Fall 2023

University of Idaho
Department of Nuclear Engineering and Industrial Management

NEWS

Message from the Chair

Dear Friends,

Greetings! This has been a great year for our department so far. We look forward to finishing the year strong.

Two of our NEIM faculty members, Dr. Aleksandar Vakanski and Dr. Amin Mirkouei, were promoted to Associate Professor and were tenured, along with affiliated faculty member, Dr. Dakota Roberson. Dr. Krishnan Raja also joined our department as a permanent tenured faculty member. We appreciate these and other highly valuable members of our team for their dedication and hard work.

Our students continue to impress all with their performance. The quality of our programs depends on the quality of our students. We continue to see greatness coming from them.

In June we had members from the International Atomic Energy Agency (IAEA) visit our Idaho Falls campus, to review our Nuclear Technology Management certificate. They were very impressed with our facilities, faculty, and students. We are pleased to announce that IAEA fully endorses this certificate in conjunction with our Nuclear Engineering and Technology Management master's degrees.

As Paulo Coelho said, "When we strive to become better than we are, everything around us becomes better too." Wish you and your family a wonderful winter holiday season! We look forward to a great spring semester. Go Vandals!

Indrajit (Indy) Charit
Department Chair
Nuclear Engineering and Industrial Management
icharit@uidaho.edu

Dr. Indrajit Charit
Department Chair and Professor
Nuclear Engineering and Industrial Management

IN THIS EDITION

FACULTY NEWS

New Faculty Member Krishnan S. Raja

August 2023

Krishnan S. Raja (Raja) joined the Department of Nuclear Engineering and Industrial Management as a regular faculty member in August 2023. His areas of research are: Environmental degradation of nuclear materials, pyro processing of used nuclear fuels, molten salt reactors, molten salt batteries, additive manufacturing of nuclear components for micro-reactors, and electrochemical engineering. Currently he is working on a DOE-EERE funded project entitled, "Innovative Technology for Continuous, Online (in situ) Monitoring of Corrosivity of Molten Salts to Prevent Catastrophic Failure of Solar Thermal Plants."

Prior to joining Idaho Falls Center, Raja was a tenured full professor of the erstwhile Materials Science and Engineering Program of the University Idaho at the Moscow campus. Raja lives in Ammon with his wife of 34 years. They have two adult sons. His elder son is a physician (internal medicine) and serves in the U.S. Airforce as a flight surgeon. His younger son is a hospitalist and an assistant professor of Internal Medicine at the Wexner Medical Center of the Ohio State.

Idaho Falls Center Executive Officer Lee Ostrom Retires, Receives Emeritus Status

June 2023

Lee Ostrom, Center Executive Officer at University of Idaho, Idaho Falls, retired on June 23, 2023. Lee has been a productive faculty member for 23 years. His accomplishments while at U of I include millions of dollars in grants and contracts, over 90 graduate students as major professor and five books. Lee specializes in risk assessment, human factors ergonomics and industrial safety. He received a Fulbright Specialist award to work in this specialty in Finland in 2018 and one to Uzbekistan in 2022. He worked in a wide variety of fields with the Department of Energy, NASA, the Department of Defense, the U.S. Navy and the Nuclear Regulatory Commission. Previously, he served as an associate dean in the College of Engineering and as director of academic programs at U of I Idaho Falls. Even while serving as center executive officer in Idaho Falls, he continued to research and publish. Lee has been a key player in growing U of I's relationship with Idaho National Laboratory as well as expanding opportunities for students and faculty.

Faculty Members' Promotion to Associate Professor and Tenure

Three faculty members in the NEIM Department, all based in the University of Idaho – Idaho Falls center, were promoted to associate professor with tenure, effective in the current academic year.

Aleksandar Vakanski
Department of Nuclear Engineering and Industrial Management

Amin Mirkouei
Department of Nuclear Engineering and Industrial Management

Dakota Roberson
NEIM Affiliate Faculty
Department of Electrical and Computer Engineering

University of Idaho Announces New Funding Program, Names First Recipients

February 2023

Seven projects have been awarded funding through the new UI-CAES Seed Funding Program that began in February. The program provides up to $10K to University of Idaho-led projects with the potential to garner additional, external funding. Its funding comes from the UI Office of Research and Economic Development, where 25% of Facilities & Administration (F&A) funds from sponsored projects are returned to UI research institutes, including UI-CAES, to incentivize competitive research awards. In launching the program, CAES Associate Director for UI John Russell said its priorities are to:

• Support novel, energy-related research, aligned with CAES focus areas

• Support innovative outreach activities focused on energy-related issues

• Provide seed funding for subsequent research proposal development

• Fund graduate student (principally PhD student) energy research

• Support pre-tenure faculty

• Enhance collaboration with CAES institutions

The following awards were announced in late February:

• Assistant Professor Amin Mirkouei's proposal, Collaborative Research: CyberTraining: Implementation: Medium: CyberTraining of Construction (CyCon) Research Workforce Through an Educational and Community Engagement Platform, received a $10K seed grant.

• Professor Indrajit Charit's project, Microstructural and Nanomechanical Characterization of Ion Irradiated Molybdenum Based Materials Joined via Pressure Resistance Welding, received a seed grant of $9,999. Professor Krishnan Raja's proposal, Additive Manufacturing of Self-healing and Irradiation Resistant Components by High Pressure Cold Spray Technology, was awarded a $10K seed grant.

• Assistant Professor Min Xian received a $10K seed grant for his proposal, Building Capabilities in Uncertainty Quantification (UQ) for Computational Models in Nuclear Materials Characterization.

