ANS HFICD

Summer 2020 Newsletter

http://hficd.ans.org

It has been an interesting year for everyone in the Human Factors and Instrumentation and Controls Division (HFICD)! While 2020 has not been what anyone expected, the Summer 2020 newsletter is here to keep you informed on what is happening in HFICD. On the following pages, the division is pleased to congratulate all of our division award winners, with Dr. Richard Wood and David Rahn winning the Don Miller Award, Pareez Golub winning the H.M. Hashemian award, and Samir Darbali being awarded the Ted Quinn early-career award. We would also like to recognize Dr. Jin Jiang, who was elevated to the distinguished grade of ANS Fellow in 2019. The division is also pleased to congratulate Dr. Wes Hines for being awarded this year's Robert L. Long award from ANS. The newsletter concludes with two articles, one written by HFICD's own Dr. Graeme West. Dr. West has provided an update on the recent research he has been conducting at the University of Strathclyde that focuses on the use of operational intelligence to support through life management of nuclear plants. The last article, a press release from the University of Purdue, celebrates the successful licensing of the first entirely digital nuclear reactor instrumentation and control system in the nation.

I hope that you enjoy the newsletter and thank you for being a part of HFICD!

- Adam Deatherage
  AMS Corporation
  HFICD Communications
  Committee Chair

CONTENTS

Save the Date!

NPIC & HMIT 2021

June 13 thru 17, 2021

We are excited to announce to the members of the HFICD information regarding the 2021 Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC & HMIT) Conference. Building on the success of the last conference in Orlando, Florida in February 2019, the next NPIC & HMIT will be an embedded topical meeting within the 2021 ANS Annual Meeting. Please mark your calendars now, and join us in **Providence, Rhode Island at the Omni Convention Center June 13 thru 17, 2021.** As a member of this division, please consider submitting a paper on your efforts in our field. We encourage you to be a part of this experience, and we are looking forward to seeing you there!

HFICD Awards

Don Miller Award

This award was established in 2009 by the ANS Human Factors, Instrumentation & Controls Division (HFICD). It is named after Dr. Don W. Miller, Professor and distinguished Program Chair at the Ohio State University Nuclear Engineering Program, a prior member of the Advisory Committee on Reactor Safeguards, and past ANS President.

The award is given to an individual or team who has made recognized contributions to the advancement of one or both of the fields of nuclear instrumentation and control or human-machine interface through individual or combined activities that reflect the life and contributions of Dr. Miller.

Click here to submit a nomination for the Don Miller Award.

H.M. Hashemian Mid-Career Award

This award was established in 2018 by the ANS Human Factors, Instrumentation & Control Division (HFICD). It is named after Dr. H.M. Hashemian, President and CEO of Analysis and Measurement Services Corporation, recognized expert in nuclear instrumentation and controls, and avid proponent of the future generation of nuclear scientists and engineers. This award recognizes an individual for sustained outstanding contributions to nuclear instrumentation and control, human factors engineering, or human machine interface over the first 15-25 years of his or her career.

Click here to submit a nomination for the H.M. Hashemian Mid-Career Award.

Ted Quinn Early-Career Award

This award was established in 2017 by the ANS Human Factors, Instrumentation & Control Division (HFICD). It is named after Mr. Ted Quinn, President of Technology Resources, recognized leader in I&C and former ANS President. This award highlights the importance of young members in the future developments of nuclear instrumentation and controls and human factors research, development, and deployment.

Click here to submit a nomination for the Ted Quinn Early-Career Award.

2020 Don Miller Award Winners

http://hficd.ans.org

Don Miller Award

Dr. Richard Wood

Dr. Wood has worked for the Oak Ridge National Laboratory from 1986 thru 2015 as the Technology area lead for instrumentation, controls, and human machine interface and previously as the ICHMI Technical Area Lead under the DOE Advanced Small Modular Reactor R&D Program. Since 2016, he has been a professor and researcher at UT-Knoxville. Over his career Dr. Wood has worked in support of U.S. NRC programs as part of the ORNL expert team, as a contributor and current Chair of the IEC nuclear standards group SC-45A, and as an instructor and technical contributor to many IAEA documents.

