



THE SOURCE

ALUMNI MAGAZINE • FALL 2020

RADIATING HOPE

Medical Breakthrough Sparks Hope
During COVID-19 Crisis. Page 4.

 NUCLEAR ENGINEERING

Atomic Wings Come to UT / NEUP Grants Fund UT-Led Research / A Life-Saving Invention



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From the Department Head



Wow, what a year. Like the rest of the nation, we were faced with profound challenges due to the COVID-19 pandemic. We took our classes fully online after spring break and the faculty, staff, and students really stepped up and performed. Many of our faculty had experience with on-line instruction since we had the first online MS in Nuclear Engineering degree starting in the late 90s. As for research, we persevered to continue to produce high-impact research. We continued all essential laboratory research on campus and our computational work was easily relocated off campus. These pandemic related challenges continue as about a third of our classes are in person, a third are fully online, and a third are hybrid. Not only did our department show flexibility, tenacity, and resiliency, we also had great leadership from our new Chancellor and her cabinet.

We also faced challenges of social justice which were magnified by the recent events throughout our country. We actively moved forward to develop and communicate a plan for positive impact by researching the problem, listening to our students and constituents, and consulting with the college and campus. Our Pledge for Allyship, Social Justice, Diversity, and Inclusion is on page 2. We followed up in August with a town hall meeting that attracted over 70 Nuclear Engineering students, faculty, and staff, which led to the development of our Diversity, Equity, and Inclusion Action Committee. In collaboration with our partners at UCOR, we recently organized a graduate seminar Bias Panel in which panelists communicated their personal experiences and thoughts and then challenged the audience to recognize bias in society and to commit to initiate change.

However, maybe the most exciting development of this year was watching the newly named Zeanah Engineering Complex come to fruition. The brick is now on the \$129M, 6 floor complex, which will be the new home for our Nuclear Engineering Department. This project will be completed next summer for an August 2021 move-in. We will have 23

new state-of-the-art laboratories, fabulous student study and collaboration areas, and administration and office spaces that will be unequaled. If you are in town next year, please reach out to me for a tour of our new facilities.

Our undergraduate and graduate students continue to impress. This issue of the Source highlights several of those talented scholars. Our enrollment remains strong, with our PhD program continuing to be the largest in the country, five years running. This is fueled by our faculty who continue to grow their research portfolios and provide PhD students with opportunities to work on impactful projects. Additionally, two of our faculty agreed to assist with the department's administration: Jamie Coble is our new Assistant Department Head for Undergraduate Studies and Service and Jason Hayward is our new Associate Department Head for Graduate Studies and Research. Their leadership is already apparent through new programs and services for the students.

Academically, this year we welcomed our first Medical Physics class of 8 students. This program is bringing excitement to the field and we have several strong medical establishments who have partnered to assist in the development of the program and provide clinical experiences. Through a partnership with Bechtel, we also developed the nation's first program in Nuclear Safety, which includes an undergraduate minor and a concentration at both the MS and PhD levels.

I wish to thank our alumni for continuing to engage with the department, influence our direction, and partner in our success. Several have stepped up to name rooms in our new building, and I am excited to see the impact of those investments. Please continue to partner with us to meet and surpass our extraordinary goals.

J. Wesley Hines

Department Head
J. Wesley Hines

TCE Director of Communications
Christie Kennedy

Project Manager
Kathy Williams

Designer
Mitchell Williamson

Writer
Élan Young

Photography
Randall Brown
Shawn Poynter

Printer
University Printing and Mail

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On the Cover:
Conceptual illustration of radiotherapy treatment for COVID-19 infections.

Our Pledge for Allyship, Social Justice, Diversity, and Inclusion

You have no doubt seen countless statements in recent months condemning the killing of George Floyd and others. We join the multitude of voices expressing shock and outrage at the realities faced by the Black community every day. The time for making statements has passed; now is the time for thoughtful and meaningful action. It is in the pursuit of transparent and measurable progress that we have outlined our first set of actions to address the effects of implicit and explicit biases in our department. The faculty and staff of the University of Tennessee Nuclear Engineering Department pledge to:

Establish a Diversity, Equity, and Inclusion (DEI) Action Committee to improve the diversity efforts of our department related to student recruitment and retention, hiring, and research activities.

Introduce graduate students to the UT ombudsperson to provide them an independent and impartial person to talk to in confidence about issues they encounter, including incidents of racism and bias. We will also invite the ombudsperson to speak to our department annually.

Integrate diversity, equity, and inclusion (DEI) into our culture and curriculum. DEI is not an explicit element of the university curriculum, but we feel it is an important component of the college experience. Therefore, we will investigate ways to integrate DEI into our undergraduate curriculum and student society meetings.

Increase the diversity of invited seminar speakers who represent the diversity of researchers, practitioners, and specialty areas in nuclear engineering. We will develop a pool of funds to provide travel support for early career and underrepresented speakers. We welcome speaker nominations from all stakeholders, including you.

Include additional graduate student representation in faculty searches, beginning with our next search. Successful practices from that search will then be codified into our department bylaws to ensure graduate students continue to provide input on searches.

Create additional opportunities for student feedback through department town halls each semester and—in addition to annual senior exit interviews—formal interviews with the assistant and associate department heads to provide observations and experience on issues of curriculum, department culture, facilities, and other issues.

Implement student recruitment and retention initiatives by working more closely with the Office of Engineering Diversity Programs and offering paid summer research opportunities to area high school students beginning next summer. We are also identifying opportunities to work with colleagues at Historically Black Colleges and Universities and Minority Serving Institutions to bring in more students for summer- and semester-long paid undergraduate research opportunities.

In collaboration with the college and university leadership, we are also investigating the potential to cancel classes on any election day and eliminating the use of the GRE in NE department admissions. There is much research that shows the GRE is a biased exam that unfairly disadvantages many extremely capable graduate researchers and does not correlate well with success in graduate school. We understand GRE scores are used for several national rankings and we will also work with those entities to encourage a change in their practice.

We are committed to continuously and critically evaluating the policies and practices in the department, university, and nuclear industry that consciously or unconsciously disadvantage members of our communities. We are committed to doing better and being better, and we welcome your voices to guide our plans. We encourage all to continue educating themselves on the realities faced by the Black community and underrepresented groups and the ways we can all be active and affect change. With our Volunteer Spirit, we are determined to take action and we will communicate our progress and challenges back to you.

Visit tiny.utk.edu/NEpledge to read our full statement.

Department Succeeds Despite Pandemic

By Élan Young.

For college students and faculty across the country, navigating the spring semester during a global pandemic proved to be a colossal adjustment. At the University of Tennessee, students left for spring break and returned to classes that had all been moved online.

For some, this transition was harder than others, but students and faculty in the nuclear engineering department persevered with the Volunteer Spirit to make sure students had what they needed to succeed to the best of their abilities and to create a sense of community when it was impossible to meet face-to-face.



Southern Company Faculty Fellow Jamie Coble says that one way she helped maintain a sense of connection and community while social distancing was by opening Slack channels for her classes. Slack is a popular app that provides a simpler way for teams and groups to communicate quickly without the glut of emails and texts.

“The Slack workspace for our class has given us a space to extend academic conversations outside the Zoom classroom and has also given everyone opportunities to share pet photos, memes, and general check-ins,” Coble said. “The new department Slack has channels for students, researchers, and faculty to seek and give help on all kinds of technical topics, from general topics to specialized programming languages and computational tools.

“Opening new channels of communication has helped me get to know my students and others in the department in ways I wouldn't have otherwise; it's a welcome bit of connectedness in a time of isolation.”

— Jamie Coble

Coble was also invited to speak at a virtual conference entitled “Working from Home—Lessons Learned,” hosted by US Women in Nuclear, which was attended by students in the department.

In it, she shared strategies that apply to working during the quarantine, such as creating asynchronous content (making use of existing content, such as related presentations on YouTube), using synchronous time to engage with students (working through examples, answering questions, and checking in with students on how they are coping), and opening new channels of communication using tools such as Slack and using Zoom for answering questions “in person” instead of through email.



Nuclear engineering sophomore Madison Allen is one student who had a positive experience with the transition to online classes.