• Xian also was awarded a $4K micro grant for Summer Projects on AI-Enhanced Materials Characterization for Recruiting Graduate Students.

• Assistant Professor Aleksandar Vakanski's project, Active Learning Method for Predicting Creep-Fatigue Behavior of Nuclear Structural Materials, was awarded a $10K seed grant.

• Associate Professor Haiyan Zhao's proposal, Enhancing Advanced Materials and Chemistry Characterization via Acquisition of Mass Spectrometer, received a $10K seed grant.

CAES Center for Advanced Energy Studies

Researchers at the University of Idaho are developing cleaner, innovative mining alternatives

Summer Sandstrom, inlander.com

Imagine a plant pulling not just water and soil nutrients up through its roots, but also raw materials for use in electric vehicles and high-intensity magnets.

While that might sound like something plucked from a science-fiction movie, researchers at the University of Idaho are working to make it a reality.

Called rare-earth elements, these minerals aren't actually rare in quantity, but are difficult to locate and extract from soil and ore. They're crucial components of many different technologies, particularly renewable energy alternatives.

"These elements have applications in clean energy like wind turbines, solar panels, electric vehicles, cutting-edge technology like laptops and cellphones," says Amin Mirkouei, an assistant professor who's leading the project at UI's College of Engineering.

Idaho has abundant reserves of these elements at several locations, including Lemhi Pass and Diamond Creek, Mirkouei says.

Rare-earth elements are also present in many electronics that have been added to landfills. According to a 2019 report by the United Nations, the world produces 50 million tons of electronic waste, of which only 20 percent is recycled.

Part of Mirkouei's team's research involves finding ways to extract rare-earth elements from these electronics to provide sustainable and cost-effective methods to reduce both waste and environmental harm resulting from mining methods.

Current extraction methods are not only bad for the environment, but unsustainable. Most of the U.S. supply of rare-earth elements are imported from China, which produces over 80 percent of the world's supply.

"The focus is on using Idaho resources, because Idaho has high reserves of some of these elements," Mirkouei says. "We can use local sources, create more jobs, and it addresses lots of national security concerns such as cyber security and energy security."

The research, funded by the Idaho Global Entrepreneurial Mission through a $440,000 grant, focuses on two methods of extraction:

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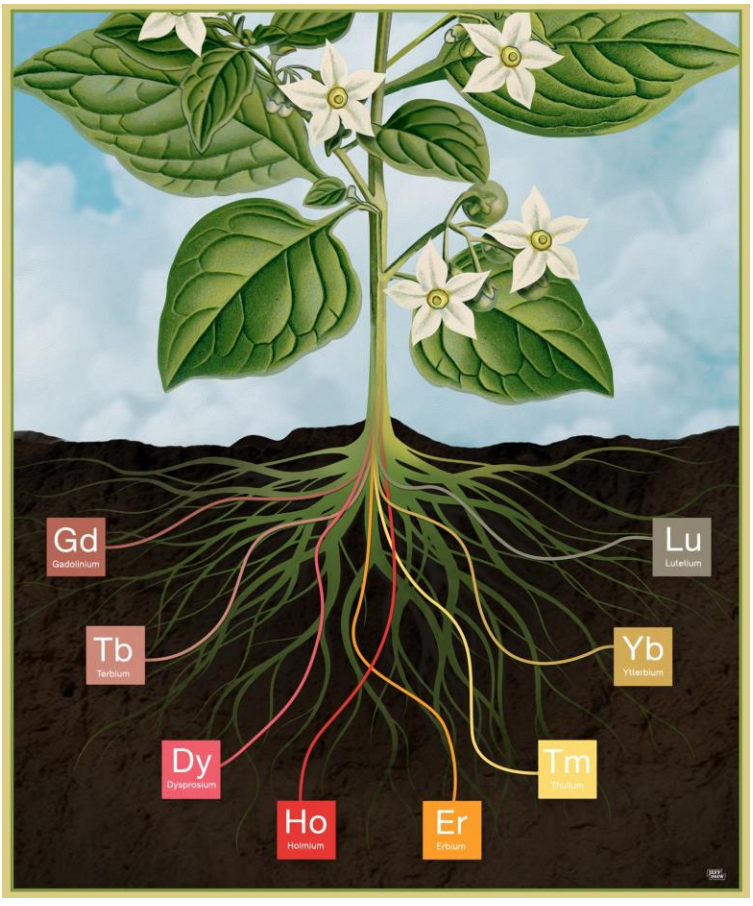


Phytomining uses plants to extract and concentrate metals, while bioleaching is a process using bacteria or acids to extract rare-earth elements from soil and ore.
At the University of Idaho, plants like nightshade, pokeweed, and brown mustard have been used to pull minerals from the soil.

Next the plants are harvested and processed to remove undesired minerals and byproducts from the rare-earth elements. Processing is primarily done through pyrolysis, or the heating of a material in the absence of oxygen, resulting in bio-ore or biochar from which the rare-earth elements can then be extracted.

The other process being researched is bioleaching, which is used when dissolving and extracting gold from ores.

Traditionally this method uses harmful chemicals like cyanide, while also producing hazardous waste that can have harmful health impacts for nearby residents if the materials and waste output are poorly handled and enter waterways.

Bioleaching serves a similar purpose to phytomining, but can be more effective at extracting minerals from low-grade ores, as well as from electronic and industrial waste.

