and instructors and the many people who support them. The award recognizes the innovative ways that Purdue faculty, instructors and staff strived to overcome the challenges of the pandemic.

Revankar's nominator wrote, "For NUCL 355, which is a laboratory course during COVID-19, he restructured the course to meet Purdue safety and protection guidelines. Students wear masks plus face shields in each lab and have been provided with two lecture classes, videos and class material so that they can come prepared and safely perform labs and receive maximum learning benefits."

Source:
https://bit.ly/3Ermoda

NE FACULTY WIN DEPARTMENT AWARDS

2020-21 Best Teacher Award

Presented to an outstanding teacher in the School of Nuclear Engineering for excellence in teaching

•Undergraduate teaching - Robert Bean, assistant professor

•Graduate teaching – Lefteri Tsoukalas, professor

FACULTY AWARDS (CONT.)

NE FACULTY WIN DEPARTMENT AWARDS

2020-21 Outstanding Research Award

Presented to a Nuclear Engineering faculty member in recognition of outstanding scholarly achievements through impactful research

Allen Garner, associate professor

STAFF AWARDS

2020-21 Best Staff Award

Presented to an outstanding staff member in the School of Nuclear Engineering for exemplary service

Teresa Luse, associate administrative assistant

STUDENT AWARDS

MORTAR BOARD TAPS NE UNDERGRAD DESTINY WHITE

The Barbara Cook Chapter of Mortar Board at Purdue University recently tapped 42 rising seniors in the Class of 2022. Among them is Destiny White, a junior in the School of Nuclear Engineering.

Those selected for this prestigious organization exemplify Mortar Board's pillars of scholarship, leadership and service. Throughout the next year, they will work to create innovative programming for the benefit of the University and its students.

Unlike many other Mortar Board chapters across the country, there is no petition or application process for the Purdue chapter.

Destiny White

A confidential nomination process is used, and other student leaders and faculty members nominate junior they feel are deserving of the honor of being involved in Mortar Board during their senior year. The current Mortar Board class then selects the new members based on these nominations.

"I feel incredibly honored and humbled to have been selected. I have an extraordinary support system of family, friends, and faculty who have uplifted me and had faith in me since day one here at Purdue, and I plan to use every second of my time on Mortar Board giving back to them with my intentions and efforts in the organization," White said. In addition to PFSB, White has been involved with American Nuclear Society (ANS) and is the treasurer for Purdue's student chapter.

Source: https://bit.ly/3eNPJVE

Note: The original article was parsed for brevity.

STUDENT AWARDS (CONT.)

CRAWFORD NAMED DIRECTED ENERGY GRADUATE SCHOLAR

Travis Crawford, Ph.D. student at the School of Nuclear Engineering (SNE), was named a 2021-2022 Directed Energy Graduate Scholar. Awarded by the Directed Energy Professional Society's (DEPS) Board of Scientific & Engineering Advisors (BSEA), Crawford was one of only twenty graduate students across the country who received this honor.

Travis Crawford

Scholars are awarded anywhere between $5,000 to $10,000 to continue studying in directed energy (DE) technology areas. Recipients must be full-time graduate students who are pursuing studies in high-power microwave (HPM) system and technologies, high-energy lasers (HEL), ultra-short pulse laser (USPL) or counter DE weapon (CDEW) technologies.

Crawford commented, "I am humbled to have received this scholarship and I am grateful that I get to continue to pursue the development of directed energy technologies. This area of research is riddled with fascinating science, physics, and engineering principles along with a vast application space. I look forward to continuing my research in such a rewarding field."

Source: https://bit.ly/3B4QMrY

Note: The original article was parsed for brevity.

STUDENT AWARDS (CONT.)

DOWNING TO PRESENT AT 2021 INTERNATIONAL RAMP MEETING

Emily Downing, a 2nd-year graduate student in the School of Nuclear Engineering, has been invited by the Pacific Northwest National Laboratory (PNNL) to present her Purdue design project at this year's international Radiation Protection Computer Code Analysis and Maintenance Program (RAMP) meeting.

Downing will virtually present the project at the Student Symposium on October 25. "I am very honored to be invited to this conference, as a lot of time and work went into the project that is being presented," said Downing. "The process has allowed for working with incredible people, and now is opening up even more opportunities in this field."