Allen has a visual impairment that necessitated that she receives PowerPoint files ahead of class lectures and enlarged text handouts. The transition to Zoom and Canvas for online learning actually saved a step

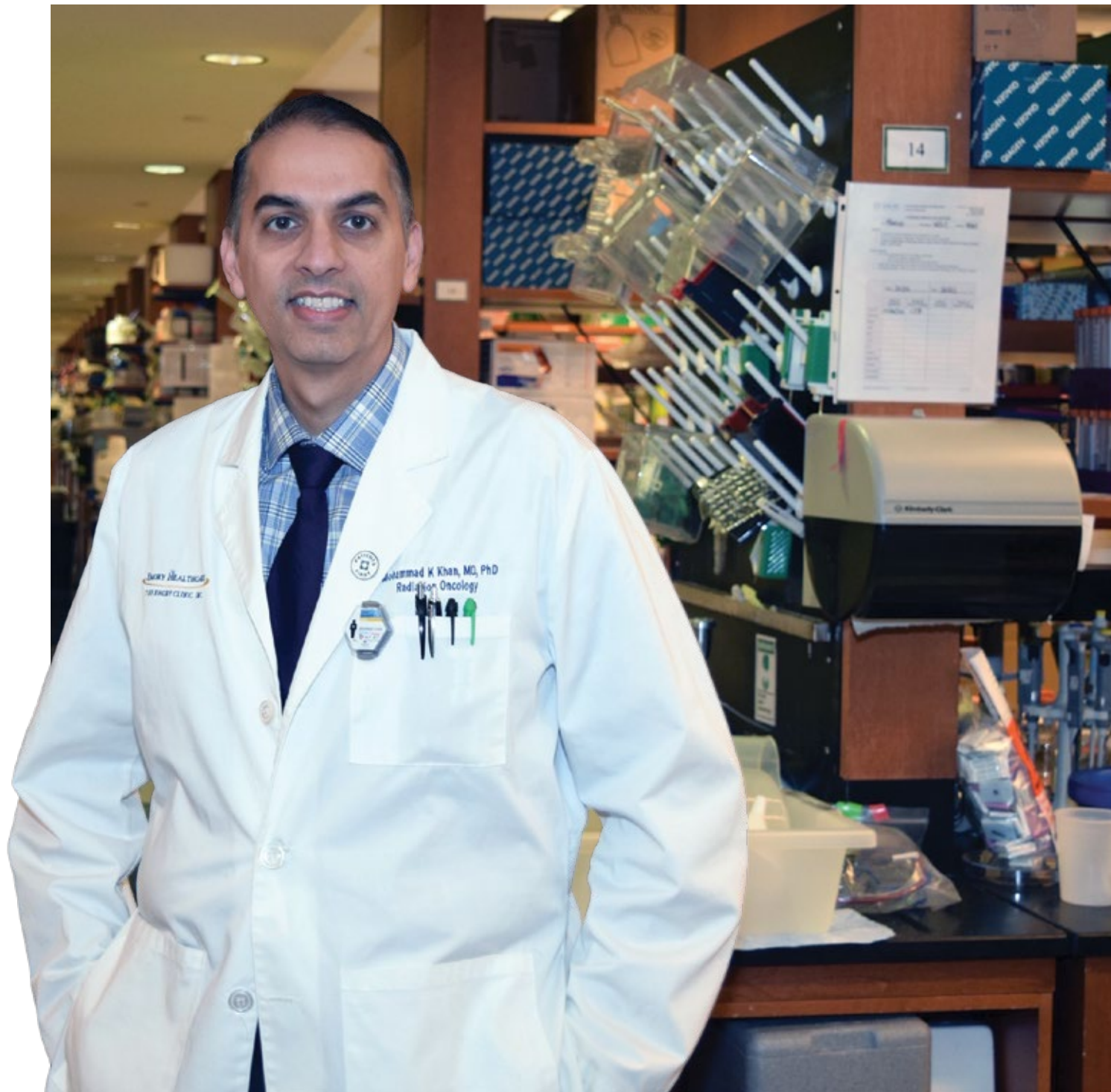
for her because she could use computer software instead of enlarged text print copies.

In her first year, she gained experience working with Zoom as a visual aid during live class on campus in the engage Engineering Fundamentals program with phenomenal help from program director, Professor Richard Bennett, as well as his team and UT's OIT department.

“The Tickle College of Engineering and the Nuclear Engineering Department have been especially helpful at providing the necessary accommodations and visual aids for me to be successful.”

— Madison Allen

“Opening new channels of communication has helped me get to know my students and others in the department in ways I wouldn't have otherwise; it's a welcome bit of connectedness in a time of isolation.” she said.



RADIATING HOPE

Khan's medical breakthrough sparks hope during COVID-19 crisis

By Élan Young.

Radiation oncologist Mohammad Khan (NE/PhD, '02) recalls the mood in March. Everyone—doctors and patients alike—was in shock about COVID-19 which led him to think about radiotherapy in a new way.

“Patients were afraid to come see us and we were afraid to see our patients,” said Khan, an associate professor at Emory University’s School of Medicine. “We also realized there weren’t enough face masks or shields, gloves, and protection for all the doctors taking care of the patients. We were wondering what could we do. I was thinking outside the box because of the circumstances of the pandemic, and the fear probably drove me to think a little differently.”

As a radiation expert, Khan is used to other medical disciplines overlooking radiotherapy treatment for infection. But in the moment of impending crisis, inspiration struck.

The Spark of Innovation Buried in the Past

As Khan was searching for answers, he came across a summary of bacterial pneumonia being treated with radiation in the 1920s and 30s. Although very different than COVID-19, Khan thought that if they did radiotherapy before the antibiotic era, it might work now, too.

He quickly pulled a team together as he wrote the clinical trial. In addition to getting a radiologist, an immunologist, the cancer director, and the departmental leadership involved, he also had to convince doctors outside the department who were skeptics.

“I had to educate them and remind them that there is anecdotal data that talks about radiotherapy helping pneumonia patients,” said Khan. “We didn’t have any other options, so it was easier to convince them that we needed to try something for these patients and could not wait for years until preclinical data are completed.”

The idea started to gain momentum and Khan asked only for a small trial of five patients from the institutional review board (IRB), which looks at the ethics of doing a clinical trial and the hypothesis and background. They concluded the trial could move forward with this small number of patients.

Safer Bedside Manner

Even before the trials began, Khan thought it would be more effective to have a bedside unit safely administer the radiotherapy to eliminate the possibility of unnecessary COVID-19 exposure.

Khan reached out to his alma mater for help. Nuclear Engineering Department Head Wes Hines saw the importance and quickly pulled in Associate Professor Eric Lukosi, John D. Tickle Professor Lawrence Heilbronn, and researchers at ORNL.

The team was tasked with rapidly developing a prototype and identifying a commercially available X-ray source of sufficient emission energy and intensity to treat a patient.

“The ancillary design is equally important to minimize unwanted radiation doses to other parts of the body, the technician, and to adjacent rooms,” noted Lukosi.

A mobile radiotherapy device could not only change the statistics of a global pandemic, but it could potentially help any high-risk patient suffering from advanced stages of pneumonia and could be useful for other purposes in the future.

“The opportunity to collaborate with outstanding team members and make a direct impact on people’s lives is very exciting and rewarding,” Heilbronn said.

The team is working as quickly and safely as possible, but getting a product to market will also include getting approval for use as a medical device, which is a yet-unknown process. They hope to have a prototype ready for field testing by the end of 2020.

“I was skeptical when Mohammad called me; however, he quickly explained the theory and we were thrilled to be asked to participate in what could be the greatest medical breakthrough during the worst medical pandemic in modern times.”

—Wes Hines

Operationalizing the trial was challenging

“We had to navigate the logistics of how to treat a COVID-19 patient safely, which required multiple levels of training, and we had to get buy-in from all the surrounding doctors,” said Khan. “We had to convince them that we could do it safely and that our processes were going to be very efficient and follow all the safeguards.” In the end, they streamlined the transportation and treatment to a mere 25 minutes.

On April 24, Khan’s team administered radiotherapy treatment to a COVID-19 patient. By April 28, they had treated all five patients in the cohort. Within seven days, four of the five patients did much better than expected and were coming off oxygen within one-and-a-half days on average. The fifth patient died, but not before his conditions first improved.