Mirkouei's team is mainly using gluconic acid, which comes from gluconic bacteria, to extract the elements. The acid oxidizes the metallic sulfides in ore or soil, producing sulfuric acid that contains high levels of rare-earth elements.

In addition to creating more domestic dependence for the production of these elements, the team is focusing on finding sustainable alternatives to traditional mining and to lower carbon emissions from such energy-intensive processes.

"We don't want to do serious mining because it really costs a lot, so the focus is extracting from the surface," he says.

The plants in phytomining also act as a decarbonization technology, simultaneously helping counter carbon emissions by collecting carbon from the air.

The research also seeks to reduce waste by providing scientists with ways to reuse existing waste materials.

"You can integrate both to produce more rare earth eventually, maybe in the future," Mirkouei says. "But if you don't have rare-earth-rich soil, we can probably recycle those electronic wastes using the same methods."

After rare-earth elements are extracted through bioleaching and phytomining, they must undergo a process called metallurgy to separate each rare-earth element to produce desired metals.

Mirkouei says the next step is to research using molten salt or electrochemical processes for metallurgy. Once that concludes, a commercializable technology for the entire extraction process can be developed. He estimates it will be about 10 years until the research goes on the market.

"Some of those strategies for recycling the waste from traditional methods are not cost effective, that's why they don't practice it," Mirkouei says. "But these are methods that need to be environmentally friendly."

Addressing Idaho's Changing Needs

June 2023

As central station power generation decreases and the number and types of energy sources grows, our college is looking for ways to support real-world, safe, scalable solutions to reliably meet energy demands.

Nuclear energy is an important aspect of long-term energy portfolios. U of I, Idaho State University and the Idaho National Laboratory are paving the way toward advancing Small Modular Reactor (SMR) and microreactor nuclear research and technologies on the Idaho Falls Campus and have exciting plans to bring this technology to the Moscow campus.

U of I is planning for the construction of an SMR-powered microgrid on the Moscow campus within the next ten years, if not sooner. Providing adequate generation to power the entire campus, the microgrid will also give students access to develop real-world expertise in energy systems production and management through hands-on research utilizing this new equipment as well as internship positions with the INL and with utility partners such as Avista and Idaho Power.

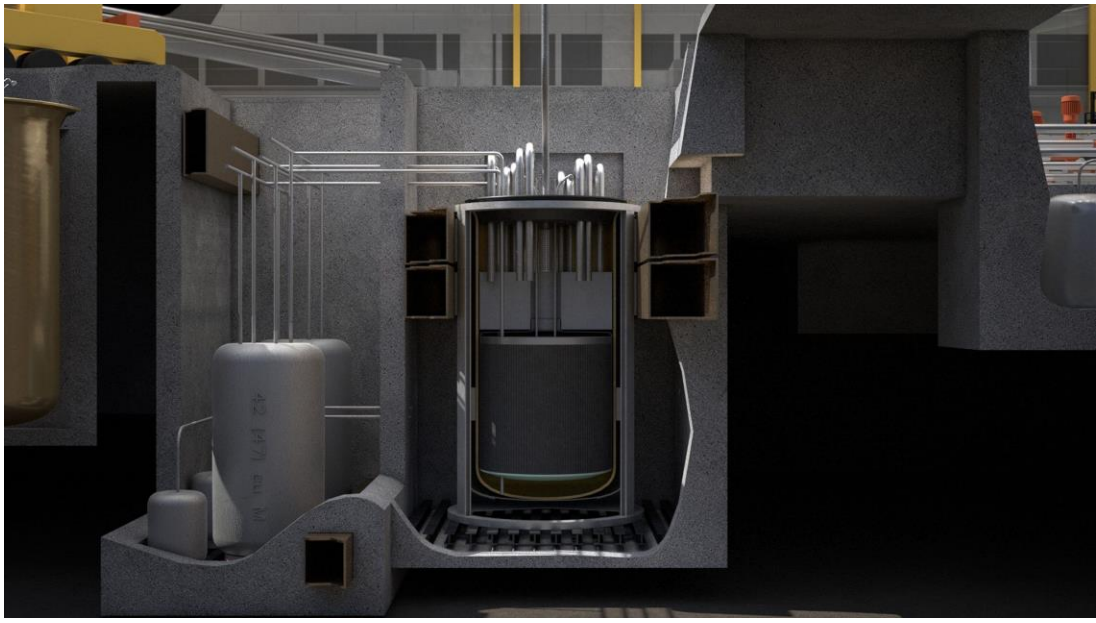
An important first step will enable U of I to design a virtual and augmented reality systems laboratory on the Moscow campus that will allow researchers to test, evaluate, and predict SMR behaviors under different operating conditions.

Population increases, changes in precipitation patterns, technology changes, and load growth are drastically changing the way we look at energy and water in our state.

Utilizing our nationally recognized expertise, College of Engineering faculty researchers are identifying ways to integrate new technologies to meet those demands while also balancing industrial, residential and agricultural demand and hydropower needs and to identify resilient strategies that benefit all Idaho communities, landscapes and watersheds.

The research is part of a recent $24 million National Science Foundation (NSF) Established Program to Stimulate Competitive Research (EPSCoR) grant focused on improving research capacity for Idaho universities to address the impacts of population, climate, and technology change on energy and water systems use in Idaho.