The project, which was done in collaboration with the U.S. Nuclear Regulatory Commission (NRC), developed a tool that determines the dose of radiation that a person could receive in the case of a radioactive plume being released from a nuclear power plant if they were to evacuate or shelter-in-place. This allows for decision makers to evaluate which protective action would result in the least exposure. "This is a great example of our industry-sponsored senior design project being recognized by others," said Dr. Seungjin Kim, the Capt. James F. McCarthy, Jr. and Cheryl E. McCarthy Head of the School of Nuclear Engineering.

Purdue Nuclear Engineering senior design projects provide students with the opportunity to obtain real-world outside the classroom experience by combining design experiences with real-life problems. RAMP develops, maintains, improves, distributes, and provides training on NRC-sponsored radiation protection and dose assessment computer codes.

Emily Downing

Source:
https://bit.ly/3jwiIiC

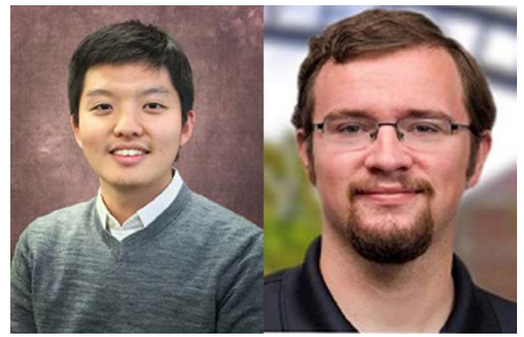
Note: Since publication of this news, Downing has presented at RAMP.

STUDENT AWARDS

BAE, RYAN RECEIVE ENGINEERING GRADUATE PROGRAM AWARDS

Junghyun Bae, Ph.D. student, received the Magoon Excellence in Teaching Award given to outstanding teaching assistants and instructors in memory of Estus H. and Vashti L. Magoon, who have influenced the lives of many engineering educators through this award.

Drew Ryan, Ph.D. student, was the recipient of the Outstanding Graduate Service Scholarship for providing outstanding service to the graduate student community, the School, the College, and/or the University.



(left to right) Junghyun Bae and Drew Ryan

Source:
https://bit.ly/2NN3RmY

CHEU SELECTED FOR SPECIAL COVID-19 TA AWARD

Darrell Cheu, graduate student in the School of Nuclear Engineering, was selected by the Purdue Teaching Academy and Office of Provost as a recipient of the Award for Graduate Student TAs who are making exceptional efforts to supports student learning through innovative and high-quality approaches to teaching during the COVID-19 pandemic.

Darrell Cheu

Source:
https://bit.ly/3CpN1yE

STUDENT AWARDS (CONT.)
NE STUDENTS WIN MAJOR AWARDS

Department of Energy (DOE) Graduate Fellowship
Tyler Ray
Nuclear Regulatory Commission Graduate Fellowship
Bailey Christensen, Logan Joyce, David Kang, Oscar Lastres, and Charie Tsoukalas
American Nuclear Society (ANS) Graduate Scholarship
Adam Darr
School of Nuclear Engineering Graduate Teaching Fellowship
Wen Jiang and Lydia Lagari
George & Mabel Anderson Nuclear Engineering Scholarship
Jacob Halpern
Frank Clikeman Nuclear Engineering Scholarship
Jackson Cowan, Benjamin Giger, Taazhykan Kurumshieva, and Ryan Zerpa
Otto & Jenny Krauss Nuclear Engineering Scholarship
Amber Gomez
Thomas Plein Nuclear Engineering Scholarship
Jackson Cowan
Nuclear Regulatory Commission Undergraduate Scholarship
Nathan Audia, Troy Barlow, Trent Bloor, Liz Bramer, Jackson Cowan, Zachery Dahm, Sydney Grahovac, Madison Green, Jacob Halpern, Susan Huster, Tyler Lewis, Connor Meeks, Sophia Shick, and Ryan Smith
American Nuclear Society (ANS) Undergraduate Scholarship
Jacob Halpern and Tyler Lewis
School of Nuclear Engineering Undergraduate Research Scholarship
Jacob Halpern and James Welch III
The following faculty, staff and students were honored:
2020-21 Academic Achievement Award
In recognition of outstanding performance in Nuclear Engineering Senior Capstone Design Project
Project: Optimization of Mask Design for Dose Reduction
Industry sponsor: U.S. Nuclear Regulatory Commission (NRC)
Mentor: Todd Smith, Ph.D., NRC
Student team members: Lorin Breen, Alec Chapman, Sarah Larson and Nick Noschese
2020-21 Outstanding Senior Award
In recognition of excellence in academic achievements and exemplary leadership
Jeremy Mateja
2020-21 Outstanding Leadership Award
In recognition of exemplary service, willingness to assist and demonstration of inspirational leadership
Jonathan Parker, Isabelle Lindsay, Elizabeth Bramer, Tyler Lewis

WHERE ARE THEY NOW?
CATCHING UP WITH SNE ALUMNI

The School of Nuclear Engineering (SNE) is starting a **new and exciting initiative** for our annual newsletter! Beginning this year, we are going to feature a handful of alumni and their achievements since graduating from Purdue, both professional and personal.