IRB then gave the approval to test another five patients, all who improved and were discharged. The ages of the 10 patients ranged from 44 to 104. The trial has now moved to phase 3 for confirmation of the results.

Atomic Wings Comes to UT

By Élan Young. Photography by Randall Brown.

On February 10, the Atomic Wings Lunch and Learn program, which is typically held on Capitol Hill, traveled to Knoxville for a special edition on campus in conjunction with Oak Ridge National Laboratory (ORNL). The US Department of Energy's (DOE) Office of Nuclear Energy lunch and learn program served to kick-off the Advanced Reactors Summit VII.

Attendees heard from subject matter experts and members of Congress, among others. The focus of this special edition was

“Propelling the Next Generation for Advanced Nuclear Energy.” The event featured graduate students Jake Gorton and Amanda Bachmann, as well as rising early career representatives from ORNL, TVA, and the greater Knoxville community.

The Atomic Wings Lunch and Learn series is a DOE-sponsored bipartisan educational series on Capitol Hill for members of Congress, Hill staff, and industry, informing both sides of the aisle on the benefits of nuclear energy.



NE graduate students Jake Gorton (left) and Amanda Bachmann (right) were panelists during the lunch and learn.



NE Department Head Wes Hines spoke about nuclear energy during the luncheon.



Michelle Harstine, DOE's Senior Advisor of Stakeholder Engagement in the Office of Nuclear Energy, was one of the speakers at the lunch and learn.



State Representative Chuck Fleischmann took questions from the audience.

ADVANCED REACTORS SUMMIT Puts *UT* in the Spotlight



“The opportunity to host the summit gave us the chance to engage leaders and share more about the great work at UT to prepare students for the next generation of nuclear technology.”

—Wes Hines, NE department head

By Élan Young. Photography by Randall Brown.

As the need for non-polluting, safe, reliable, and economically viable energy grows, there's great interest in the next generation of nuclear energy from advanced reactors that stand to become available within five to seven years. The up-and-coming advanced reactor designs are on track to make fission a safer and more environmentally friendly alternative to other forms of power, including hydraulic fracturing and coal generation.

In the spring, UT hosted the Advanced Reactors Summit VII, a nuclear industry conference that brought together about 300 professionals from across the industry and government leaders to share and learn about the latest developments in advanced reactors.

The summit included top speakers from the field and also featured a technology showcase. At the end of the summit, attendees could attend technical tours, such as to the Clinch

River reactor site that TVA hopes to turn into an advanced reactor, and to ORNL's Manufacturing Demonstration Facility to see advanced manufacturing techniques.

The experience also gave students a chance to explore the field of advanced reactors and meet executives from the US Nuclear Industry Council, TVA, US Nuclear Regulatory Commission, ORNL, and many more.

The summit, held under the auspices of the United States Nuclear Industry Council, focuses on showcasing technology developers and advancing solutions on the cost and deployment timeframe of advanced reactors, as well as practical ideas and concepts that have the potential of significantly improving advanced reactor design, deployment, and operations.

UT, TVA Sign Agreement on Advanced Nuclear Reactor Demonstration

By Élan Young.

A new partnership between UT and the Tennessee Valley Authority (TVA) will help prioritize the development of one or more advanced reactors at TVA's 935-acre Clinch River Nuclear Site in Roane County, Tennessee. TVA has not made a decision to build and would first need approval from the Nuclear Regulatory Commission for a specific design.

The partnership will allow collaboration, evaluation, and potential demonstration and operation of light-water or non-light-water fission reactors that build on the success of the current generation of reactors and will also leverage the expertise of UT's nuclear engineering department.

"Established in 1957, our department is the first and one of the largest and most prestigious in the country," said Department Head Wes Hines. "This strategic partnership with TVA to build highly efficient advanced reactors will help us pave the way for a clean, reliable energy future."

Nearly 40 percent of TVA's current generation portfolio is nuclear power, which provides the majority of the region's carbon-free energy. With increased interest in cleaner power sources, the potential of expanding safe, reliable, and economically viable nuclear energy grows.

"UT offers unique capabilities supporting TVA's mission for innovation in nuclear power," said TVA president and CEO Jeff Lyash. "This partnership allows us to better explore new nuclear technologies through UT's advanced modeling and simulation tools as we continue to pursue a clean energy future."

Advanced reactor designs build on more than 50 years of operational experience with the current generation of nuclear power reactors. They offer advanced passive safety systems and increased operational flexibility while continuing to provide the only continuous source of carbon-free energy.

“UT offers unique capabilities supporting TVA's mission for innovation in nuclear power.”

—TVA president and CEO Jeff Lyash



TVA's Sequoyah Nuclear Plant, just north of Chattanooga.

UT Researchers Contribute to Advancement of Nuclear Power Tech

By Élan Young.

UT nuclear researchers will contribute to the advancement of technology related to the design and control of state-of-the-art nuclear reactors as key members of a General Electric Research-led team working on an Advanced Research Projects Agency-Energy (ARPA-E) project.

The Department of Energy-funded project focuses on integrating digital twin technology to virtually replicate the reactors as well as using artificial intelligence to help guide the team's decisions.

"We are proud that our instrumentation and control expertise will be integrated into this high-caliber project to advance small modular reactor technologies," said Department Head Wes Hines. "The collaboration of an ARPA-E project of this scale illuminates the progress and potential for the next era of nuclear energy."

Other partners include GE Hitachi Nuclear Energy (GEH), ORNL, and Exelon Generation. Exelon operates the largest fleet of nuclear power plants in the US and will provide historical data based on its significant experience to inform the design of the model. Targets are aimed at reducing the operating and maintenance costs of advanced reactors.

UT collaborators include Associate Professor and Southern Company Faculty Fellow Jamie Coble and Professor Richard Wood.

"This project allows UT to significantly contribute to advancing the state of the technology toward more nearly autonomous operation of nuclear power plants," said Wood. "The integration of operational performance and system health information with AI-based analysis and decision capabilities can ensure cost-effective, highly-reliable power generation along with efficient asset management."

The GEH team is responsible for building a digital twin of a BWRX-300 small modular reactor and identifying critical components. They will develop artificial-intelligence predictive technologies to make risk-informed decisions to support design, regulation, operation, and maintenance of the advanced reactors.

"The team assembled by GE Research enables us to make great strides forward in safe, cost-effective maintenance optimization for the future nuclear power industry," said Coble. "The approaches and technologies we develop under this program will widely support advanced reactor technologies across the board and the safe, economic deployment of these reactors in fundamentally new paradigms."



“The integration of operational performance and system health information with AI-based analysis and decision capabilities can ensure cost-effective, highly-reliable power generation along with efficient asset management.”

—Robert Wood

Nuclear Energy Holds Key Role in a Low-Carbon Future

By Élan Young.

Climate change is recognized by the United Nations as “the most systemic threat to humankind,” but even with global awareness of the problem, the demand for fossil fuels remains high. Meanwhile, the World Health Organization says that air pollution is the world’s largest environmental risk, with an estimated 7 million people dying prematurely from air pollution each year.

The rise of renewable energy sources like wind, solar, and geothermal underscore the demand for more sustainability in the energy industry; however, these technologies alone can’t supply the nation’s increasing demand for reliable energy.

Advanced nuclear reactors and fusion technology stand to help nuclear energy play a critical role in solving the climate crisis, something joint faculty Associate Professor Steven Skutnik says will be necessary due to nuclear energy’s low-carbon base load.

“Electricity is only one-fifth of the total carbon emissions right now, so if we’re really talking about deep cuts in carbon emissions we have to think about other sectors,” he said. “It’s a question of how do we go beyond cutting carbon out of the electricity sector and start actually eating into the problem in other sectors. For instance, if we wanted to decarbonized transportation, it means we’re probably going to electrify. In order to do that, we will need a lot more zero carbon power.”

Advanced nuclear reactors, and even fusion reactors, could provide a reliable source of energy to be deployed on a large scale, potentially replacing fossil fuel plants altogether.

“Nuclear energy is the largest and most important low carbon electricity source in the United States,” said Associate Professor Nick Brown. “Advanced nuclear reactors have potential missions far beyond electricity generation, such as process heat for industrial applications or efficient desalination of water. Microreactor concepts could provide remote power for isolated communities such as in northern Alaska, or in forward operating bases for the military.”