Don Miller Award

David Rahn

Mr. David Rahn has over 38 years of design and licensing evaluation experience in safety and non-safety instrumentation and control (I&C) systems in the nuclear industry, including the application of digital technologies in nuclear power plant applications. Over his career, he has completed several challenging, first-of-a-kind digital I&C design and licensing projects for nuclear power generating stations. In his current role as Senior Electronics Engineer in the I&C branch of the NRC Office of Nuclear Reactor Regulation, he is responsible for evaluation of license applications and license amendment requests from USNRC licensees of nuclear power reactors, development of regulatory guidance products (regulatory guides, standard review plan sections), support of reactor oversight processes, rulemaking, and other activities supporting the mission of the Office of Nuclear Reactor Regulation in the regulatory area of instrumentation and controls.

ANS HFICD

2020 H.M. Hashemian and Ted Quinn Award Winners

H.M. Hashemian Mid-Career Award

Pareez Golub

Ms. Golub has 27 years of instrumentation and controls experience in leadership, licensing, plant design and modification engineering, training, and project management. Ms. Golub has been awarded the H.M. Hashemian Mid-Career award in recognition of her outstanding and sustained contributions to ANS, HFICD, and the Field of Digital I&C and for her leadership in revising the NRC licensing process for Digital Protection Systems, increasing utility confidence and clarity in the implementation of Digital Protection Systems Upgrades.

Ted Quinn Early-Career Award

Samir Darbali

Mr. Samir Darbali is an Electronics Engineer at the U.S. Nuclear Regulatory Commission who is recognized for his exceptional engineering accomplishments in protecting public health and safety by ensuring the safe operation of nuclear power plants through advancements in licensing process, SDOE, and EMP guidance. Mr. Darbali has also supported some of the most complicated and challenging efforts undertaken by the Nuclear Regulatory Commission, including the safety evaluation of major digital upgrades for reactor protection and emergency systems at the Oconee and Diablo Canyon nuclear power stations. Mr. Darbali's engineering leadership has directly led to significant improvements in nuclear safety both in the U.S. and throughout the world.

2019 ANS Fellow Dr. Jin Jiang

Dr. Jin Jiang

As an Industrial Research Chair Professor in Nuclear I&C for the past 16 years, Dr. Jiang has established a world-class research team dedicated to control, instrumentation, and electrical systems for nuclear power plants. He has made significant contributions in several areas, e.g. safety system design and analysis, fault detection, diagnosis and fault-tolerant control, and wireless technologies for nuclear power plants. His work has been cited over 11,600 times (by Google Scholar). He has also developed 4 patented technologies, two of which are being commercialized. He works closely with nuclear industries in Canada and around the world. He has trained over 10 PDFs, 30 PhD and 40 MESc students, many of them are now contributing to nuclear industries.

Hines Receives 2020 Robert L. Long Award

Courtesy of The University of Tennessee Department of Nuclear Engineering

Department Head Wes Hines is the 2020 recipient of the Robert L. Long Training Excellence Award given by the American Nuclear Society's Education and Training and Workforce Development Division's (ETWDD) Honors and Awards Committee.

"Wes Hines is a rising champion in the nuclear community and is by far the most efficient and productive engineer and manager that I have ever seen," said Hash Hashemian, president and CEO of Knoxville-based Analysis and Measurement Services Corporation, member of the ETWDD Honors and Awards Committee, and alumnus of the department ('80).

Hashemian said that Hines's personality also contributes to the nuclear engineering community as well.

"He is also super fun to work with and a funny guy," he said. "Everyone who knows Wes loves him for his intellect, efficiency, effectiveness, and sense of humor. Wes has it all. We in Knoxville, Tennessee, and the University of Tennessee are lucky to have Wes in our community. He is a treasure to not only the nuclear industry but also our community."

"It's an honor to be recognized by the ANS for this award," said Hines, who also serves as both Postelle Professor and Chancellor's Professor in the department. "Education and training of the next generation of nuclear engineers is our passion at UT, and I'm proud of the program we've built together with the help of our industry partners."

The award was established in 1993 and renamed in 2010 to honor Robert L. Long, PhD, who served as ANS President from 1991–1992 and is intended to recognize an individual or group who has demonstrated sustained excellence in nuclear training.