Purdue Bell Tower (Purdue University photo)

This is completely voluntary, and is meant to further engage and connect our vast alumni network. We know success can look different to everyone, and we want to give our former students the opportunity to share how their Boilermaker experience impacted their lifelong journeys.

This edition of 'Where Are They Now? Catching Up With SNE Alumni' will spotlight Justin R. Hardy, Natalie Houghtalen, Todd Smith, and Terry Grimm. We hope you enjoy reading their recaps as much as we enjoyed putting them together! With their brief accounts, we have included their photos, of 'then and now.'

If you are interested in being featured in our next newsletter, please see the relevant information below. We cannot wait to connect with you and give you the chance to catch up with your Boilermaker cohort.

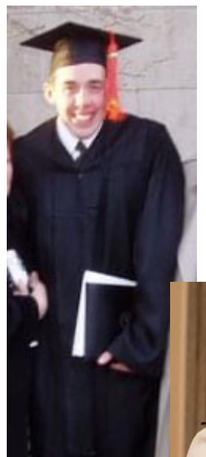
We'd love the opportunity to feature you in our next newsletter! It is a great opportunity to engage with your alumni network and share your personal and professional achievements since your Boilermaker days!

For inquiries, contact our Associate Marketing & Communications Specialist, Ashvini Malshe, at malshea@purdue.edu.

JUSTIN R. HARDY

CLASS OF 2004

Justin R. Hardy received his bachelor's degree from SNE. He was recently promoted as Commanding Officer of the USS ALASKA Gold (SSBN 732). He previously served on the USS VIRGINIA (SSN 774), USS MISSOURI (SSN 780), USS HAWAII (SSN 776), and USS JOHN WARNER (SSN 785). He has had multiple overseas deployments. Prior to command of the ALASKA, Hardy served as the Director of the Nuclear Power School where he oversaw the six-month training of all future naval nuclear propulsion plant operators. In addition to his BS, he also received a MSE from Purdue (2011), MA in strategic studies from the US Naval War College (2012) and a doctorate in education from Liberty University (2020). Hardy is now married to the former Lee-Anne Mitchell of East Falmouth, MA and they have two boys together.



Hardy 'then'

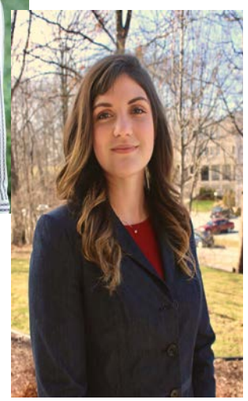
Hardy 'now'

NATALIE HOUGHTALEN

CLASS OF 2020

Natalie Houghtalen received her bachelor of science from SNE and a minor in political science in 2020. After graduation, she moved to Washington D.C. to work in clean energy policy. She interfaces with the federal government, industry, and national labs to set the stage for nuclear energy technologies. Her work touches on front- and back-end fuel cycle development for new fuel types, new licensing structures for advanced reactors, and domestic and international project financing. Most of her time is spent developing policy for new, competitive markets for nuclear energy such as hydrogen production and the integration of nuclear heat, steam, and electricity for industrial decarbonization. On a personal level, Houghtalen enjoys exercising, spending time with friends, and exploring the food and entertainment scene in D.C.

Houghtalen 'then'



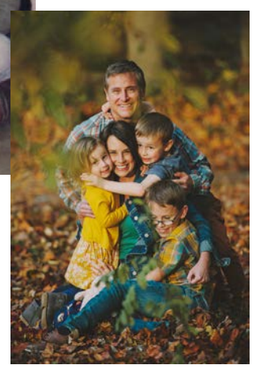
Houghtalen 'now'

TODD SMITH

CLASS(ES) OF 1996, 1999, & 2002

Todd Smith received his bachelor's degree (1996), master's degree (1999), and PhD (2002) from SNE. He currently works for the U.S. Nuclear Regulatory Commission (NRC). A highlight from his decade at Purdue is his time spent at the Thermal-Hydraulics and Reactor Safety Laboratory (TRSL) studying under Mamoru Ishii, Walter Zinn Distinguished Professor of Nuclear Engineering. It was special to him because of the people he got to work with and learn from. He says, "The work was challenging, but there was no end to the level of support received from the professors, fellow students, and machinists at the lab. And when it was time to take a break, we always enjoyed good conversation around a cup of coffee or going out for lunch." Purdue also always makes Smith think of family, because that is where he met his wife, Darcie. They have been married for 15 years and have three wonderful children together: Owen, Elliot, and Cora. They now live in Maryland, but come visit family and friends in Indiana every chance they get.