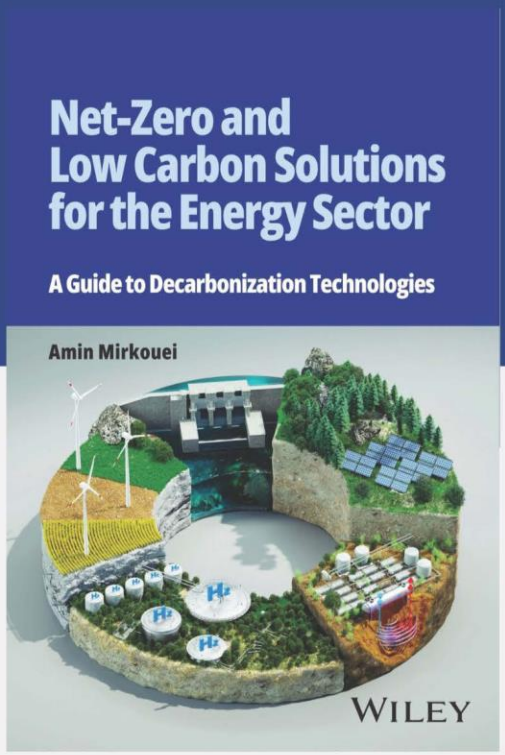
The award will support early career faculty hires, post-doctoral researchers and graduate student hires in universities around the state. Engineering faculty participating in the recent award are Nuclear Engineering Associate Professor Robert Borrelli, Computer Science Professor Terence Soule, Electrical Engineering Assistant Professor Hangtian Lei, and Schweitzer Engineering Laboratories Endowed Chair in Power Engineering Brian Johnson, who is one of the university leads on the project.



Dr. Amin Mirkouei Selected as Editorial Board Member, Publishes Book

August 2023

Dr. Amin Mirkouei has been selected and is serving as an editorial board member of *Nature Scientific Reports*, in Biotechnology. He is also publishing a book, *Net-Zero and Low Carbon Solutions for the Energy Sector*, available Spring 2024. Book details outlined below.



Net-Zero and Low Carbon Solutions for the Energy Sector: A Guide to Decarbonization Technologies

Using mature solutions and case studies, this book advises how to choose and invest in decarbonization technologies to achieve net-/near-zero emissions targets across various industrial sectors.

This book proposes mature (high technology readiness level) net-zero and low carbon pathways and technologies in the energy sector. It discusses net-/near-zero solutions for producing and storing power, heat, biofuel, and hydrogen, and highlighting various pathways and processes to achieving net-zero targets and addressing climate concerns, with case studies to demonstrate their applications.

Each chapter provides a case study, covering decarbonization solutions that have high potential to be used in the near future, such as solar-hybrid systems for net-zero power generation, CCUS-hybrid systems for low carbon power generation, pumped hydropower for power storage, commercial concentrating solar power plants for heat generation, gasification with CCUS for biofuel production, and hybrid thermochemical process for hydrogen production, etc.

Written to be a valuable resource for businesses, academics, and policy makers who are looking for net-zero and low carbon solutions in energy sector, and active in contributing to net-zero emissions targets for keeping the atmospheric CO2 eq. levels below the dangerous range.

Amin Mirkouei

Dr. Amin Mirkouei is an Associate Professor of Renewable and Sustainable Manufacturing in the College of Engineering at the University of Idaho (UI), a certified Professional Engineer (PE), an experienced Technologist, and a Sustainability Contributor at Forbes Magazine.

ISBN: 978-1-119-98216-6
Print
Available in spring 2024
from www.wiley.com

Instructor Highlight: Vickie Lawrence Emergency Planning and Management

August 2023

Vickie Lawrence joined the U of I NEIM department as part-time faculty in the area of emergency planning and management. Vickie has a strong professional interest in emergency planning and management after a career working in the U.S. Department of State's Diplomatic Corps. She lived and worked in seven countries, including two warzones, over her twenty-three years with the State Department. Her work was in the management field, where preparing for the next natural disaster or political upheaval was a constant and ever evolving process.

Emergency situations, both man-made and natural, occur all around the world and in every country and city. As just two examples, while in Benin, Vickie had to deal with electricity in embassy homes for only 4-6 hours every 24 hours for months and in Iraq, delayed food trucks from Kuwait resulted in a salad bar of beets and packages of ketchup for 3,000 people living on the palace grounds. Without the requirement for 6 weeks of food to be always on hand, the dining facility would have been providing the dreaded Meals Ready to Eat (MREs) for weeks. And believe it or not, one of the best lessons in preparedness came in the Washington, DC area after a tropical storm raced up the eastern seaboard. Vickie's house, only seven miles from the Lincoln memorial, was without power for almost seven days in July when the temperatures were in the 90s.

Vickie Lawrence, pictured here with her CERT deployment bag and the 72-hour Go-Bag that she keeps in the car for an emergency.

After completing U of I's graduate studies for an academic certificate in Emergency Management and Planning, Vickie went onto training with the Federal Emergency Management Agency (FEMA) on how to run a Community Emergency Response Team (CERT). Today she is the Program Manager for the CERT in Latah County, the home of Moscow, ID and the main campus for the U of I. Vickie believes that a prepared community is a resilient one that is better able to respond to small and large crises and disasters.

Currently Vickie is teaching the National Management Incident System (NIMS) (INDT 472) and Emergency Planning and Management (TM 525) graduate online courses which are 2 of the 3 required courses for the 15-hour graduate certificate in Emergency Management and Planning.

NSF EPSCoR Funding for Workshop: Intelligent Manufacturing for Extreme Environments

August 2023

Recently, NSF has funded our proposal that sought funding to host a two-day conference at the Center for Advanced Energy Studies (CAES) in Idaho Falls, Idaho. The conference will be held from May 1st to 2nd, 2024. This conference will feature keynotes, panels, and breakout sessions with an estimated sixty participants covering various aspects of intelligent manufacturing for extreme environments. The conference will convene world-class experts, researchers, educators, and students to identify gaps and envision solutions in relevant areas of great importance.