Using a life-cycle assessment, the greenhouse gas emissions of every stage of the production of nuclear energy can help identify the overall carbon footprint. Over the course of that life-cycle, nuclear produces about the same amount of CO₂ per unit of electricity as wind.

According to new research published in Nature Energy, the full life-cycle greenhouse gas emissions of solar, wind, and nuclear extending to 2050 are significantly lower than fossil fuels. This includes the “carbon debt” of emissions produced in manufacturing, construction, and supply chain processes.

The voluntary emissions reduction of the Paris Agreement was a first step to gain global cooperation to reduce emissions, but stronger global decarbonization measures will be needed to meet critical climate targets.

More than 40 governments around the world have put a high price on carbon, yet it is still not politically expedient to issue a carbon tax or otherwise enact strict regulations that would limit carbon emissions because of fears such measures would hurt the economy.

In May 2020, the highest ever monthly average of CO₂ in the atmosphere was recorded at the Mauna Loa Observatory at 417.1 ppm. Climate leaders agree that nuclear energy is a key factor in meeting electricity demand, which is increasing about twice as fast as overall energy use and is likely to rise by more than half by 2040.

Nuclear power reduces CO₂ emissions by some 2.5 billion tons per year compared to coal-fired generation, demonstrating why it is seen as an essential part of a low-carbon future.

“I have had an amazing time working on the new USS John F. Kennedy (CVN79) at Newport News Shipbuilding. The hands-on co-op experience I’ve had around the nuclear propulsion plants has taught me so much about the inner workings of a Navy aircraft carrier’s engine room and how what I’ve learned at UTK is applicable to real world applications.”

—Elizabeth Smoak (BS/NE, '22)



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FACULTY NOTES

Promotion and Tenure

John D. Tickle Professor **Lawrence Heilbronn** has been promoted to full professor. Heilbronn's research interests include medical isotope production, nuclear space sciences, health physics, space radiation transport and shielding, neutron and light ion production cross section measurements, heavy ion cross section, and thick-target measurements.

David Donovan has been promoted to associate professor with tenure. Donovan's research interests include fusion energy science, plasma physics, plasma-material interactions, near-term applications of nuclear fusion devices, material characterization tools, helium ion damage to tungsten in fusion relevant environments, plasma and heat flux diagnostic development and implementation, surface chemistry analysis, boundary plasma experimental research, and impurity transport studies in magnetically confined fusion devices.

Wood Receives Lifetime Achievement Award from ANS



In the American Nuclear Society (ANS) Professional Division Awards, Professor **Richard T. Wood** was honored with the Don Miller Award from the Human Factors, Instrumentation, and Controls Division. This award recognizes his lifelong commitment and contributions to nuclear digital system design, licensing, and standards, with an emphasis on all aspects of digital system safety, reliability, and qualification in the US and international communities.

Wood is the fourth UT nuclear engineering professor to receive this award since its inception in 2010. Others include Professor Robert Uhrig, Professor Rafael Perez, and Professor Emeritus Belle Upadhyaya.

Sobes Stands Out with Early Career Award from ANS

Assistant Professor **Vlad Sobes** has received the Early Career Reactor Physicist Award from the American Nuclear Society (ANS). This award was established in 2013 to recognize early career members of the Reactor Physics Division who have made significant contributions in the field of reactor physics.

Specifically, Sobes earned the award for Technical Leadership in Nuclear Data and Contributions to Reactor Physics in the Areas of Sensitivity and Uncertainty Quantification and Analysis.

Wirth's Research Selected for Cover of Surface Science

A recent publication by UT-ORNL Governor's Chair for Computational Nuclear Engineering **Brian Wirth**, UT post-doctoral researcher Dwaipayana Dasgupta, and Professor Dimitrios Maroudas at the University of Massachusetts, Amherst, was selected for the cover art of *Surface Science*, volume 698.

The publication, entitled "Prediction of temperature range for the onset of fuzz formation in helium-plasma-implanted tungsten," discusses "fuzz" formation in tungsten following low-energy helium plasma exposure.

Tungsten is the material of choice for plasma facing-components in tokamak fusion reactors, and experimental observations of significant tungsten surface changes and formation of a low density, nanoscale "fuzz" following low-energy helium plasma exposure were first observed in the mid-2000s.

Such surface features impact heat transfer, fuel (deuterium and tritium) recycling, retention and permeation, and surface material sputtering and erosion, all of which are detrimental to fusion reactor operation.

This research provides the first mechanistic explanation for the role of temperature in "fuzz" formation, and demonstrates that "fuzz" can grow at temperatures lower than those reported in the literature at sufficiently long plasma exposure periods.

ANS Elects Three UT Faculty to Leadership Roles

The American Nuclear Society (ANS) recently elected three UT nuclear engineering faculty members to its leadership.

Professor of Practice **Richard Lagdon** who also serves as the chief engineer of nuclear operations and safety at Bechtel National was elected to the national board of directors.

John D. Tickle Professor **Lawrence Heilbronn** was elected to vice chair/chair-elect of the Radiation Protection and Shielding Division, which is responsible for developing and promoting radiation protection and shielding aspects of nuclear science and technology.

Associate Professor **Nicholas Brown** was elected to vice chair/chair elect of Nuclear Installations Safety Division. This division seeks a better understanding of the role of safety in the design, construction, and operation of nuclear installation facilities and promotes engineering and scientific technology advancement associated with the safety of such facilities.

Zinkle Publishes Book on Nuclear Reactor Alloys

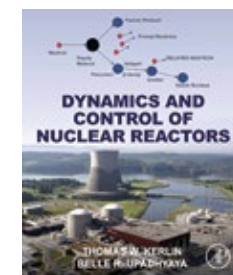
UT-ORNL Governor's Chair for Nuclear Materials Professor **Steven Zinkle**, along with G. Robert Odette, Distinguished Professor Emeritus from the University of California Santa Barbara's materials and mechanical engineering departments, have assembled an advanced reference book called *Structural Alloys for Nuclear Energy Applications*.

Consisting of 13 chapters (including two chapters written by the editors), the book covers high-performance alloys like austenitic and ferritic steels, nickel-base alloys, zirconium alloys, and other structural alloys in nuclear energy applications that can withstand the high radiation and thermomechanical operation environment of nuclear reactors.

The scope includes structural alloy applications in current water-cooled fission reactors as well as proposed next-generation (Generation IV) fission and fusion energy systems.

With many experienced staff in the nuclear industry, research laboratories, and academia facing retirement during the coming decades, this authoritative reference is designed to be a resource for the next generation of researchers and industry staff.

The book is available in both print and electronic formats from Elsevier.



Kerlin and Upadhyaya Publish Textbook about Nuclear Reactors

Professors Emeriti **Thomas Kerlin** and **Belle Upadhyaya** have co-authored a textbook about nuclear engineering. *Dynamics and Control of Nuclear Reactors* (Elsevier-Academic

Press, 2019) presents the latest knowledge and research in reactor dynamics, control, and instrumentation—important factors in ensuring the safe and economic operation of nuclear power plants.

The book provides current and future engineers a single resource containing all relevant information, including detailed treatments on the modeling, simulation, operational features and dynamic characteristics of pressurized light-water reactors, boiling light-water reactors, pressurized heavy-water reactors, and molten-salt reactors. It also provides pertinent, but less detailed information, on small modular reactors, sodium fast reactors, and gas-cooled reactors.

The book is available in print and electronic formats from Elsevier.

NE Faculty and Staff Receive TCE Awards

Academic and administrative colleagues of the Tickle College of Engineering show appreciation for each other every day as a matter of course. Each spring, the college makes the highest of these acknowledgements official at the annual Faculty and Staff Awards Banquet. Due to the pandemic, this year's banquet was postponed, with winners notified by email.

Award Winners



Amanda Lovelace, Undergraduate Advisor

Pass the Torch Award

In recognition of the outstanding all-around achievement of one staff member through their exceptional service and effort to go above and

beyond in their work to help others with a high degree of excellence, professionalism, and integrity.