Smith 'then'



Smith 'now'

TERRY GRIMM

CLASS OF 1987

Terry Grimm received his bachelor's degree (1987) from SNE. Since 2005, he has been the founder, president, and senior scientist of Niowave, Inc., a world industrial leader in superconducting accelerator research. Grimm founded Niowave to commercialize superconducting electron linear accelerators in fields as diverse as healthcare and national security. Sharing highlights from his time at Purdue, he says, "The Chernobyl accident occurred while I was taking Prof. Karl Ott's nuclear reactor dynamics course. The real time analysis and understanding has stuck with me through the years. Also, the licensing requirements of a reactor and fuel reprocessing facility were still being discussed in class, which helped immensely when our company licensed a small facility for medical radioisotopes." Recently, Niowave has commissioned a subcritical nuclear reactor and fuel recycling facility for the production of medical isotopes. Over the next few years, they plan to become a major supplier of isotopes from uranium and radium.

Grimm 'then'

Grimm 'now'

THE GATEWAY COMPLEX

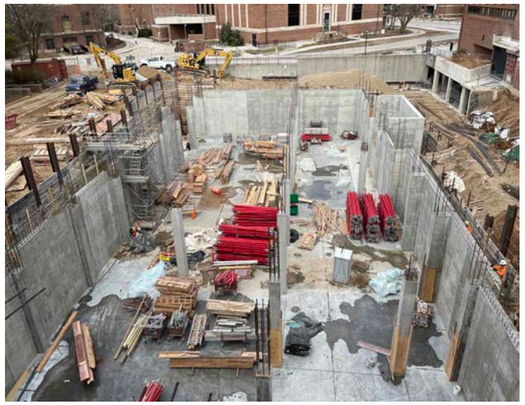
AN UPDATE ON NE'S NEW HOME

We at the School of Nuclear Engineering (SNE) have an exciting update to share on our new home, the Gateway Complex! Once building is completed, we will be in Dudley and Lambertus Hall within which three new additional teaching labs will be installed. These include: the Nuclear Code Lab, Nuclear Security Lab, and the Plasma & Fusion Lab. The multidisciplinary facility will improve student learning, industry partnerships, virtual labs, and job-ready education. SNE will be on the fifth floor, overlooking Potter, Knoy, and Electrical Engineering. We look forward to calling Gateway home in Spring of 2023!

A TIMELINE OF THE GATEWAY'S CONSTRUCTION

The previous Nuclear Engineering building

The Nuclear Engineering building is torn down in 2019



Construction of the Gateway Complex begins

SNE's assistant professors stand in front of the south-facing side of the Gateway Complex in November 2021

Construction progress is made in early fall 2021

3D rendering of the Gateway Complex in 2023

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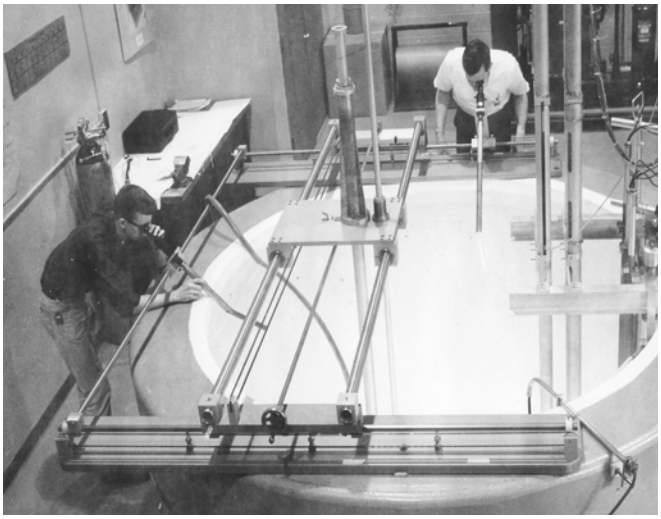
Past SNE students head to an ANS Conference.



People peer through reactor telescopes, 1966.

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