The conference will promote exchange of ideas and knowledge during the proposed event and will catalyze new collaborations and research directions that will support the growth of carbon-free advanced nuclear energy research in Idaho, Wyoming, as well as other western states. The conference organizers will use the funding for travel grants, aggressively recruiting people from diverse and underrepresented groups. The outcomes of the conference will include an opportunity for researchers and educators to network and form collaborations, leading to preparation of a full report to inform policy makers, industry, and the academic community of various challenges and opportunities of advanced manufacturing, specifically in the nuclear energy sector.

The overarching goal of this conference proposal is to host a two-day conference on Intelligent Manufacturing for Extreme Environments. The conference will identify gaps and envision solutions for five inter-related challenges of intelligent manufacturing in extreme environments. These challenges are: (1) printable electronics that can survive extreme environments, (2) in situ manufacturing process monitoring and feedback control, (3) machine learning to optimize process variables in manufacturing and materials composition, (4) extreme temperature qualification and testing, and (5) workforce development and community college engagement.

The project team: Indrajit Charit (PI, University of Idaho), John Russell (co-PI, University of Idaho); David Estrada (co-PI, Boise State University); Marco Schoen (co-PI, Idaho State University); Patrick Johnson (co-PI, University of Wyoming, currently at Iowa State University).

AFFILIATED FACULTY NEWS

Vivek Utgikar Earns Fulbright-Nehru Academic and Professional Fellowship, Publishes Textbooks

January 2023

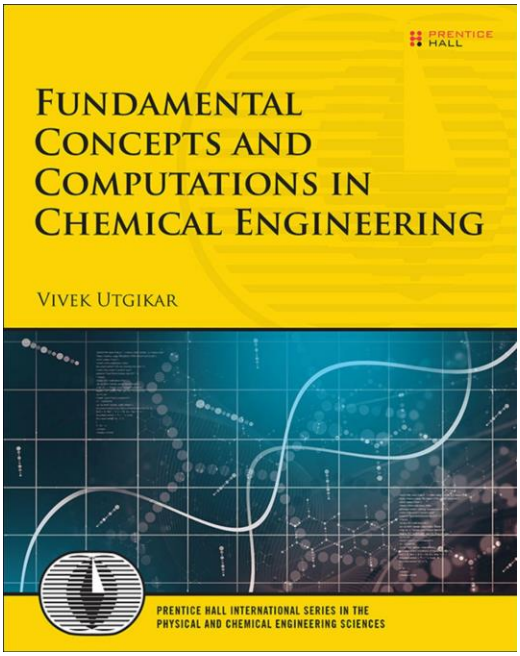
Chemical Engineering Professor Vivek Utgikar recently earned a Fulbright-Nehru Academic and Professional Fellowship. Recognized by Idaho Sen. Mike Crapo, the grant supports teaching, research or a combination of both.

Utgikar's research involves an innovative process for the recovery of rare earth elements from electrical and electronic waste, or e-waste. Experimental investigations are being conducted to verify the technical feasibility, economic viability and environmental impact of the process. The process recovers critical resources consisting of rare earth metals for use in future electronic products, remediating the environment and reducing impact on economies affected by supply chain shortages.

The research will seed future collaborations between U.S. and Indian researchers to tackle global challenges in the critical materials resource recovery and environmental remediation arenas.

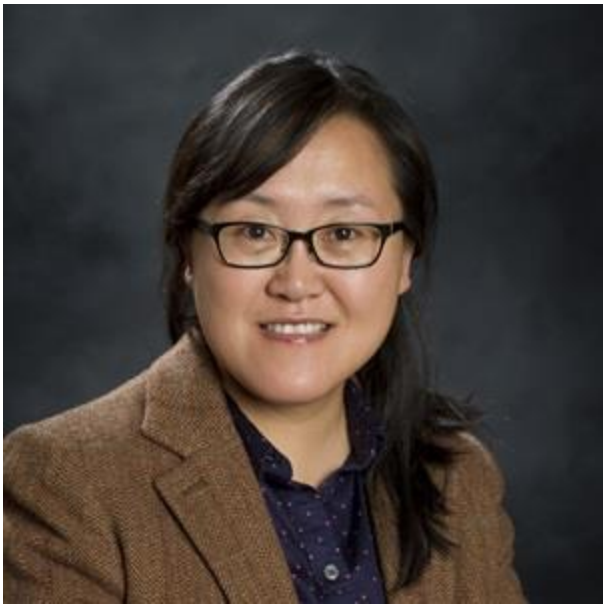
Link: USIEF

Professor Vivek Utgikar also published two books with Pearson Press. "Fundamental Concepts and Computations in Chemical Engineering" is a reference guide designed for students entering chemical engineering programs. "Chemical Processes in Renewable Energy Systems" illuminates technical principles and policy perspectives influencing the move to renewables.



American Chemical Society Symposium by Dr. Haiyan Zhao

August 2023



Haiyan Zhao
Department of Chemical and Biological Engineering

Affiliated faculty member Dr. Haiyan Zhao organized a 3-day symposium at the American Chemical Society Annual Meeting at San Francisco. She had two presentations in high temperature hydrogen production.