Jamie Coble, Associate Professor and Southern Company Faculty Fellow

Professional Promise in Research Award

In recognition of tenured or tenure-track faculty members at the assistant or associate professor rank who have received national and/or international recognition in their fields and show professional promise in their research.



Jason Hayward, Professor and UCOR Fellow

Research Achievement Award

In recognition of tenured faculty members who have received national and/or international recognition in their field, to stimulate research and emphasize research as integral to the mission of the college.

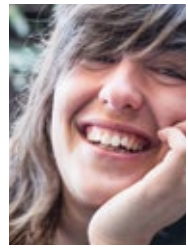


David Donovan, Associate Professor

2020 TCE Teaching Fellow Award

In recognition of superior teaching in the college.

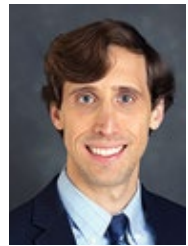
► New Faculty Join NE



Sandra Bogetic will be joining NE as an assistant professor in January. Her doctoral research was done within the Nuclear Science and Radiochemistry group at the National Ignition Facility (NIF).

BS ('11), energy engineering, Polytechnic University of Milan, Italy; joint MS ('13), nuclear engineering, Swiss Federal Institute of Technology in Zurich and Swiss Federal Institute of Technology in Lausanne; MS ('16) and PhD ('20), nuclear engineering, UC Berkeley, where she was the Lawrence Livermore National Laboratory Scholar.

Her previous research experiences have introduced her to the fundamentals of nuclear research such as computational methods and the importance of validation and verification of computational methodology—one of the major drivers that pushed her to inquire about possibilities that would allow her to connect computational methods, such as the Monte Carlo transport codes for neutrons, to experiments on modeling nuclear spectra.



Michael Liesenfelt joined NE as a research assistant professor last spring after six years in industry. His research broadly covers all advanced radiographic, imaging, detection, and non-destructive testing (NDT) methods.

BS ('06), MS ('09), PhD ('16), nuclear engineering, University of Florida.

He hopes to help industry advance portable hand-held X-ray backscatter imagers to stop drugs, guns, human trafficking, and money smuggling at our borders. Additionally, he will support high-energy neutron radiography NDT methods for the Y-12 national security complex and assist the new UT medical physics program by advancing medical imaging technology.



Giovanni Pastore has joined NE as a research associate professor after eight years at Idaho National Laboratory.

BS ('05), physics engineering; MS ('08), nuclear engineering; PhD ('12), radiation science and technology, Polytechnic University of Milan.

Pastore has spent year-long assignments as a visiting scientist at the European Commission's Joint Research Center (2010–11), the OECD Halden Reactor Project (2015–16), and MIT (2018–19).

His research deals with modeling the complex, in-reactor thermo-mechanical behavior of the nuclear fuel elements. One specific area of his work is the development of models to predict the release of fission gas from nuclear fuel, which is the largest source of uncertainty in engineering-scale nuclear fuel performance codes.

Pastore has developed a fission gas behavior model that is currently being used in multiple nuclear fuel performance codes in the US as well as in the European Union. Other areas of research he has been involved in include modeling light water reactor fuel element behavior during design-basis accidents, oxide fuel behavior at high burnup, and advanced technology fuel and cladding materials technology.



Vladimir Sobes has joined NE as an assistant professor after six years at ORNL.

BS ('11), PhD ('13), nuclear science and engineering, Massachusetts Institute of Technology.

Sobes's research covers a broad spectrum of reactor physics, from nuclear physics to reactor design. With a background in nuclear data, he continues to work on problems in the nuclear data pipeline with a particular interest in the application of artificial intelligence/machine learning algorithms.



Fan Zhang has joined NE as a research assistant professor after receiving her PhD in nuclear engineering from UT last year.

BS ('13), MS ('16), nuclear engineering, North China Electric Power University; MS ('19), statistics, PhD ('19), nuclear engineering, University of Tennessee.

Zhang's primary research area is on the cybersecurity of industrial control systems. She has developed cyber-physical testbeds using simulators and physical components to investigate different areas of cybersecurity, including network architecture, authentication, different cyber-attack scenarios, cyber-attack detection methods, and risk assessment strategies.

Eight-Time “Professor of the Year” Retires After 25 Years

By Élan Young.



Ronald Pevey with Ruth, one of four grandchildren, in 2018.

Associate Professor Ronald Pevey retired at the end of the 2019–2020 academic year after 25 of years teaching. Pevey pursued research in reactor physics, thermal hydraulics, computer methods development, shielding, and nuclear criticality safety.

Much beloved by students in the program, Pevey leaves his post with the distinction of earning Nuclear Engineering Professor of the Year Award for the eighth time. This award is selected by UT's nuclear engineering seniors and shows students' appreciation for a faculty's teaching style as well as their ability to convey complex engineering information in the courses. This award cannot be won two years in a row.

“Dr. Pevey is probably the most likable guy I've ever met, and the students agree,” said NE Department Head Wes Hines. “He is a great story teller.”

Some highlights of Pevey's tenure at UT include:

- Shielding designs for medical facilities, including both isotope production and radiation treatment facilities, and for nuclear facilities such as the Spallation Neutron Source at ORNL;
- Criticality safety analysis at Rocky Flats, Y-12, Savannah River, Yucca Mountain, and Portsmouth nuclear sites;
- Over 60 research publications in both technical journals and international conferences and numerous technical analysis related to consulting work.

In addition to teaching and pursuing research, Pevey also performs on stage in musicals for community theater, including shows at UT's Clarence Brown Theatre. Pevey also taught two classes for UT Choir students called the Culture and History of Ireland and the Culture and History of England for UT's School of Music. These classes prepared students for summer trips abroad, which he and his wife also attended.

In retirement, Pevey will continue to add value to the department as a professor of practice.

Fall 2020 Update ZEANAH ENGINEERING COMPLEX



Labs and offices of our Department of Nuclear Engineering will fill this wing of the new building.



This open and airy space is the future reception area for the college's administrative offices.



The new complex will offer engineering with a view, invoking civil, environmental, industrial and other fields while being home to nuclear engineering.



Workers add the elegant brick exterior to the north side of the new building. This area will be home to first-year studies and the college administration.

NEUP Funds More UT-Led Research



Brian Wirth



Nick Brown

By Élan Young.

The DOE's Nuclear Energy University Program (NEUP) funds millions of dollars in research being conducted at US colleges and universities in support of DOE's mission and goals.

Funded projects focus on the needs and priorities of key Office of Nuclear Energy programs, including fuel cycle, reactor concepts, and mission-supporting research.

UT-led research projects and projects with UT co-principal investigators that received NEUP awards include:

UT-ORNL Governor's Chair for Computational Nuclear Engineering **Brian Wirth** (PI) and Associate Professor **Nick Brown** (Co-PI):

- "Multi-physics Fuel Performance Modeling of TRISO-Bearing Fuel in Advanced Reactor Environments"

Associate Professor and Southern Company Faculty Fellow **Jamie Coble** serves as Co-PI on two projects:

- "A Holistic Artificial Intelligence Tool to Mitigate Human Factor Uncertainty in Operation and Maintenance" — led by UT Industrial and Systems Engineering Associate Professor Anahita Khojandi
- "Innovative Enhanced Automation Control Strategies for Multi-unit SMRs" —led by University of Michigan Nuclear Engineering and Radiological Sciences Assistant Professor Brendan Kochunas

UT-ORNL Governor's Chair for Nuclear Materials **Steven Zinkle** (Co-PI)

- "Investigation of Novel Nickel-Based Alloys for Molten Chloride Fast Reactor Structural Applications" —co-led by University of Cincinnati Materials Science and Engineering Professor Vijay K. Vasudevan



Jamie Coble



Steven Zinkle



Department Celebrates Outstanding Members

Due to the pandemic, we were not able to host our annual awards banquet in person and hosted an online edition instead. Although nothing can replace the atmosphere of an in-person celebration, we are still so proud of our faculty, staff, and students who have continued to shine through these challenging times.