OPERATIONAL INTELLIGENCE TO SUPPORT THROUGH LIFE MANAGEMENT OF NUCLEAR PLANTS

By Dr. Graeme West

Operational Intelligence is part of an EPSRC Prosperity Partnership collaborative research program developing innovative and advanced approaches to extend the life of UK and international nuclear plants, facilities and assets. The EPSRC has provided £2.16M of funding to establish a relevant industrial and academic partnership that will tackle key challenges in nuclear operations. The aim is to significantly improve operational management and maintenance of existing infrastructure, and to improve understanding and knowledge of lifetime and degradation processes. This will significantly increase the life of existing assets, minimize operational risk and reduce through life costs. On-going industrially focused research is categorized into three research themes: Advanced Through-Life Inspection Solutions; Biotechnology for the Treatment and Repair of Concrete Nuclear Infrastructure; and Operational Intelligence.

The Partnership

The program brought together a partnership of industrial, supply chain and academic experts that have the combined expertise to solve nuclear plant life-time challenges, deliver industrially applicable solutions, and create new products and services for commercial exploitation. Industrial and supply chain partners include Babcock International, EDF Energy, Bruce Power, BAM-Nuttall, Doosan Babcock, Weir Group, Kinetrics, Peak NDT, Trillium Flow Technologies and the National Physical Laboratory (NPL); and the academic partners: the University of Strathclyde, the Alan Turing Institute and Cranfield University.

Dr Graeme West from the University of Strathclyde is leading Instrumentation and Controls activities in a research theme entitled Operational Intelligence, which is part of a large international multi-partner research program. This program aims to leverage both data-driven machine-learning techniques and classical knowledge-based artificial intelligence approaches to provide actionable decision support to nuclear power plant engineers.

Focus on Operational Intelligence

Operational intelligence is concerned with improved understanding of plant performance and behaviour, primarily through leveraging technologies including data analytics, image and signal processing, machine learning, and artificial intelligence to enable faster, more robust and more qualified decisions to be made. This research area has seen significant advances in recent times, through many applications in domains such as autonomous vehicles, smart home assistants, social networking and AI for medical diagnosis. However, key challenges remain when deploying these technologies to support nuclear power plant operations. Firstly, many machine learning techniques are so-called black box techniques, which do not provide a clear and transparent explanation of how an anomaly detection or fault classification was reached. A voice assistant incorrectly selecting the latest Lewis Capaldi hit when requesting Bruce

Springsteen won't have far reaching consequences (and won't necessarily warrant an explanation for the mistake). However, mis-diagnosing the surface condition of steam generator pipework, or wrongly attributing an increased vibration signal to a change in plant operational state could have significant and far-reaching consequences for both an operator's business and for the supply of electricity to end users. Secondly, many techniques require a balanced data set, where many instances of each class to be learned are available. For example, when training a driving assistant algorithm to recognise road signs, many instances of the various types can be obtained, and very cheaply. However, within nuclear power plants failure data is thankfully very rare, and though operational data is frequently gathered and stored through plant historian systems, the resulting datasets are extremely unbalanced towards routine operational behaviour. Furthermore, the cost of gathering and labelling data is very expensive, based on the expertise of a limited number of human experts. Thirdly, many successful applications have close association between the digital platform (for example a mobile web app) and the end user, whereas in many nuclear power plants there is a cyber/physical disconnect. Much of the decision support relies on examining multiple streams of data, along with a mental model of some underlying physical process or engineering system, and often takes place within the engineer's head, or through peer assessment with a number of different plant experts, with no feedback to the data gathering and storage systems of any arising action undertaken.

Dr. West's team is addressing these issues in the research programme through the development of software-based technology demonstrators. Using real plant data for case studies, these provide working examples of how the techniques and