Dr. Zhao also has published three papers:
1) Kumar, K.; Ding, L.; Zhao, H.; Cheng, M.-H. Waste-to-Energy Pipeline through Consolidated Fermentation–Microbial Fuel Cell (MFC) System. Processes 2023, 11, 2451. https://doi.org/10.3390/pr11082451
2) AS Nilkar,* CJ Orme, JR Klaehn, H Zhao, B Adhikari Life Cycle Assessment of Innovative Carbon Dioxide Selective Membranes from Low Carbon Emission Sources: A Comparative Study - Membranes, 2023, 13(4), 410; https://doi.org/10.3390/membranes13040410
3) Adam Bratten, Visharad Jalan, Meng Shi,* Tyler Gerczak, Haiming Wen, Peter Doyle, Haiyan Zhao, Xiaoqing He, High-temperature oxidation behavior of the SiC layer of TRISO particles in low-pressure oxygen. 03 February 2023, Journal of American Ceramic Society, https://doi.org/10.1111/jace.19032

STAFF NEWS

Debbie Caudle Recieves Outstanding Staff Award

April 2023

Debbie Caudle
Student Services Coordinator, Idaho Falls Center

Congratulations to Debbie Caudle! Debbie received an Outstanding Employee Award in the non-faculty exempt staff category for 2023.

In his nomination letter, Dr. Indrajit Charit told the committee: "Debbie makes sure that students' concerns and questions are promptly addressed and reaches out to faculty advisors to resolve the matter as needed. She creates a safe place where students can come with their issues and be heard."

Debbie has been with the University of Idaho since December 2007.

STUDENT NEWS

Engineer Returns to College to Polish 'Soft' Skills

April 2023 by Kyle Pfannenstiel

Space might seem far away to some.

Donnie Olsen knows it's all around us — in practical ways.

From phones connected to satellites that let us talk to people thousands of miles away, to GPS systems that guide people through towns and ships across oceans, the links might not be readily visible.

But to Olsen, they are an anchor for life.

That's part of why Olsen came to University of Idaho. He wanted to shift from a life on the seas as a naval nuclear engineer to a career maintaining systems in the skies, as one of the U.S. Navy's maritime space officers, a new position created in 2021.

His work on a master's in engineering management honed the practical "soft" management skills he needed to stand out as an applicant for the new job, which was only hiring 25 candidates each year. Returning to school rekindled his love for learning, and the support offered in the program — geared toward working professionals — has helped him advance his career goals while earning an education.

"Whether I continued with the nuclear community or got out in the civilian world, I knew my degree was going to be something that was going to be able to help me out, and something that was applicable," said Olsen, who will graduate in Spring 2023. "It wasn't me doing the classic 'checking the box' master's. It was a master's that could really benefit me."

Back to School

Much of Olsen's schooling at U of I was to develop "soft" project management skills that he hopes to bring back to military operations work.

One of Olsen's favorite classes at U of I has been a conflict management communication class.

"Avoiding conflict is a valuable tool sometimes, but not always, especially if you're in an organization where these people are going to be working together for several years. Conflict resolution will pay off in the long run," Olsen said.

(Continued next page.)

He's thankful for having Denise Engebrecht, academic programs and student services manager, to help with long-term education and career planning in the college. He said Engebrecht helped him navigate the higher education landscape, finding courses that would work best for his schedule and career path.

"To come back into school and navigate the idea of work and school at the same time, I don't have the free time I had in undergrad to plan out my entire degree path," Olsen said.

Teaching Form Over Formula

Olsen started teaching at U of I in Fall 2020, waiting a semester to begin courses for his graduate degree. He teaches two classes on naval sciences, divided into ship systems and naval systems.

At U of I, Olsen tries to teach what people need to know, rather than just getting students to memorize concepts and facts. He is passionate about space and nuclear energy, but he knows pilots in-training don't need to learn everything about his passions.

"They need education on what's valuable to them," Olsen said.

So, he focuses on the facts they'll need and will stick with them a decade down the line.

"Anything that I could give them to save their life or save someone else's life is something I'm going to focus on a lot more than the technical specifics," he said.

He's grateful to have professors who shared that mentality.

Most of Olsen's classes have been with Sandy Lieske, a lecturer in engineering management who joined U of I after decades of leadership at Hewlett Packard, an electronics manufacturer. Olsen said Lieske's classes taught him the ins and outs of project management, helping him learn to manage a budget. In the military, Olsen said, finances are often handled by supply personnel and administrators at a higher level, but having a fiscal mindset can be helpful to him and others doing field work.

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Denise Engebrecht
Academic Program & Student Services Manager, Boise

Sandy Lieske
Lecturer, Engineering Management

"I spent over 30 years in a corporate job doing more traditional project management, and that is very different than a military approach of managing a mission," Lieske said. "But there's a lot of parallels and a lot of knowledge and tools that you can take away."

Lieske said career shifts like Olsen's, from sea to space, are part of what the program makes possible by giving engineers the tools and skills they need to pursue the career they want.

"My objective at U of I in the engineering management program is really to share knowledge, tools and frameworks that the students can not only apply to their current job to make them more effective, but also to enable them to grow in their career, whether it's getting a promotion or switching roles," she said.

Lieske is quick to say her teachings are not a cookbook, with rigid instructions that students can apply.

"I think what Donnie did was look for opportunities to apply them in a military perspective," Lieske said. "Donnie really tried to dig into the assignments to see what he could take away and apply in his own environment."

Finding His Dream Job

Olsen is a self-proclaimed "absolute nerd when it comes to space." And he always has been.

In high school, Olsen was constantly doing deep dives on the internet, pouring through Wikipedia articles about military technology, initiatives and battles.