Faculty Awards

Nuclear Engineering Professor of the Year Award
Associate Professor **Ronald Pevey**

Research Faculty/Associate Excellence Award
Research Scientist **Caen Ang**

Nuclear Engineering Faculty Service Award
Assistant Department Head and Southern Company Fellow **Jamie Coble**

Special Faculty Service Award
Professor **Michael Howard**

Student Awards

Student Ambassadors
Amanda Bachmann, Kyndal Biladeau, Parker Forehand, Emily Hutchins, Kate Joshi, Madison Ratner, and Jonathan Wing

Outstanding Student Ambassador Award
Amanda Bachmann and Jonathan Wing

Alpha Nu Sigma Inductees
Robert Kile, Mairead Montague, Quinton Terry, Kyle Anderson, John Wagner, and Andrew Decker

Top Academic Performers

Top First-Years
Annie Berens, David Burgess, Lance Drouet, William Fritsch, Katie Karl, Marissa Knofczynski, Gabe Lentchner, Anthony Tom, and Austin Zachary

Top Sophomores
Kenneth Bott, Jonathan Barthle, and Cale Overstreet

Top Juniors
Emma Houston, Miller McSwain, and Alex Zeringue

Staff Awards

Nuclear Engineering Outstanding Staff Award
Pam Arrowood

Nuclear Engineering Staff Service Award
Michelle McBee

Outstanding Fellow Staff Award
Tonya Mathes

Outstanding Undergraduate Researcher Award
Heath Davis

Master's Graduate Research Excellence Award
Amanda Bachmann

PhD Graduate Research Excellence Award
Peter Doyle

Top Seniors
Irfan Ibrahim, Luke Seifert, and Sam Wehby

Student First Step Awards
This award gives recognition for students who publish their first peer-reviewed journal article. Publishing is an important step towards a scholarly career and should be celebrated.

Sujana Chandrasekar, Cordell Delzer, Jonah Duran, Jacob Gorton, Seungsup Lee, Thomas Looby, and Anurag Maan

STUDENT NOTES

Gorton, Hernandez, and Wheeler Win Nuclear Technology R&D Awards

By Élan Young.

Doctoral students **Jacob Gorton**, **Richard Hernandez**, and **Alexander Wheeler** each recently received a 2020 Innovations in Nuclear Technology R&D Award from the US Department of Energy's Office of Nuclear Technology R&D.

Jacob Gorton received the award for his paper, "Reactor Performance and Safety Characteristics of ThN-UN Fuel Concepts in a PWR," which was published in the *Nuclear Engineering and Design journal* in December 2019.

Richard Hernandez received the award for his paper, "Review of Pool Boiling Critical Heat Flux (CHF) and Heater Rod Design for CHF Experiments in TREAT," which was published in the *Progress in Nuclear Energy journal* in May 2020.

Alexander Wheeler received the award for his paper, "Plutonium Diversion Effect on Molten-Salt Reactor Dynamics," which was presented at the American Nuclear Society Winter Meeting in November 2019.

In order to be successful and retain its leadership role in nuclear technologies, the United States must foster creativity and breakthrough achievements to develop tomorrow's nuclear technologies. The US Department of Energy has long recognized that university students are an important source of breakthrough solutions and a key component in meeting its long-term goals. The Innovations in Nuclear Technology R&D Awards program was developed for this purpose.

Four Students Receive ANS Awards

Four students have earned funding from the American Nuclear Society (ANS) to pursue their education in the nuclear field. ANS has awarded 59 scholarships totaling \$157,000 to students pursuing degrees in nuclear science and technology for the 2020-21 academic year.

Madison Allen

John and Muriel Landis Scholarship
Hans P. Loewen Memorial Scholarship

Sawyer B. Irvine

Robert E. Uhrig Graduate Scholarship

Charles Miller McSwain

ANS Oak Ridge/Knoxville Local Section
Undergraduate Scholarship

Amanda M. Bachmann (MS '20)

ANS Oak Ridge/Knoxville Local Section Graduate Scholarship
(Award for pursuing PhD at University of Illinois, Urbana-Champaign).

Gussev Receives DOE SCGSR Award



Third-year PhD student **Igor Gussev** is one of two UT graduate students to receive a DOE Office of Science Graduate Student Research (SCGSR) award. Since its inception in 2014, UT ranks number one in the country for SCGSR awards with 19 recipients.

Gussev's research explores the atomic-scale structure of glasses and ceramics under extreme conditions and evaluates the potential implications for nuclear energy technologies. Funding provided by the award gives him the opportunity to conduct research at ORNL, collaborating with experts on advanced modeling techniques to gain further insight into the fundamental disordering mechanisms in ceramics and glasses.

NEGSA Wins Graduate Student Organization of the Year

In its first year of operation, the Nuclear Engineering Graduate Student Assembly (NEGSA) won the Graduate Student Organization of the Year Award from UT's Center for Student Engagement.

"Any of NE's graduate students are free to join," said NEGSA's president, **Tyler Steiner**, who also founded the organization in 2019 to make sure graduate students could help in shaping the department. "NEGSA seeks to collectively give a voice to our grad students and improve our department through collaboration and new perspectives."

The organization serves as a forum to empower graduate students to initiate and engage in discussions, events, and programs to better the nuclear engineering department and its graduate students. In addition to serving as a resource through which grad students can share their thoughts with the department, NEGSA also offers the ability for more communication between grad students themselves, helping build an improved community.

Steiner said that the success of NEGSA's first year would not have been possible without the executive board, including vice president **Mairead Montague**, treasurer **Edward Duchnowski**, and public relations chair **Emily Hutchins**.

In its first year, the group managed to:

- Establish an NE graduate student orientation;
- Create a form and procedure for students to request colloquium speakers;
- Welcome new spring semester graduate students;
- Significantly revamp recruiting efforts;
- Organize and lead several outreach events to local schools, food pantries, and more.

Senior Design

The department congratulates its 2020 senior design award winners. While the seniors did not get a chance to show off their projects in person this year due to the pandemic, the winners were recognized in an online presentation. All of the teams worked hard to pull off their projects despite the limitations of quarantine. This year's winners demonstrated excellence through technical expertise and an ability to work well as teams, among other traits.

Top NE Senior Design Award

The Nuclear Fuel Storage Temperature Monitoring System Team

This project, sponsored by EPRI, was a joint venture between the Department of Nuclear Engineering and the Min H. Kao Department of Electrical Engineering and Computer Science to develop a low-cost temperature sensor for monitoring used nuclear fuel in dry cask storage. Presently, once used nuclear fuel is removed from on-site cooling pools, it is stored in large metal canisters surrounded by concrete, where the fuel continues to be cooled via natural convection. A key design requirement of these systems is to ensure continuous airflow and monitor for blockages, a task that is currently performed via daily inspections. This project sought to replace these daily inspections with a low cost, low maintenance, and high accuracy device that monitors the outlet temperature of these vents and notifies plant workers of a temperature anomaly.

Team Members: **Martino Hooghkirk** (NE), **John Wagner** (NE), **Brian Chrisman** (EECS), **Christian Haynes** (EECS), **Melissa Quirin** (EECS), and **Michaela Williams** (EECS)

Best Nuclear Engineering Design Teamwork Award

The Fast Neutron Source Design for Criticality Safety Team

This project involved the creation of operation procedures and a criticality safety evaluation of the loading and storage of fuel material and spectrum-moderating material in the new Fast Neutron Source for the new Engineering Complex. As part of this effort, the group also designed the working table and storage container for the materials along with establishing a criticality safety program for the department.