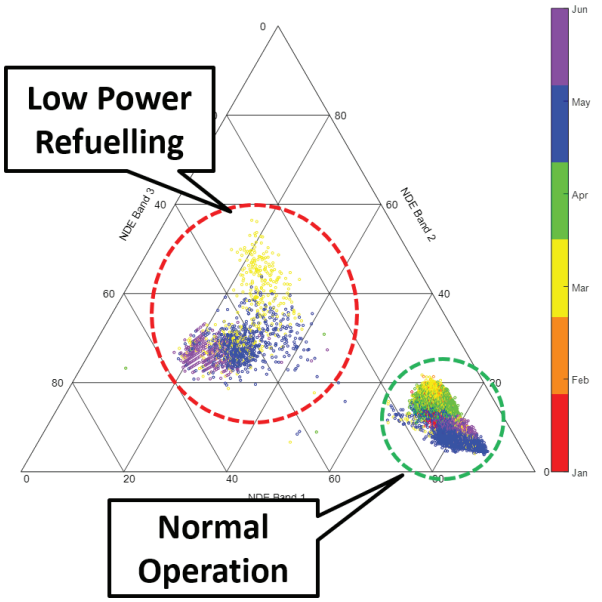


Figure 1. Ternary Plot of non-driving end bearing frequency components for low power refueling events.

algorithms can be implemented on (or support) real industrial procedures, which can be tested and evaluated by end users. To date, this has included:

- Reducing the burden on analysts through the development of automated pump diagnostic techniques based on the capture and codification of plant and pump OEM expertise

- Quantifying operating strategy benefit through the development and implementation of probabilistic pump curves

- Managing evidence from multiple sources through a) development of anomaly detection utilising multi-variate change point analysis and b) development of remaining useful life modelling using compositional statistics

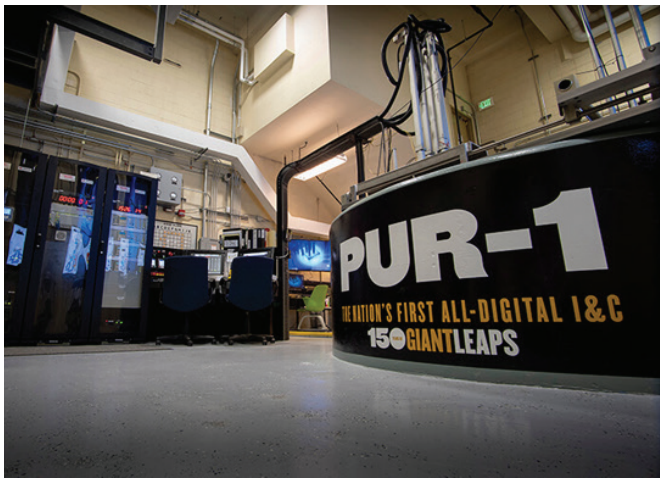
Continued on Page 11

First All-Digital Nuclear Reactor System in the U.S.

Excerpt from Purdue Press Release Written By: Kayla Wiles

WEST LAFAYETTE, Ind. — Nuclear power plants generate 20% of the nation's electricity and are the largest clean energy source in the U.S. But to further offset climate change, the nuclear energy sector needs to extend the lifetime of existing facilities as well as build new ones.

This requires the U.S. switching from traditional



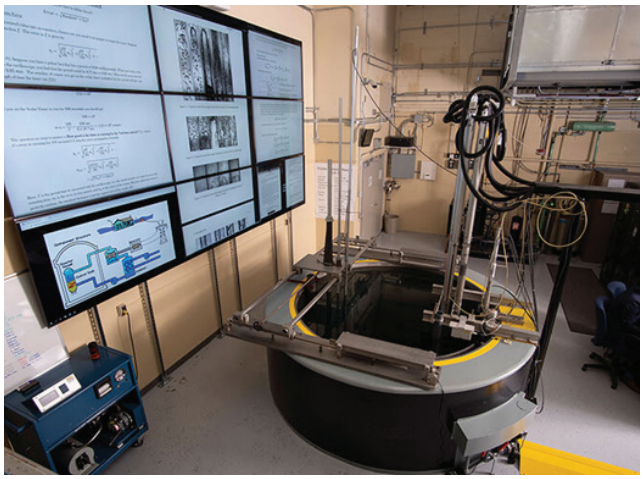
(Purdue University image/Vincent Walter)

analog technology to the latest advances in digital technology, a change already made in other countries.

The U.S. Nuclear Regulatory Commission has licensed Purdue University Reactor Number One (PUR-1) as the first entirely digital nuclear reactor instrumentation and control system in the nation. The upgraded reactor and facility, originally built in 1962, paves the way for widespread implementation of digital technology in both research and industry reactors.