When the Navy announced its maritime space officer job designation in 2021, Olsen was eager to apply. But he didn't have much experience working in space issues outside of his personal interests.

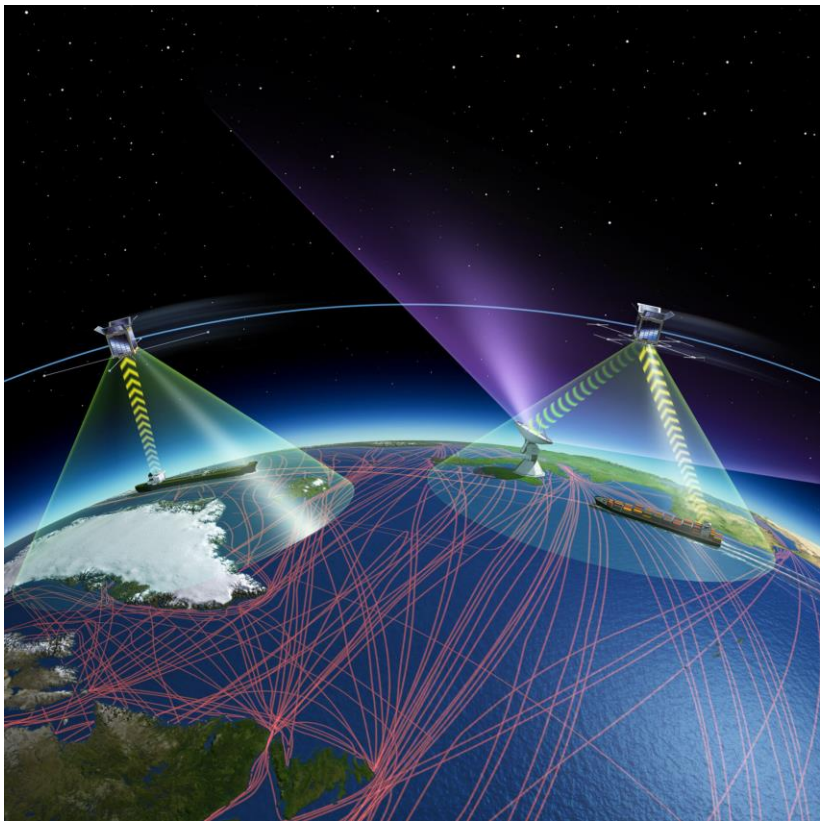
He didn't make the cut for the first 25 officers announced for the job that year.

But when the time came to apply in August 2022, Olsen was ready. He had honed his management and leadership skills at U of I, which he credits with helping his application succeed.

"To be able to have something that I've always loved be my actual career, and with this career having access to a whole lot more stuff than on Wikipedia, it is definitely a dream come true," he said.

He said he knows his high school self would be proud of his trajectory.

"To have found a career where I'm 100% devoted to space warfare and helping defend the United States and our space assets, it's an absolute dream come true," Olsen said. "Even middle school or elementary school me would have thought the same thing."



Rare Earth, Real Sustainability

March 2023 by Alexiss Turner

Sustainable methods to extract rare earth elements from Idaho-sourced soil could reduce national dependence on foreign countries for high-tech manufacturing needs.

Not all engineers have a green thumb, but Dave Zirker does.

His gardens are robust, thriving and capable of extracting some of the most integral components to our daily life – rare earth elements or REEs.

"When a farmer plants a field, they plant corn or grain, then harvest that grain and turn it into bread," the University of Idaho nuclear engineering master's student said, "We're planting plants that can be turned into metal products."

Funded by a more than $440K award from the Idaho Global Entrepreneurial Mission, Zirker is working with a team of engineering and science students, led by Idaho Falls Assistant Professor Amin Mirkouei, to build two distinct – and highly sustainable – methods of REE extraction.

One method uses plants to remove metals from the soil through their roots. The other replaces harmful chemicals currently used in a common method of REE extraction with an organic bacteria capable of doing the same job.

REEs power our everyday lives. They comprise essential components used in cell phones, wind turbines, medical devices, hybrid vehicles, aerospace communication systems and mechanics, national defense technologies and more. The U.S. currently depends on foreign countries for these elements.

Idaho has several known rare earth deposits, many of which are minerals the U.S. imports from other countries. The team is partnering with Coeur d'Alene based mining company Idaho Strategic Resources, Inc. (IDR) and others to gather samples from surface soil.

"We are excited to collaborate with IDR and

(Continued next page.)

others to advance Idaho-sourced REEs for potential commercialization," Mirkouei said. "We want to use Idaho resources to create Idaho jobs. If we need these elements for advanced technologies in the foreseeable future, we need to attain them in a more sustainable or environmentally conscious way."

We Need REEs

U.S. dependence on foreign countries for rare earth minerals became apparent in 2021, after President Biden signed an executive order to review the nation's reliance on foreign supply chains.

China leads REE mining and processing. In 2020, China supplied over 80% of REEs globally and controlled more than 90% of processing capabilities.

REEs are no rarer than other metals. Their moniker comes from the difficulty in extracting them from natural rock or sediment, commonly called ore. Some traditional mining techniques to harvest ore have obvious environmental impacts and safety concerns. They are also tedious and expensive, taking decades to carry out because of domestic permitting challenges and infrastructure development costing millions.

John Swallow, CEO of IDR, said these challenges often lead to offshore mining activity in countries with less stringent environmental and labor requirements. In many instances, he said, critical minerals like REEs are only available from other countries.