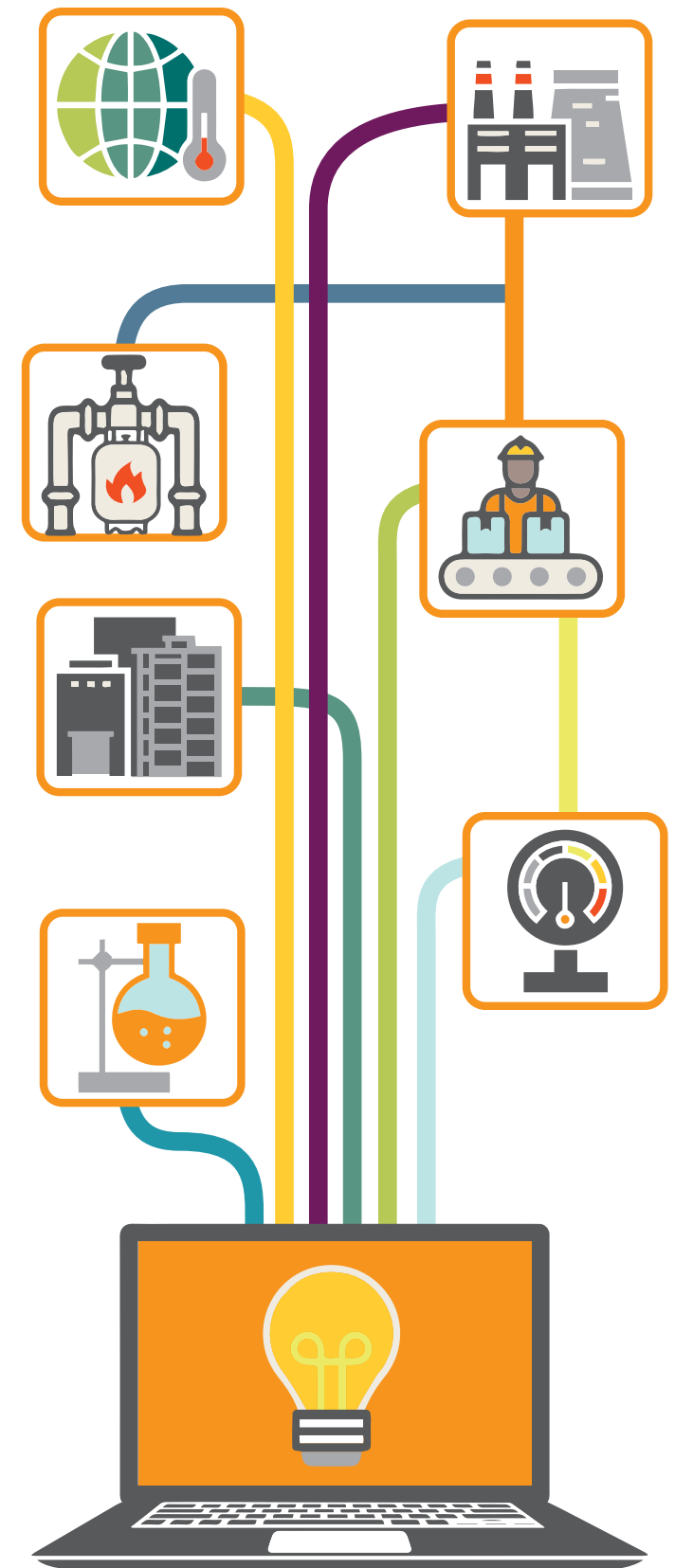
Team Members: **Bridget Wood**, **Felipe Novais**, **Matthew Hipkins**, and **Parker Forehand**
Forehand also won the Top Design Team Leader Award.

Best Interdisciplinary Design Award

The Rapid Autonomous Pneumatic Transport System Team

This project's aim was to design and construct a pneumatic transfer system to transport small material samples between a material loader, a nuclear irradiation facility located on a different floor of a building, a radiation counting system, and a disposal canister. The system operates autonomously, provides radiation transparency, and strongly considers safety and reliability.

Team Members: **Cameron Salyer**, **Kaleb Peete**, **Bradley Bloedorn**, **Seth Walker**, and **Marcos Escudero**





Goluoglu Brings Engineers Without Borders to UT

By Élan Young.



At her first meeting with student organization leaders across the Tickle College of Engineering, Associate Dean Ozlem Kilic posed an important question: How, as the Volunteers, did UT not have an Engineers Without Borders (EWB) chapter?

As the president of Women in Nuclear, third-year nuclear engineering student Ashley Goluoglu attended Kilic's

meeting. When she heard this, she set out with true Volunteer spirit to bring EWB to campus.

The mission of EWB is to build a better world through engineering projects that empower communities to meet their basic human needs and equip leaders to solve the world's most pressing challenges.

Goluoglu's father immigrated to the US from Turkey after receiving his first college degree, and she visits Turkey for about a month every year or every other year. Growing up with this experience has given her a valuable global perspective, and as an Engineering Vol, she sees the value engineers can bring to communities in need.

"There is a difference between a country's reality and how it is portrayed culturally, economically, and politically in the media," she said. "What I have found is that the picture people tend to have of Turkey is a far cry from the beautiful reality of a place I consider a second home."

This underscores the values Goluoglu wants EWB's members and operations to have. She explains that the club will only go places where members have a significant connection through someone who knows the culture, the area, the language, and the problems.

She also believes it is important for all club members to be mindful and self-aware.

"We need to recognize that these problems we talk about, like access to clean water or food or energy, are problems that occur right here in East Tennessee," she said. "It's important to not look down on any other community for problems we have in our own community."

Goluoglu has always wanted to start her own club. Once she decided to bring EWB to UT, she took initiative to write the group's constitution, project proposals, and report templates, building in efficiencies to serve the group for the long term.

Already, the proposals, complete with diagrams, budgets, and timelines, are helping to build the group's reputation in the local community.

"I wanted this club to be mature and professional, so I wrote templates to give a sense of uniformity," she said. "The proposals and reports help people we work with understand and support our goals as well as help future members follow previous projects and ideas."

As a trial run, the group focused its first efforts in East Tennessee. The first two projects included a community-centered outdoor space at Vine Middle School and solar-powered charging station at KAT bus stops around Knoxville.

At Vine, they created an outdoor classroom, a sensory garden, rainwater collection system, and an aquaponics garden. The area will also be cleaned and painted with colorful educational murals.

With about 50 members from across all engineering disciplines, EWB is able to mobilize general engineering in the community.

"Any student in the Tickle College of Engineering can participate," Goluoglu said. "As engineers, our goal is to design a system that is simple enough it can be operated or replicated by anyone."

For the bus stop project, the group considered the importance of having a phone to get and keep a job, and how vulnerable populations could use extra support for keeping a device charged.

As the group grows, they are beginning to investigate possibilities for taking on new projects abroad.

Students Take Nuclear Engineering to Elementary School

By Élan Young.

Doctoral student Alyssa Hayes loves doing outreach in schools, so she volunteered to be the outreach coordinator for the Nuclear Engineering Graduate Student Assembly (NEGSA).

Eventually, she met Anne Skutnik, education coordinator for the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT), a research center funded by the National Science Foundation and the US Department of Energy.

CURENT is housed within the Min H. Kao Department of Electrical Engineering and Computer science, but accepts engineers from all disciplines to go into the schools once a month, and Skutnik was able to help Hayes connect with one such opportunity.

At a January event at Powell Elementary in Knoxville, K-5th-grade students and their families had a chance to attend an event set up like a fair, where they could interact with students at different tables representing a variety of college majors. Each table had its own activity to engage young minds.

"I saw that there was aerospace, mechanical, civil, bioengineering, and others," Hayes said. "It was great to be able to bring a nuclear engineering focus as well."

NE doctoral students Emily Hutchins and Robby Kile were also there to represent the department, with a cloud chamber from John D. Tickle Professor Lawrence Heilbronn and a ping-pong ball game from Southern Company Faculty Fellow Jamie Coble.

"All the kids get two to three ping pong balls, the kids are the uranium atoms, and the ping-pong balls are neutrons," said Hayes. "If a neutron touched a kid, then they had to 'split' and throw their 'neutrons' out. This fun activity is supposed to demonstrate a chain reaction."

Another activity involved marshmallows and toothpicks. Kile walked the kids through the different parts of the atom and guided them to build models of hydrogen and helium.

This kind of outreach is not only fun for college students; it's also essential for opening up young minds to science and engineering with exposure to new concepts.



UT students in Powell Elementary School, including NE students Robby Kile, back row, far left; Alyssa Hayes, front row, fifth from right; and Emily Hutchins, front row, sixth from right.

Burahmah Explores Cosmic Radiation

By Élan Young.

For doctoral student Naser Burahmah, who is studying medical isotope production, a two-week radiation summer program in Europe last year was one of the highlights of his life. He found himself one of the few lucky students to take part in such a program.

The European Space Agency (ESA), formed a partnership with the Facility for Antiproton and Ion Research (FAIR), currently being built at the Helmholtz Center for Heavy Ion Research (GSI). The collaboration brings together an accelerator and space agency concerned with developing research on potential materials to help protect humans from cosmic radiation, either for future missions into space, but also right here on earth.