"Modern control technology in the nuclear sector will allow for big data applications and increased reliability," said Clive Townsend, the supervisor for Purdue's reactor. "We're going from the vacuum tubes and hand-soldered wires of the '60s, to LEDs, ethernet cables and advanced electronics."

Traditional analog consoles make it difficult to take research data accurately and quickly, while a digital system allows values to be measured instantly. Going digital means that much more data can be processed and analyzed, opening the door to capabilities that haven't been as possible yet in the nuclear sector, such as predictive analytics, machine learning and artificial intelligence.
Digital technology also allows reactor facilities to identify performance interruptions which may occur before the scheduled maintenance time, making them safer and extending their lifetime. If parts needed to be replaced, digital ones are far less expensive and more commercially available than analog parts.



(Purdue University image/Vincent Walter)

While university reactors like Purdue's aren't used for powering energy grids like industry reactors, they provide a platform for research. Examples that might surprise you include understanding how heavy metals affect mental health, identifying the origins of a 1,000-year-old artifact or eventually predicting how well pilots will fly new planes.

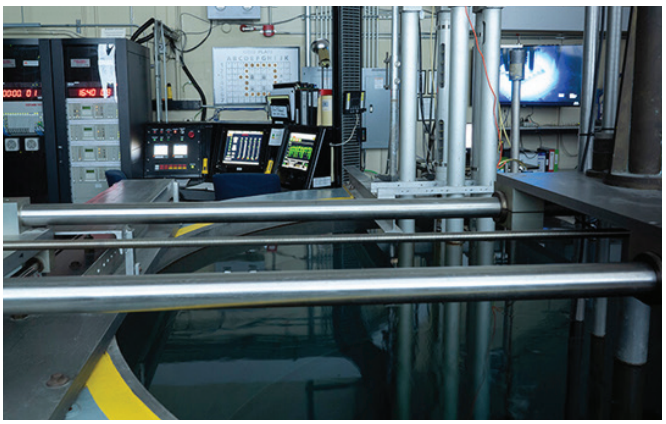
The digital conversion of PUR-1 began in 2012, when the U.S. Department of Energy awarded Purdue a grant through its Nuclear Energy University Program to replace the reactor equipment with a state-of-the-art instrumentation and control system. Purdue developed and built the fully digital system in collaboration with Mirion Technologies and the Curtiss-Wright Corp.

"The reactor's use in recent years had shifted from fundamental reactor physics research to serving primarily as an educational support facility," said Seungjin Kim, the Capt. James F. McCarthy Jr. and Cheryl E. McCarthy Head of the School of Nuclear Engineering at Purdue.

"Now, we can return to that impactful research while also significantly expanding the reactor's teaching capabilities," he said.

PUR-1 now includes a 150-square-foot video wall, which enhances data display and engages prospective nuclear engineering students. A YouTube video is available at https://youtu.be/fDPqqGegOSE.

"The nuclear reactor with fully digitized instrumentation and control is a milestone for Purdue's School of Nuclear Engineering," said Mung Chiang, the John A. Edwardson Dean of Purdue's College of Engineering. "The research and teaching enabled by the new PUR-1 will also contribute to the next chapter of nuclear energy, safety and security in the country."



(Purdue University image/Vincent Walter)

U.S. NRC licensing of the PUR-1 system is unprecedented in other ways, as well: Some of the parts are certified under the German Nuclear Safety Standards Commission (KTA), rather than under domestic standards.

Historically, the U.S. NRC has accepted only parts certified under domestic standards, which are generally cost-prohibitive for use. The U.S. NRC accepted these parts in PUR-1 through the agency's initiative for a risk-informed and performance-based regulatory process.

"The fact that the NRC is accepting a digital console for a small research reactor, with parts certified under the KTA standards, signals the regulatory body moving toward approval in a large industry reactor," Townsend said.

A digital university reactor offers several benefits both to industry players and educational settings. As a cyberphysical test bed, collaborators and corporate partners will be able to evaluate "Testing

code and simulations in smaller university facilities allows more flexibility, ease of access and quicker development cycles than would be available at larger industrial partners," said Robert Bean, the PUR-1 facility director and an assistant professor of nuclear engineering at Purdue. "At low cost, researchers will be able to quickly evaluate their work and achieve full-scale deployment."