Agromining

The agromining process starts with hearty plants – like brown mustard, black nightshade and pokeweed.

"We wanted plants that are tough, not delicate," Zirker said, "We want to give them as little attention as possible and still get minerals from the soil. We also wanted something that wasn't invasive, anything that would cause harm to local farmers or our ecosystem."

Plants are grown in surface soil from Salmon. "We're not disturbing large swaths of earth, we're not strip mining the area or cutting down lots of forests," Zirker said.

Mature plants can be harvested in seven to 16 weeks. Full

(Continued next page.)

plants are heated without oxygen, a process called pyrolysis, which creates a black mass of carbon and ashes called bio-ore.

The bio-ore is sent from the Idaho Falls lab to U of I's Moscow campus, where the amounts of REEs are measured and quantified. Plants like mustard and nightshade have shown promising results, but further testing is needed to refine methods of separating metals from the bio-ore to make the sustainable process viable.

"Growing plants for rare earth extraction from Idaho soil and rocks can be a promising strategy for producing rare earth materials locally and addressing the nation's needs," Mirkouei said. "And at the same time, growing plants is an important strategy for decarbonization, as plants absorb carbon from the air through their leaves."

Bioleaching

Mirkouei's team is also exploring an improved method of bioleaching. The process is already used in gold mining, but the team's method replaces harmful chemicals like cyanide with a simple organic bacteria commonly used in the food and beverage industry in the fermentation process of vinegar.

Their bacteria - gluconobacter oxydans – is easy to grow and handle and is non-pathogenic.

"Rare earth elements are difficult to extract because they are so chemically similar," said Rebecca Brown, a U of I environmental science doctoral student and Idaho National Laboratory microbiologist. "Harsh chemicals that are not good for the environment have to be used. We need to be able to do this more sustainably without ruining the environment around us."

In gold mining, cyanide is used in some instances to dissolve the gold present in the ore. Although the chemical process is highly efficient, its caustic nature can have major environmental impacts when handled incorrectly. Cyanide spills around the world have harmed ecosystems and contaminated drinking water in regions where less stringent environmental and labor regulations exist.

Much like the process of extracting gold, the team's novel methods can be used to extract REEs from ore even at low levels, making the extraction process more profitable.

"There's a lot of research and scaling up needed to make this process cost-effective and efficient," Brown said.

Next Steps

Research to improve these methods will continue, and partnerships with Idaho industries that are actively exploring and developing these resources will help identify areas best suited for sampling and extraction.

"IDR is the largest REE company in the U.S.," said Swallow. "With over 90% of IDR's properties located within the state, and with the right support and investment, Idaho could be on the vanguard of future REE advancements. There is a lot more awareness that needs to occur if we are all going to advance these areas simultaneously."

Steps are also being taken to partner with larger corporations – like General Electric – to better understand the need for REEs and supply chains available once these processes can be commercialized.

Mirkouei said these sustainable innovations can also be used for recycling REEs from old electronics.

"These novel methods are expected to continue to improve and become more widely adopted in the coming years," he said.

Left to right: Arnold Pradhan, Sam Root, and James Zillinger
Idaho Falls Center Commencement Ceremony, May 17, 2023

CONGRATULATIONS TO OUR GRADUATES!

Engineering Management

Spring 2023
Donald C. Olsen, M.Engr.
Florence D. Webster, M.Engr.
Dennis D. Miller, M.Engr.
Jason Wayment, M.Engr.

Summer 2023
Mattie Cupps, M.Engr.
Benjamin Schappell, M.Engr.
Daniel Steik, M.Engr.
Tyler Tolman, M.Engr.

Industrial Technology

Spring 2023
Keith O. Hughes, B.S.Tech.
Michael D. Glaser, B.S.Tech.

Nuclear Engineering

Spring 2023
Eugene T. Engmann, Ph.D.
James D. Richards, Ph.D.
Joseph A. Christensen, Ph.D.

Summer 2023
Olin Calvin, Ph.D.
David Kamerman Ph.D.
Dave Zirker, M.S.

Technology Management

Spring 2023
Charles M. Johnson, M.S.
Roger C. Chunn, M.S.
Sheldon W. Christensen, M.S.

Summer 2023
Bassim AlShedokhy, M.S.

* Ph.D student in NE, Drew Glenna, presented his MS work in molten salt and Ph.D research for CO2 direct air capturing at American Chemical Society Annual Meeting at San Francisco in August.

* Ph.D student in NE, Eugene Engmann, started working at INL as a Postdoc.

International Atomic Energy Agency Visit to University of Idaho, Idaho Falls (UIIF)

IAEA
International Atomic Energy Agency

A team from the International Atomic Energy Agency (IAEA) visited UI-IF in June 2023 to provide a follow-up assessment of our Nuclear Technology Management (NTM) program. IAEA now endorses our program. There are currently nine endorsed NTM programs worldwide and ours is the tenth. The NTM certificate is comprised of the following courses:

- TM 514 Nuclear Safety (3 cr) - online
- TM 516 Nuclear Rules and Regulations (3 cr) - online
- INDT 434 Power Generation and Distribution (3 cr) – live/online
- TM 538/NE 528 Management of Nuclear Facilities (3 cr) – live/online
- TM 537/NE 527 Nuclear Material Storage, Transportation and Disposal (3 cr) – live
- NE 450 Principles of Nuclear Engineering OR TM 520 Leadership and Conflict Resolution (3cr)

The certificate is taken in conjunction with the Nuclear Engineering Masters or the Technology Management Masters.

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Department of Nuclear Engineering and Industrial Management

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