Astronaut Thomas Reiter presented Naser Burahmah with a certificate for participating in the ESA-FAIR.

The program accepts 15 members from European states and only three from elsewhere in the world. As the only person from the US in the program, Burahmah was able to get a global perspective like no other, and one that has already served him well since returning.

Because the program brings together student researchers from across the sciences, Burahmah was able to learn from peers across the world studying biology, medicine, physics, geology, and other scientific disciplines.

All participants received a fundamental understanding of physics and biology in space and foreign environments to better understand how the human body reacts to those environments. Most of the uncertainty on space radiation risk is associated with the limited knowledge of biological effects of cosmic rays, creating a need for new investigations.

At the close of the program, participants were to write a proposal and present it. They could also apply for time using the facility and the particle accelerator to advance their research.

A Life-Saving Invention

By Elan Young.

Micah Folsom, a recent doctoral graduate in nuclear engineering, has invented a radiation detector design that may one day be used to stop the smuggling of nuclear material or help emergency responders find radiation spread from a dirty bomb.

Folsom took a concept that was built for gamma ray detection and made it work for neutron scatter imaging technology.

This design successfully uses compact, optically separated plastic scintillator planes and an optical coded mask pattern inside of each plane in order to image/localize each neutron interaction within a module. It has also achieved reconstructions of the neutron spectrum, which helps to identify neutron source type.

Similar cameras that image neutron sources like plutonium are large and bulky because the neutron must interact at least twice, typically in two well-separated planes, and the energies and locations of the neutron scatters must be known.

Folsom's camera design is the first working compact neutron scatter camera, similar to a fast neutron equivalent of the Advanced Compton Telescope used in gamma ray astronomy.

"This design has very good potential to be able to image neutron sources rather quickly due to high potential for excellent imaging efficiency," said Professor Jason Hayward, who served as Folsom's thesis advisor.

The camera takes pictures of radiation, fast neutrons, and then shows where those fast neutrons are coming from. The camera is designed to be compact enough for someone to carry on their person.

"There are systems that exist like this already. These are fast neutron scatter cameras; however, they are large and two people have to wheel them around, making them inefficient for law enforcement," Folsom said.

The camera utilizes what's called coded-aperture imaging, which consists of a very specific shadow pattern and a light source. The source will cast a shadow right through the pattern, similar to how light will go right through fingertips.

There's a very specific pattern cast onto the photo systems; then the shot is recorded and an unfolding algorithm is used to figure out where the light came from.



Micah Folsom in front of the accelerator at ProVision, a radiation therapy facility in Knoxville.

"This design has very good potential to be able to image neutron sources rather quickly."

—Jason Hayward

Because the current technology requires a physical separation between two larger detector planes, the devices are bulky and take minutes to make an image. In contrast, this camera technology could allow for a more compact device that could be carried by law enforcement to help detect

smuggling of nuclear materials or be used by technicians to map nuclear material contamination in real-time. It could be carried, for example, with a handle, or in a backpack.

One of the next steps is to further optimize the efficiency of the device so that it can better detect neutron scatters that are often only a few centimeters apart, which will allow images to be collected even faster. It also needs to be developed and ruggedized for commercialization and field use.

ALUMNI NOTES

Dodds and Mihalczko Inducted into Department's Hall of Fame

By Élan Young.



Lee Dodds

Professor Emeritus Lee Dodds and former Ford Foundation Professor and ORNL researcher John Mihalczko are the 2020 recipients of the Department of Nuclear Engineering's Hall of Fame Awards. The Hall of Fame was created to show current students that anything is possible and to honor those who have made the department proud to be Volunteer Engineers.

"It is critical to me that the inductees we select have demonstrated both significant contributions to the field and have fostered the lifelong connections to the department necessary to inspire our students," said Department Head Wes Hines. "Both Lee Dodds and John Mihalczko not only have extraordinary career accomplishments, but they are also Volunteers at heart and continue to be dedicated to making this department, college, and university better than ever."

Inductees are considered and selected after careful deliberation by the dean of engineering, department head, and department's board of advisors.

Dodds, who is also a former nuclear engineering department head, is a three-time graduate of the department, having earned his bachelor's in 1966, master's in 1969, and doctorate in 1970. He joined the department as an associate professor in 1976 after working for the Savannah River Laboratory, ORNL, and NASA. Dodds then became department head in 1997 and led the department to a top ten national ranking by U.S. News and World Report.

He is a past member of the Accreditation Board of the National Academy for Nuclear Training, the National Board of Directors of the American Nuclear Society, and the National Board of Directors of the Nuclear Energy Institute. Dodds has received many awards during his career including the Arthur Holly Compton National Teaching Award and the Robert L. Long Training Excellence Award. He is a Licensed Professional Engineer and a fellow of the American Nuclear Society.

Mihalczko earned his doctorate from the department in 1970. He is an ORNL Corporate Fellow and a true US nuclear pioneer. He worked at the Curtiss Wright Corporation from 1953 through 1958 on nuclear propulsion and a variety of other nuclear reactor applications. He joined the Neutron Physics Division of ORNL in 1958 as a researcher at the Oak Ridge Critical Experiments Facility, staying until he joined the ORNL Instrumentation and Controls Division in 1973.

At the Critical Experiments Facility, he performed a wide variety of research related to reactor design, nuclear criticality safety, and reactor physics. His criticality experiments, development of nuclear weapons verification technologies, and other vital research is world-renowned. For these contributions he was awarded fellow of the American Nuclear Society.



John Mihalczko

AROUND THE DEPARTMENT



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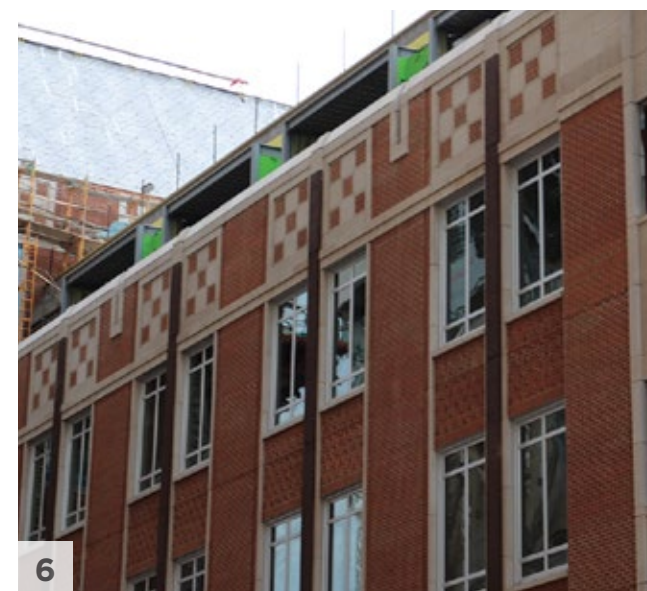
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6

- 1: Southern Company Faculty Fellow Jamie Coble and Professional Advisor Amanda Lovelace spent the day at Y-12 National Security Complex for Introduce a Girl to Engineering Day.
- 2: Several students, led by UCOR Fellow Jason Hayward, visited ORNL's Safeguards Laboratory, where they conducted exercises with a portal monitor, hunted for materials with handheld detectors, made enrichment measurements, and engaged in a nuclear holdup measurement competition using mock nuclear processing equipment.
- 3: Graduate student Mairead Montague attended the Atomic Wings Lunch and Learn in the spring and provided social media coverage for the department during the luncheon.
- 4: NE Department Head Wes Hines received the H.M. Hashemian Mid-Career Award from ANS in honor of the UT alumnus. Hashemian presented the award to Hines.
- 5: NE faculty and staff dressed up as "The Addams Family" for the college's annual Boo in the Courtyard costume competition. The "family" won the second-place award.
- 6: Zeanah Engineering Complex: The classic Ayres Hall checkerboard is nicely done in the brickwork around the new complex, which will be home to the Nuclear Engineering Department

301 Nuclear Engineering Building
1412 Circle Drive
Knoxville, Tennessee 37996-1410
Phone: 865-974-2525
Email: utne@utk.edu
Web: ne.utk.edu



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big orange. big ideas.



Mohammad Khan and his team spark a medical breakthrough. Page 4.