Digital technology also means that Purdue can utilize the reactor to send live data to remote locations, helping researchers to match reactor status in real time to their experimental results, and students to visualize from their monitors how a reactor responds.

"We can send signals to areas, such as schools in developing countries, that do not have the luxury of their own nuclear reactor facility and the associated educational infrastructure. As long as they have internet and this partnership with Purdue, they can see and study how the reactor works," Kim said.
A ribbon-cutting ceremony for the newly licensed PUR-1 will kick off a three-day summit, "Atoms for Humanity," on Sept. 3 at Purdue University.

The milestone aligns with Purdue's Giant Leaps celebration, acknowledging the university's global advancements made in health, space, artificial intelligence and sustainability as part of Purdue's 150th anniversary. These are the four themes of the yearlong celebration's Ideas Festival, designed to showcase Purdue as an intellectual center solving real-world issues.

Congrats to our HFICD Student Conference Paper Winners!

Paper 1: Control Rod System for USMA Subcritical Assembly: CROSSA-01

Written by: Reniel Banayag dela Cruz, Mitchell T. Brown, Samantha N. Polen, Megan R. Kinsey, Kenneth S. Allen, (United States Military Academy)

Paper 2: Development of In-Water Transient Boiling Detector

Written by: Ezekiel Thomas Villarreal, Heng Ban (University of Pittsburgh), Austin D. Fleming, Eric D. Larsen, Colby B. Jensen (Idaho National Laboratory)

'Operational Intelligence to Support through life management of Nuclear Plants', by Dr. Graeme West, continued from page 8

These have been applied to a variety of plant items including core structural components, rotating machinery and electrical plant and cables. It has been estimated that adopting some of the techniques developed for just one asset for only one of the industrial partners is estimated to be worth £300k per year in reduced overhaul costs; £500k in reduced costs for each equipment trip that can be avoided; and £72k per year in reduced data analysis costs.

ANS HFICD

HFICD Governance

http://hficd.ans.org

2020-2021 HFICD OFFICERS

Mehdi Tadjalli
CHAIR
Chief Engineer and Director
Enercon Federal Services, Inc.

Carol S. Smidts
1st VICE CHAIR
Professor
The Ohio State University

Daniel G. Cole
2nd VICE CHAIR
Associate Professor
University of Pittsburgh

Hyun Gook Kang
SECRETARY
Associate Professor
Rensselaer Polytechnic Institute

Ronald L. Boring
TREASURER
Distinguished Scientist
Idaho National Laboratory

EXECUTIVE COMMITTEE (NEW MEMBERS)

Nesrin Cetiner
R&D Staff
Oak Ridge National Lab

Adam Deatherage
Applicatons Engineer
AMS Corporation

Ronald King
Sr. Program Manager
Nuclear Instrumentation and Control, EPRI

Graeme West
Senior Lecturer
Department of Electronic and Electrical Engineering
University of Strathclyde

PAST HFICD CHAIRS

Brent D. Shumaker
2019–2020
Senior Engineering Manager
AMS Corporation

Raymond L. Herb
2018–2019
Digital Principal, Fleet Design I&C
Southern Nuleear Opearting Company

Sacit Cetiner
2017–2018
Group Leader - Instrumentation, Controls, and Data Science
Oak Ridge National Lab

HFICD Executive Committee

Term Ending in 2021
Ronald Boring
Eric Harvey
Hyun Gook Kang
Pradeep Ramuhalli

Term Ending in 2022
Brenden J. Heidrich
Craig Primer
Jamie Baalis Coble
Padhraic Mulligan

Term Ending in 2023
Nesrin Cetiner
Adam Deatherage
Ronald King
Graeme West

Board Liaison
Peter B. Lyons

Ex Officio
Brent D. Shumaker

Upcoming ANS Meetings

ANS Virtual Winter Meeting
NOVEMBER 15-19, 2020

2021 Student Conference
April 8-10, 2021
Raleigh, NC
Raleigh Marriott City Center

2021 ANS Annual Meeting and NPIC HMIT 2021
June 13-17, 2021
Providence, Rhode Island
Omni Convention Center

2021 Utility Working Conference and Vendor Technology Expo
August 8-11, 2021
Marco Island, FL
JW Marriott Marco Island